Ministerie van Verkeer en Waterstaat

stuvwxyz

Programmadirectie Ontwikkeling Nationale Luchthaven

Falls of migrant birds

An analysis of current knowledge

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Inhoudsopgave

'Up to 75,000 Redwings with the same number of Fieldfare (150,000 thrushes in total) were seen circling anticlockwise around the Buchan A platform in the central North Sea in the morning of 25 October 1991 (57°54'N, 00°01'E).'
Anonymous , 1992

'Axell and Pearson, in a very detailed account of events in the country, have estimated that more than half a million birds descended along the 24 miles of coast between Sizewell and Hopton (Suffolk) on 3rd September 1965.'
Davis , 1966

Preface and acknowledgements

Birds and flight safety is an important topic in planning a possible airport island in the North Sea. This even has been ranked as a go / no go factor in the forthcoming decision making process. For this reason, birds and flight safety has been defined as a distinct topic for research within the ONL framework. Several workshops have been convened in order to produce a comprehensive research programme (Branderhorst in prep.), describing both short-term (1999) and long-term (2000-2004) projects.

In order to be able to evaluate bird risks properly, the research programme must focus on bird species and behaviour that cause the main risks. Therefore, one of the starting points in the research programme ‘Birds and flight safety’ is defining the risk of falls, the circumstances for falls and the species involved. This project was done in commission of the Ministry of Transport, Public Works and Water management, Directorate North Sea by Bureau Waardenburg bv, CSR Consultancy (CSR) and the Institute for Forestry and Nature Research (IBN-DLO). For this project Bureau Waardenburg bv was the leading partner.

For Bureau Waardenburg R. Lensink (literature survey, LWVT database, Radar information, editor) and S. Dirksen (project management, editor) were involved in this project, for CSR Consultancy C.J. Camphuysen (literature survey, NZG/NSO, NZG/CvZ, SASBASE), and for the Institute for Forestry and Nature Research M.F. Leopold (Helgoland), H. Schekkerman (Constant Effort Sites) and D.A. Jonkers (Light Vessels).

On behalf of the commissioner this project was guided and supported by H. Branderhorst and H. Schobben.

Information from the LWVT database was made available by Hans van Gasteren, from the CvZ database by Ico Hoogendoorn, from the database on Light Vessels by Tineke Prins (ISP-Amsterdam). Information from the Constant Effort Site on Helgoland was obtained from Volker Dierschcke and dr. O. Hüppop. Data from ringed birds from the Dutch North Sea coast were collected by the ringing group 'Vinkenbaan Castricum' and made available by Arnold Wijker. L.S. Buurma (Royal Netherlands Air Force) answered questions on radar use and data from radar observations in the past.

Summary

Birds and flight safety is an important topic in the current discussion about a possible airport island in the Dutch North Sea. For this reason, birds and flight safety has been defined as a distinct topic for research within the ONL framework. ONL (Development of the National Aviation) has been established to co-ordinate discussion and research for future aviation in the Netherlands. In order to estimate the risk of such an airport, research is focused in risk species and risk behaviour. One of the risky behavioural aspects are falls.

A fall is defined as a sudden arrival of an exceptional high number of migrants at a certain location. Falls may occur when migration is interrupted by the rapid onset of adverse weather, such as gales or fog. This study presents information on the risk of a fall, the species involved and the circumstances for a fall. Only existing data sets are consulted or explored.

The following databases are consulted to look for facts or patterns that could be linked to falls. It is emphasised that none of the programs behind these databases have been developed to investigate falls.

NZG/NSO	beached birds	1965-1999
NZG/platforms	sea watching	1978-1986
NZG/offshore	sea watching	1987-1999
Light vessels	dead birds	1958-1971
CES-site Castricum	trapped birds	1989-1998
CES-site Helgoland	trapped birds	1989-1998
LWVT	visible bird migration	1982-1993

Furthermore, literature has been scanned on documented falls, and on the relation between weather, birds (migration) and falls. Trapping figures from constant effort sites along the English East coast were available, but not accessible within the time schedule of this project. Finally information on Dutch radar work has been reviewed in order to judge the possibilities for future fall research.

Strong bird migration mostly coincide with favourable weather (good visibility, clear sky, no precipitation, tail wind) whereas migration is minimal under adverse weather (poor visibility, clouds, precipitation, head wind). In autumn the strongest migration could be expected after the passage of a front and along the east and south side of a high. Falls around the southern North Sea seems to coincide with favourable migration weather in the area of origin (Scandinavia) and non-favourable weather above the central (no land within reach) or southern areas of the North Sea (land within reach). So, falls could happen in areas with bad weather (in the frontal passage) or good weather (behind the frontal passage). In falls a variable number of birds is in poor condition, and for that reason the length of stay after the event varies too.

From the databases consulted consistent patterns arise. High numbers of dead bodies found on the beach or on light vessels and strong passerine migration across the North Sea as observed from platforms and ships, are exclusively registrated in spring and autumn. In this period huge numbers of birds migrate from their wintering area to their breeding grounds vice versa. Falls seem to be restricted to the main annual migration periods, i.c. March-May and August-November. Trapping figures from constant effort sites along the Dutch coast confirm this, although good catches might be the result of just strong migration under favourable weather conditions.

Thrushes, starlings, finches and warblers are the most observed species in the database. In each database, one or more of these families dominate the picture. In the beached bird survey and observations from platforms and ships, the larger species are more numerous.

On light vessels and constant effort sites smaller species are regular found as well. Nevertheless, the spectrum of species in falls seems to be consistent. Moreover, the spectrum is similar with the known species composition and numerousness of species migrating across the North Sea. Warblers (long distance migrants) dominate the scene in April/May and August/September and the other species (all short distance migrants) in March and October/November.

In the literature some falls have been documented. Three of them have been found in the databases consulted, autumn 1978, 1982, 1988. Most likely these falls were large scale phenomena, which have occurred around the whole southern North Sea. They coincide with favourable weather over southern Scandinavia and a frontal passage from the south-west over the southern North Sea. Even in small scale falls huge numbers of birds could be involved, as shown by a well documented case along the east coast of England and published observations from platforms. From the databases consulted these small scale events did not show up, because they only could be observed if observers were on the right spot on the right time. In conclusion, falls seem to happen a few times every year. In most cases scale and size seem to be limited, but almost every year there is a chance on a big fall, either in size and/or in scale. Based on the observed numbers around platforms and data from the literature, a small scale fall probably involves more than 10.000 birds and a large scale fall more than 100.000 birds.

Data from inland broad front migration are used to show how different intensities could lead to different fall sizes on the island. Size and composition of this migration should be comparable with broad front migration across the North Sea. Each autumn at least 14 days migration intensities of >25,000 birds passing over an island of 10x10 km could be expected and some days of 135,000 birds or more. Under specific weather circumstances, such intensities could easily lead to two or three times these numbers of birds migrating towards an offshore airport. island. These can get grounded and result in a small or big fall respectively.

In a dark environment illuminated objects could attract large numbers of birds, as shown by documented observations from lighthouses, light vessels and platforms. Especially in the case of low clouds, poor visibility and/or precipitation, this could lead to large scale movements of birds around the illuminated object. These movements can cause large numbers of victims, due to disorientation followed by exhaustion. On the other hand, these lights could show the way to a save place, especially under adverse weather conditions. The risk of light attracting birds is bigger during dark nights around new moon.

In the near future more research is needed on the scale and frequency of falls, in relation to large scale and small scale (local) weather. Research could partly be based on existing datasets. Besides, there is a need for new field research, in which radar and field observers collect data on birds as well as weather. The research should lead towards a model for predicting the chance on a fall in relation to the weather (forecast). This could be a valuable tool in a bird warning system on the new airport. Light is a complicating factor in falls because it attracts birds towards the island, and thus enlarges the size of a fall. On this aspect future research is needed too.

1 Introduction

Birds and flight safety is an important topic in the current discussion about a possible airport island in the Dutch North Sea. This even has been ranked as a go / no go factor in the forthcoming decision making process. For this reason, birds and flight safety has been defined as a distinct topic for research within the ONL framework. ONL (Development of the National Aviation) has been established to co-ordinate discussion and research for future aviation in the Netherlands. Several workshops have been convened in order to produce a comprehensive research programme (Branderhorst in prep.), describing both short-term (1999) and long-term (2000-2004) projects.

Large numbers of land birds, especially songbirds, are migrating over the North Sea, from their breeding areas to their wintering ground and vice versa. Birds are quite capable to cross this barrier under normal conditions. When they meet adverse weather en route the migration flight takes more time (and energy) and the risk of getting exhausted increases. If they do not manage to reach land in time, they will drown at sea. If these birds reach land they could come down en masse. These events with (unusually) high numbers of birds in a relative small area are called falls.

Under adverse weather conditions migrating birds concentrate in the lower air layers. In these layers birds are a potential risk for aircraft, especially during take off and landing (Blokpoel 1978). After coming down, for instance on an island, they will rest there for some time (days), and could cause more problems with aircraft, due to local bird movements. If a new island will by built in the North Sea, at 10-20 km distance from the coast, birds will concentrate on this island. In case of incoming adverse weather during high migration intensities, this island may attract birds in huge numbers. Such falls might cause a potential risk for aircraft.

In order to be able to evaluate bird risks properly, the research programme must focus on bird species and behaviour that cause the main risks. Therefore, one of the starting points in the research programme 'Birds and flight safety' is defining the risk of falls, the circumstances for falls and the species involved. Rijkswaterstaat, Directorate North Sea, has commissioned Bureau Waardenburg, Camphuysen Seabird Research and the Institute for Forestry and Nature Research with this project. The project has three parts: a literature survey on current knowledge about falls, an analysis of different databases on patterns related to falls and a description of the timing and amount of the most numerous species involved. The three parts together should serve as a basis for research priorities for 2000-2004.

2 Background information

2.1 Falls, a definition

A fall is defined as a sudden arrival of an exceptional high number of migrants at a certain location. Falls may occur when migration is interrupted by the rapid onset of adverse weather, such as gales or fog (Campbell & Lack 1987). In falls, a variable part of the birds involved are in poor condition, as a result of which their stay may vary from a day to more then a week, normally spent foraging.

In this definition four elements are important
- exceptional (large) number of birds;
- areas in which falls occur;
- environmental conditions;
- condition of the birds in relation to length of stay after a fall.

In this study 'a large number of birds' is used in the meaning of a large number compared to 'normal conditions'. It is assumed that these numbers also are large with respect to aircraft flight safety (risk of collisions).

A wreck is a to falls related phenomenon. It is defined as mass mortality on sea, in this case due to a fall of birds, which were too exhausted to fly anymore and thus did not reach land.

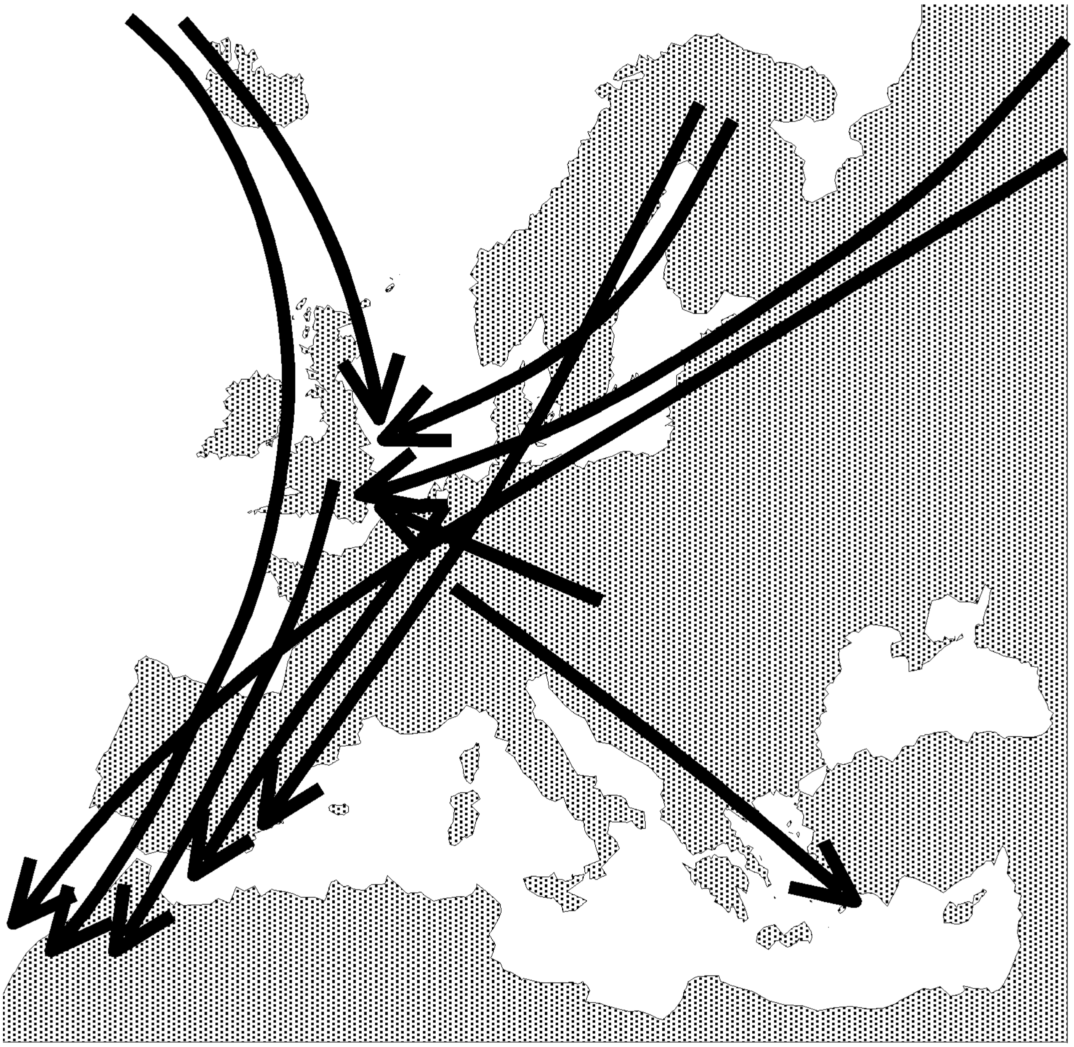
2.2 Origin of birds migrating over the North Sea

The North Sea forms a barrier for land birds migrating from the continent to Great Britain or vice versa. Migrants wintering in the U.K. mainly originate from Scandinavia and Northeast-Europe. Birds originating from (western) Scandinavia and wintering in Southwest-Europe or Africa may cross the North Sea as well. The last group of North Sea migrants consists of birds breeding in the UK, Iceland or Greenland and wintering in south(west)-Europe or Africa (Figure 2.1) (Lack 1963b, Lensink & van der Winden 1997).

In summer the main flight direction of birds above the North Sea is SW-W (Lack 1962). In late summer, when summer visitors leave for South Europe and Africa, the main direction is S-SE. In autumn the main direction over the North Sea of migrants is W-SSW, with a substantial amount of birds flying S-SE. In autumn the latter probably fly according to the two-directional hypothesis formulated by Buurma (1987): birds leaving Scandinavia either start flying (N)W but change direction after several hours towards S-SE, or start flying S(E), several hours later followed by a track towards W.

Figure 2.1

The most important migration routes of birds crossing the North Sea (after Lensink & van der Winden 1997).



3 Methods and databases

In this chapter all databases used are presented. Fieldwork for these databases was originally organised to unravel certain aspects of bird life in and around the North Sea. They all cover a different aspect of the occurrence on, above or around the North Sea. Non of them was designed to study falls. Databases were analysed to identify patterns (probably) related to falls.

3.1 NZG / NSO Beached Bird Surveys

Beached bird surveys are designed to record bird strandings along the coast (Camphuysen 1989, 1995). The prime aim is to monitor the occurrence of oiled (water-) birds, but all species of birds and mammals are recorded. As a result, (mass) strandings of passerines and other landbirds along the coast have been systematically recorded and can be used as an indication of the occurrence of falls offshore. In this study, peaks in strandings are used as indication of the occurrence of a fall of our coast since 1964. Species composition and the scale of the events are described and compared with other sources of data. There are two important shortcomings of the dataset: effort is heavily biased to the winter period (November-April), whereas many falls occur in autumn (particularly September-November) (Figure 3.1). A second shortcoming is that smaller passerines are less likely to end up on beaches, because predators at sea consume the entire bird rather than only its fleshy parts (Camphuysen 1988).

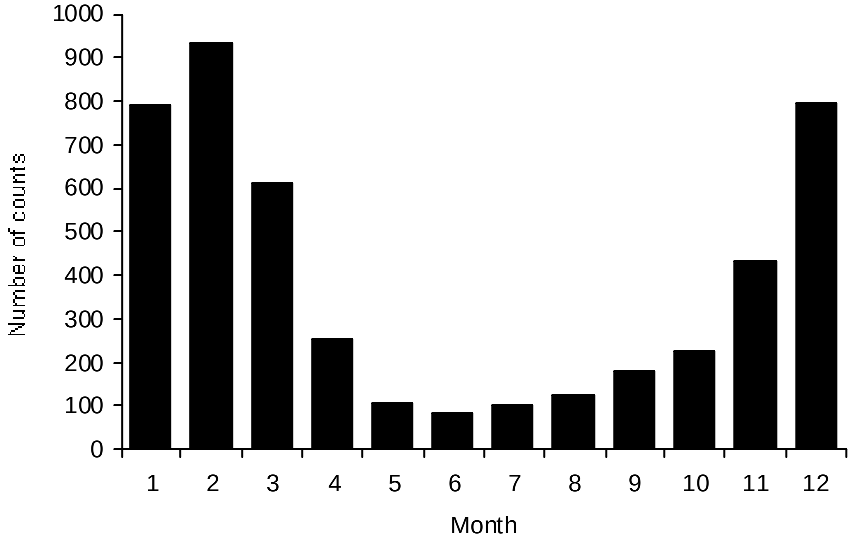
3.2 NZG / CvZ platform based observations

In the late 1970s and early 1980s, observers of the Dutch Seabird Group visited a number of offshore installations as an expansion of their normal sea watching activities. Between 1978 and 1982, Meetpost Noordwijk was irregularly manned both during the spring and autumn migration periods (Camphuysen 1979; Camphuysen et al. 1982; Den Ouden & Camphuysen 1983; Den Ouden & Van der Ham 1988; Appendix KC2). Low-flying passerines (or calling birds) and other land birds were recorded just as seabirds (Van der Ham 1988). The methods of sea watching deployed on this installation (constantly looking through binoculars or telescopes fixed on tripods) is certainly not an optimal method for the registration of non-seabirds, particularly passerines. However, the presence of large numbers of low-flying landbirds or the presence of substantial numbers on the installation itself, both possibly indicative for the occurrence of a fall or wreck, was certainly not missed by the observers. Hence, a qualitative description of the occurrence (or rather the absence) of large numbers of passerines in the lower layers of the atmosphere can be provided.

In winter 1984/85, four expeditions were sent to gas production platforms K7-FA-1 (53°34'N, 03°18'E) and K8-FA-1 (53°30'N, 3°22'E) some 120 km WNW of Den Helder. Again, seabirds were the main targets of observation, but passerines and other landbirds were also recorded (Platteeuw et al. 1985). With a total of 15 days of observation in December 1984 (K7) and another 14 days in January 1995 (K8), this is a rather small dataset. The extensive notes on (local) weather and the presence of passerines around the installations make it a useful set, though.

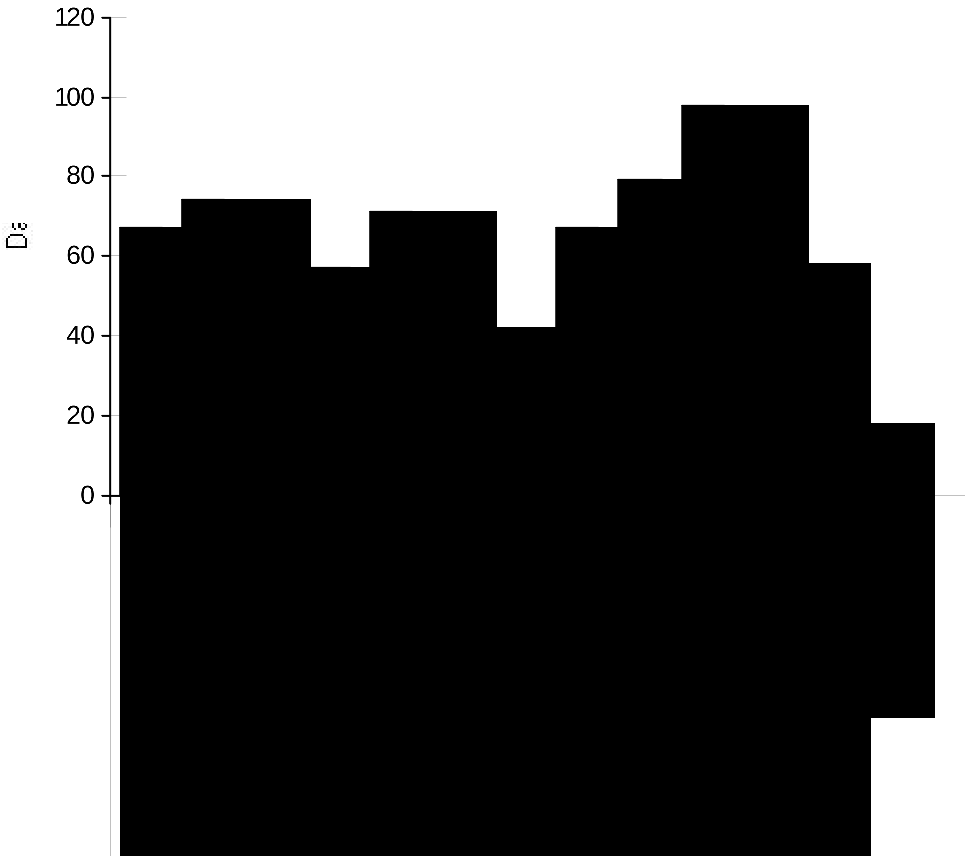
Figure 3.1

Observer effort: beached bird surveys in The Netherlands (North Sea coast only). Monthly number of beach visits (1965-98), illustrating the bias in observer effort towards the winter period. Mass strandings of passerines were easily missed in summer and (early) autumn. See also Appendix KC1.



In contrast to beached bird survey results, the exact date of the event is known from these data. However, in the absence of observers, an event will be missed, while stranded corpses will remain on a tideline for several weeks, so that a fall can be recorded with hindsight from beached bird survey results.

Figure 3.2
Observer effort: number of days at sea in the Dutch sector (1987-99). See also Appendix KC3.



and to one side of the ship (Camphuysen & Leopold 1994). Flying birds, and particularly flying non-seabirds, are no high priority, although all birds that are seen are recorded. From these data, as from counts from the fixed platform Meetpost Noordwijk mentioned earlier, a qualitative description of the occurrence (or the absence) of large numbers of passerines in the lower layers of the atmosphere can be provided. Again, and in contrast to beached bird survey results, the exact date of the event is known from these data. However, in the absence of observers, an event will be missed. The observer effort is summarised in Figure 3.2.

3.4 Constant effort sites Dutch coast

Along the Dutch North Sea coast there are several sites where more or less standardised ringing is being carried out. From North to South these sites are: Schiermonnikoog, Vlieland, Texel, Castricum, Bloemendaal, Zandvoort, Den Haag and Schouwen. Nocturnal migrants are trapped mainly in mist nets at most sites, while clap nets are used on the so-called "vinkenbanen" on the mainland coast, mainly to catch diurnal migrants. Seasonal coverage, trapping effort, level of standardisation, and numbers of birds caught all differ between sites, with most sites operating only during the autumn migration period. Data could be made available for several of these sites, but given the short period of this study, only readily available data from Castricum have been analysed.

Analysis of Castricum trapping data
One of the coastal ringing sites where catching effort has been most intense and most constant over a long stretch of years is the vinkenbaan at Castricum, 8 km N of the IJmuiden harbour. This site is close to the search area for a North Sea airport island. The vinkenbaan is situated on the transition between the open and the forested part of the coastal dunes, about 900 m from the sea. Mist nets are placed among reeds, sea-buckthorn, low poplars and oak trees up to 6-8 m high.

Standardised ringing with the use of mist nets started in 1977. Since then it has been continuous, but data from eight years have not yet been computerised (to be remedied autumn/winter 1999). For this analysis therefore, data from 14 years between 1980-1998, plus 1999 up to 1 September, were available. During the main autumn migration period (August-October) the vinkenbaan has been in operation on c. 80% of all days (Figure 3.x), with most of the missing days being due to bad weather with little or no bird movement (strong SW or NW winds or heavy rain). Coverage was also substantial in July and November (c. 50%). During autumn, 200-230 m of mist nets are opened daily, spread over an area of c. 10 ha. From late December to February, the station is operated mainly during spells of frost and snow when "cold rushes" may occur (12% of all days). During spring migration, the vinkenbaan has been in operation on c. 40% of all days, but the number of mist nets opened was less than during autumn (usually 50-100 m). Coverage has been below 10% only in June; however the probability of migrant falls occurring in this month is negligible.

Diurnal migrants (pipits, larks, starlings, waders) are also trapped at the vinkenbaan, using clap nets, but this type of trapping is insufficiently standardised to yield useful information for the current project. Therefore, data were analysed only for a selection of 24 species trapped in the mist nets (Table 3.1). Almost all these species are nocturnal migrants and either insectivorous or frugivorous passerines. The list includes all the species which are nocturnal migrants and which can be expected to be involved in numbers in migrant landbird falls in the North Sea area (with a notable exception of the finches, which are mainly caught in clap nets, like the main diurnal migrants). Total numbers of birds trapped per day were calculated for all species involved in the present analyses, and for three size classes separately (tiny, 5-10 g body mass; small, 10-20 g; and medium-sized, 50-100 g).

Table 3.1

List of species for which trapping data from Dutch coastal ringing sites are used. The size class to which each species belongs is also given: 1 5-10 g body mass; 2 10-20 g; 3 50-100 g.

Scientific name	English name	Dutch name	size
Troglodytes troglodytes	Wren	Winterkoning	1
Phylloscopus collybita	Chiffchaff	Tjiftjaf	1
P. trochilus	Willow Warbler	Fitis	1
Regulus regulus	Goldcrest	Goudhaantje	1
Prunella modularis	Dunnock	Heggemus	2
Erithacus rubecula	Robin	Roodborst	2
Luscinia megarhynchos	Nightingale	Nachtegaal	2
Phoenicurus phoenicurus	Redstart	Gekraagde Roodstaart	2
Locustella naevia	Grasshopper Warbler	Sprinkhaanzanger	2
Acrocephalus schoenobaenus	Sedge Warbler	Rietzanger	2
A. scirpaceus	Reed Warbler	Kleine Karekiet	2
Sylvia curruca	Lesser Whitethroat	Braamsluiper	2
S. communis	Common Whitethroat	Grasmus	2
S. borin	Garden Warbler	Tuinfluiter	2
S. atricapilla	Blackcap	Zwartkop	2
Muscicapa striata	Spotted Flycatcher	Grauwe Vliegenvanger	2
Ficedula hypoleuca	Pied Flycatcher	Bonte Vliegenvanger	2
Parus ater	Coal Tit	Zwarte Mees	2
Parus caeruleus	Blue Tit	Pimpelmees	2
Parus major	Great Tit	Koolmees	2
Turdus merula	Blackbird	Merel	3
T. pilaris	Fieldfare	Kramsvogel	3
T. philomelos	Song Thrush	Zanglijster	3
T. iliacus	Redwing	Koperwiek	3

The frequency at which 'exceptionally large arrivals' or 'falls' of nocturnal migrants occur, depends on their definition, which is partly arbitrary. To quantify this frequency for Castricum, the mean number of birds trapped per day in the peak month (September/October) was used as a baseline, and the number of days on which multiples of this baseline number were caught was calculated. In doing this, one large source of bias had to be accounted for. In 1987-1988, the use of nocturnal song broadcasts was introduced, which caused a marked increase in the catches of some migrants (notably Blackcap, Garden Warbler, Robin and Reed Warbler; Figure. 5.7). To correct for this effect, different baseline values were used for the years 1980-1986 (33) and the period 1989-1999 (65), based on the fact that numbers ringed per day in half-months between July and November were on average twice as high after 1988.

3.5 Constant effort sites United Kingdom

Along the British North Sea coast, several so-called "bird observatories" are situated. At these sites, bird abundance is recorded on a daily basis in a more or less standardised way, from counts or daily observation logs. At several sites, ringing of passerines is also undertaken, usually with mist nets. Several observatories have one or two professional staff; coverage varies but is usually during migration periods only.

A questionnaire was sent to all bird observatories situated on the Southern North Sea coast (from N to S): Isle of May, Spurn Head, Gibraltar Point, Landguard Point, and Dungeness. The aim of this questionnaire was to learn what type and quantity of data are collected and in what form, and if these could be made available for a more elaborate study of migrant falls in relation to a North Sea island. Answers were received from all observatories except Dungeness (near the British Channel, in Kent).

All bird observatories were willing to make their data available for this study at a small cost. However, the vast majority of data is at present only available on paper. Entering the data into a computer will take time that was unavailable in the present exploratory project. In a future phase however, analysis of the data from especially Landguard point and Spurn Head seems worthwhile. Though the Isle of May is much further away from the search area, it is of interest because the observatory is situated on an island.

Isle of May Bird Observatory
This northernmost observatory is hardly in the southern North Sea, being situated on an island in the Firth of Forth, east of Edinburgh. Field observations have been carried out on a daily basis from March through November, essentially covering the period from 1949 to present. The recording format has been standard over all years, with numbers of individuals noted. The most recent 10 years of data are available on computer disk; the paper archives could be made available for inspection.

Spurn Bird Observatory
At Spurn Head, at the mouth of the Humber River near Hull, birds have been counted on an almost daily basis since 1946, with almost full coverage during migration periods from 1964 onwards. However, counts were not standardised and observer coverage varies greatly. Ringing activity has similarly varied greatly and none of the data have been computerised. Copies of the daily logs could be made available for this study.

Gibraltar Point Bird Observatory
This bird observatory is situated in a dune reserve on the Lincolnshire coast near Skegness. Field observations and ringing have been carried out since 1949, but have not been standardised and have relied mostly on casual observations by reserve visitors etc. Ringing effort has diminished considerably over the last ten years. All records prior to 1999 are stored in the form of daily logs on paper.

Landguard Bird Observatory
This observatory, situated at Landguard Point on the coast near Felixtowe (Suffolk), is the closest to the Dutch part of the North Sea. Since 1983, field observations and daily ringing have been carried out in the migration periods. Nearly all species are recorded in a more or less standardised way. Data are available at present only in the form of daily log sheets and monthly spreadsheets on paper.

Of interest is a detailed ringing project carried out at Fagbury Cliff (3 km inland) for several years. This project was curtailed when the Port of Felixtowe changed its lighting to lower intensity bulbs which resulted in ringing totals plummeting. This data is also not computerised but is of interest due to the effects of lighting.

3.6 Constant effort sites Helgoland

At the island of Helgoland, situated in the German Bight of the North Sea at 54º11´N, 7º53´E, at some 45 km offshore from the Wadden Sea, birds are trapped (almost) daily in a so-called Helgoland trap. Birds have been trapped and banded at Helgoland for many decades, but for this project only the data for the last 10 years (1989-98) have been analysed. The data have been analysed, with respect to two questions:

1. How often were numbers of birds caught that were exceptional?
2. What were the bird species involved?

3.7 Observations on light vessels

Birds that find themselves at sea during adverse conditions will, as a last resort to avoid drowning, try to land on any object available. Such objects need to be found first. Well-illuminated structures, such as ships, offshore platforms, but particularly light vessels, are the most obvious candidates. In the days before Global Positioning Systems, key locations for navigation at sea such as the beginning or junctions of shipping lanes or clusters of obstacles such as shallow banks, were marked by light vessels. Offshore weather data were also collected from these lightships. In the south-eastern North Sea, several light vessels were operated from the 1940's. With increasing technology, the lightships first became fully automated (without a crew on board) and were then replaced by automated buoys. Light vessel Noord Hinder was the last at sea; it was automated in 1981 and replaced by a buoy in 1994. The lightships were equipped with a rotating lamp of 2000 Watt, comparable with lighthouses on the Dutch coasts.

Crews of four of these light vessels shipped birds that were found dead on board out to the Zoological Museum of Amsterdam (ITZ) in the years 1958-1971 (one until 1966, Table 3.2). At the museum, date of arrival of parcels of birds, its contents, name of light vessel, and if known, the date at which the birds were found dead was noted. For this first analysis, we extracted information on species sent in by vessel and by month. The unit of recording is the number of parcels, not the number of birds. An overview of the numbers of parcels sent in by ship and by year is given in appendix MF1.

Table 3.2
Light vessels, distance offshore and periods when parcels were sent in.

name of light vessel	distance offshore (km)	period
Terschellingerbank	??	1958 – 1961
Texel	37	1958 – 1969
Noord Hinder	96	1958 – 1971
Goeree	33	1958 – 1966

3.8 LWVT database on visible migration

Between 1976 and 1993 an extensive network of observation sites for visible bird migration has been operational in the Netherlands. Migration was counted in a standardised way and all species were included. Results are published in a series of reports. A comprehensive overview of all results is forthcoming (LWVT/SOVON in press). The database of the LWVT (National Working Group on Bird Migration) is based on observation of visible bird migration, during daylight hours. Observation sites were spread over the country. Observations of the LWVT only have an indirect link to falls. Firstly, they concern only diurnal migration, and only in the lower air layers. Secondly, because actively migrating birds are recorded instead of grounded birds, links can only be made indirectly.

Along the Dutch coast diurnal migration is influenced by the nearby sea. The numbers here are (much) higher than on sites more inland because a part of the migrants hesitates to cross the sea or follows the coast line after coming in from the sea (Tinbergen 1956, Buurma 1987). Furthermore daily numbers in leading line migration vary much more than in broad front migration (Gatter 1978). For this reason the numbers observed on sites along the coast will not be representative for migration across the North Sea some tens of kilometres out of the coast, although the species composition might be about the same. Above the presumed airport location, there will be broad front migration. Therefore, some data are presented from two coastal sites (Haarlem, The Hague) and from an inland site, i.c. Arnhem, 100 km from the coast. Here diurnal migration is broad front.

The observation site The Hague was manned between 1984 and 1990. Observations in spring began on 10 February and lasted till 10 June, whereas autumn migration was recorded between 11 June and 15 December. Observations were made almost daily and they covered the complete daylight period. During winter 1984/85 and 1986/87 there was a nearly complete coverage as well. Data from Haarlem cover the period 1982-1990. Most data concern the first 2.5 hours of the daylight period. In autumn (1 August - 1 December) there was a good (almost daily) coverage in 1984-1989 , and in spring (15 February- 30 May) in 1986-89.

Near Arnhem the observation site is manned almost daily, from the beginning of August till the beginning of December (see Lensink 1996 for details). The registration of visible diurnal migration started in 1981 and still continues. Counts start half an hour before sunrise and last 2.5 hours. Of the 2268 mornings up to now, 1864 have been covered (82.2%). In 1983, 1993 and 1997 the observations already started at the end of June (coverage 81.7%).

To give insight in the probability of strong diurnal broad front migration the daily average (450 birds) was defined as the baseline. Next, the frequency of days with >2x, >5x and >10x the baseline number is calculated.

3.9 Radar observations by the Royal Netherlands Air Force

Within this study, it was not possible to perform analyses on data from radar observations by the Royal Netherlands Air Force to trace falls or related patterns. However, from some papers, based on their radar work (Buurma 1989, 1992, 1995a, 1995b, 1997), a summary is made in order to judge the usability of radar for research on falls. Here, some remarks will be made about the detectability of bird migration by radar, i.c. the direction, altitude and intensity of migrants.

Since the fifties radars have been used to detect bird migration (e.g. Eastwood 1967). One of the advantages is the large range covered and the height reached. However, it is impossible to detect migrating bird in de lower airlayers, because of ground clutter and the curvature of the earth surface. A second shortcoming is the impossibility to detect species. However, with modern technology (tracking radar) it is possible to give echoes a species (group) name, based on wing beat frequency and other characteristics of the echo. Nevertheless, most radar studies and applications are dealing with the number of echoes as a measure for migration intensity, irrespective of species and flock size.

3.10 Literature survey

The literature survey on circumstances for falls is mainly based on information in review papers and summarising books. For instance, on the relation between weather factors and the timing and amount of migration, a wealth of references is available, at least a few hundred. They are summarised in Richardson 1978, 1990. Information on other casual factors was found in books and some specific references.

References which document falls around the North Sea are scarce, but all we could find are summarised.

Available information on the number of birds (non-seabirds) migrating across the North Sea is summarised in Lensink & van der Winden (1997). Parts of this information is used here. Information on the timing of migration is mainly based on LWVT (in press). This review is based on 67.000 hours of standardised observations on visible bird migration between 1976 and 1993.

Figure 4.1

General synoptic weather picture, in spring (top) and autumn (bottom) with a high and two lows and the accompanying frontal systems. Areas of heavy migration, rain and strong winds are indicated. (after Richardson 1978)

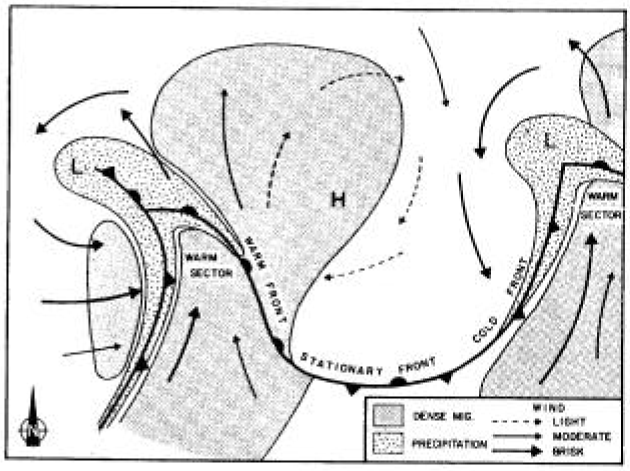


Fig. 1. Typical configurations of high (H) and low (L) pressure systems, fronts, precipitation and winds at north temperate latitudes. Stippling shows portions of pressure systems were northward migration tends to occur.

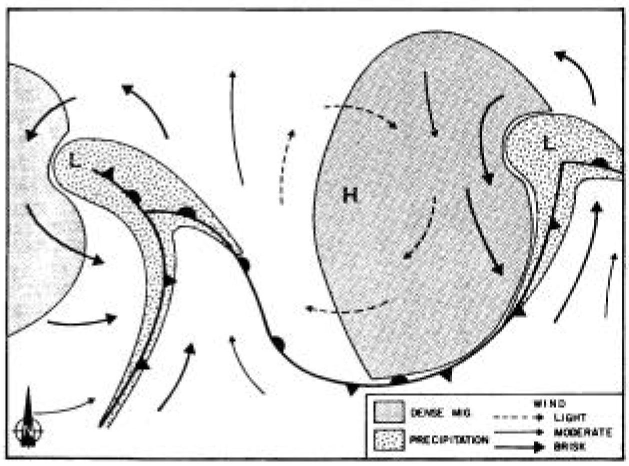


Fig. 3. Synoptic weather situations in which southward migration tends to occur (northern hemisphere).

4 Conditions leading to falls

4.1 Number of birds

The main characteristic of a fall is the (unusually) high number of birds in a certain area. High numbers of grounded birds are only possible when high numbers of migrant birds have been aloft.

In the literature quite a few examples of falls are given. In most cases the exceptionally high number of one or more species occurring in unusual numbers was the reason to write the paper or note. Along the British east coast at least one fall is known including tens of thousands of birds along a stretch of a few kilometres (Elkins 1984). Other examples are given by Alerstam (1990) concerning hundreds of birds landing on a ship off the coast of New Foundland during incoming adverse weather, and the two cases quoted on the title page.

4.2 Weather circumstances in relation to the number of migrants aloft

Two factors seem to be of main importance, wind and precipitation (Richardson 1978, 1990, Alerstam 1978). Nonetheless, all factors mentioned in Richardson (1978, 1990) will be briefly summarised.

Synoptic weather features

At least a few birds are aloft at most times, but peak numbers of birds migrate when the pressure gradient falls from the right to left side of the primary direction of the birds; such occasions lead to tail winds in the northern hemisphere (Figure 4.1). Many birds also migrate in the fair and relative calm conditions near the centres of high pressure areas. In autumn, birds that fly south-east often move in peak numbers immediately after cold front passages, about a day before those that fly south-west. In spring, birds flying NE-E often arrive behind cold fronts that are followed by SW-W winds. When birds catch up with a slowly moving front, they occasionally fly over or through it, despite the hazards of turbulence, precipitation and cloud (Richardson 1978, 1990).

Wind

Most birds seem to migrate in peak numbers with tail winds. During calm periods or with side or lightly opposing winds numbers are smaller. The smallest numbers migrate with strong opposing winds. Thus birds with different primary directions move in peak numbers in different wind conditions. This is consistent with known and suspected selection pressures. Actual ratios of numbers aloft and on the ground differ with wind conditions. Because wind affects conspicuousness (low or high flying) numbers aloft might by biased towards low numbers. However, some species seem more closely associated than others with tail winds. Also other considerations may override the preference for following winds (Richardson 1978, 1990). For instance, after a long period of severe weather, mass migration might even occur with head winds (Alerstam 1978).

Pressure, temperature and humidity

Spring migration tends to occur with falling pressure, high and/or rising temperature and high humidity; autumn migration with rising pressure, low and or falling temperature and low humidity. This is consistent with the data from synoptic weather (see before). In autumn, birds that fly SSW-WSW tend to migrate with high pressure and low temperature, those that fly SE-SSE with low pressure and average temperature. These differences require corroboration but are consistent with evidence that SE flights follow cold fronts more closely than do SW flights. There is suggestive evidence from both field and laboratory studies that migrants actually respond to temperature and pressure (Richardson 1978, 1990).

Stability and updrafts.
There is little information available about flight behaviour or number aloft in relation to atmospheric stability, inversions, turbulence or updrafts other than thermals. These phenomena are often highly localised or ephemeral, so local weather data as well as precise records of flight behaviour are needed (Richardson 1978, 1990).

Precipitation, cloud and visibility
Cloud and precipitation both suppress migration, but generally not completely. Migrants sometimes avoid entering fog, but with exception of soaring birds, which re rare at sea anyway, there is little evidence that total numbers aloft are reduced by fog alone. Fog rarely reaches up to the flight altitudes of nocturnal migrants.

4.3 Orientation in relation to weather circumstances

The main clues for orientation in migrant birds are the stars, the sun and the earth's magnetic field (Berthold 1991). Especially for night migrants the stars play an important role. One of the reasons that less birds migrate under cloudy conditions is the limited opportunity for orientation. During the day the same is true in relation the visibility of the sun.

Especially in fog or under clouds, with no visible clues, birds face the risk of getting disorientated. Under such circumstances birds above the North Sea could move in all directions (Lack 1963b). This coincides with a high risk of being attracted by lights from lighthouses, platforms, etc., due to disorientation, especially during new moon (Verheijen 1981). Nevertheless, most of the time during extensive fog, there is less migration, because birds do not start migration or fly above the fog.

4.4 Weather circumstances over the North Sea in relation to migrants

Spring
The big eastward departures in March and April from Britain towards the continent mainly take place with westerly winds and in warm weather, both factors being important (Lack 1964b). In April and May arrival and passage of birds wintering in South Europe and Africa mainly occur with southerly winds.

Summer
In summer the main (westward) movements over the southern North Sea are of Lapwing, followed by Black-headed Gull and Starling. These flights mainly occur during fair winds from N-E, and to a far lesser extent with head winds (Lack 1962). But, since radar cannot monitor movements in the lower air layers, migration with weak head winds might be stronger, especially in the lower layers (Lack 1964b, Richardson 1978, Buurma et al. 1986).

Autumn
Migration over the southern North Sea is far more dense with tail winds (NE) than with head winds (SW). Like in other seasons, heavy migration with cross and head winds can be strong when the wind is light (Lack 1964a). Migration is commoner under clear than under cloudy weather, and in anticyclonal than in disturbed (cyclonal) weather.

Winter

In winter, during adverse weather with snow and frost reaching Western Europe, mass movements birds towards S-W occur. Snowfall in Holland and Northern Germany is often linked to a frontal passage over the North Sea, with upper wind from SW-NW , whereas on the continent the lower level wind still blows from (N)E.

4.5 Weather circumstances over the North Sea in relation to falls

At the east coast of Britain, autumn falls generally occur when incoming birds meet rain, full overcast or a strong opposing wind, and not during tail winds or very light opposed winds (Lack 1964b). Big falls only occur when the weather circumstances in the area of origin have been favourable to take of for migration, i.c. tail winds or weak cross or head winds (Elkins 1984, Riddiford 1985).

During autumn, conditions for mass migration from North-Europe towards the British Isles occur with a high above Scandinavia. Along the south of the high (north)easterly winds trigger birds to start migration. When a low enters the North Sea from the (south)-west, the risk of falls is there. En route birds encounter (strong) head winds, clouds and rain. If migrating above the North Sea, they land en masse on the first island or coastal area they meet.

In spring falls of summer visitors are known from Britain's east coast. A review of falls of Willow Warblers is presented in Riddiford (1985). Big falls occur with favourable weather above northern France. Calm or light winds and clear conditions here are suitable for the initiation of large scale migration, whereas birds fly into frontal systems towards the British coast. Such weather coincides with a high above Central Europe and a low passing over Scotland. At the western edge of the high birds meet southerly winds over Western Europe, while crossing the Channel and Southern North Sea the meet (strong) westerly or even northerly winds along the south of the low.

4.6 The condition of migrants and the length of stop-over

Migrant birds prepare themselves for migration by storing fat. Among songbirds the mean amount fat content stored in relation to fat free body mass ranges from 14-40 %, whereas outside the migration season they carry 9-12% fat (e.g. Kaiser 1993). In order to cross large hostile areas like deserts, mountain ridges and seas, birds should be able to accumulate much fat, more than birds migrating over land, with plenty of suitable habitat within reach (Berthold 1996). Species migrating in longer hops, like long distance migrants, have on average higher fat contents than species migrating in shorter hops, like short distance migrants (Berthold 1996). It is also suggested that fat deposition rates of birds changes in the course of the season, probably depending on species specific routes (Berthold 1996).

Results from Falsterbo and Ottenby (Sweden) show that birds (Robins) migrating over land have on average a higher body mass and a lower fat content (Falsterbo) than birds having crossed the Baltic Sea (Ottenby) (Karlsson et al. 1988, Ehnbom et al. 1992) Åkesson et al. 1992,). Those figures suggest that migrating over land make short hops and do not accumulate large fat reserves, whereas birds having to cross large unhostile areas, make long hops and accumulate large fat reserves. This implicates that birds migrating in short hops only makes short stops and the other group longer stops, mainly because the fat accumulation rate in species seems to be limited. Another study in south Sweden have showed, that there could be competition on stopover sites among resting birds (Goldcrests, Hansson & Pettersson 1989). After large arrivals birds loose weight the first day, later on gaining mass again. It is supposed that the main reason for weight loss is competition for limited food resources. Moore & Young (1988) studied migrants at a stop-over site along the Gulf of Mexico and found lower mass gain rates under high competition and faster rates under low competition.

Based on the fat contents of birds (long and short distance migrants) caught in Central Europe, theoretical flight ranges are calculated (Kaiser 1993). They ranged from 84-216 km for small respectively larger passerines. Since most birds in Central Europe could migrate by short hops these distances are relatively small. Studies in Sweden, Britain and elsewhere in Europe have shown that birds migrating over large unhostile areas likes seas and deserts accumulate more fat (e.g. Bahrlein 1991, Ellegren & Fransson 1992, Philips 1994). These birds thus have a larger theoretical flight range, large enough to cross the unhostile area.

Based on retraps, stopover periods in central Europe are 4.8 days for long distance migrants and 6.2 days for all birds (Kaiser 1996). Birds with a low body mass and fat content at first capture, stayed longer than the average stopover period, whereas fat birds only stayed a few days. From this information it is estimated, that birds in fact stay some days longer than the calculated stopover period (Berthold 1996). So the figures mentioned about stopover periods are absolute minima. But, since birds in a fall were not predetermined to stay on the fall site, these figure may not be applied directly to birds involved in falls. Their length of stay will depend on their rate of exhaustion, ic. the distance travelled in relation to the fat content and the distance covered before, in and after the adverse weather.

Research on Thrushes on Helgoland shows that the condition of arriving migrant birds varies strongly (Raiss 1976). Birds arriving with a low body mass gained weight, during an average stay of about 4-6 days. Birds in good condition with sufficient body fat, stayed shorter, and even lost some weight during their stay on the island. The mortality rate of arriving migrants varied from year to year and from day to day. Birds arriving during adverse weather had a higher chance to die, as well as birds arriving with very low body masses (poor condition).

Under non-favourable weather conditions above the North Sea birds face (strong) head winds. Under these circumstances the continuation of their migration flight will cost more energy, with a higher risk of not reaching land before getting exhausted.

4.7 Documented falls around the North Sea

3 September 1965 (Davis 1966, see also Elkins 1983, Berthold 1996)
In the second half of August 1965 a few lows passed over the Low Countries and southern Scandinavia. After the last August day weather circumstances improved with a high developing over Northern Europe. This system slowly moved east. At the same time low systems developed over Southern Europe and moved towards the Low Countries. Under these conditions mass migration from Scandinavia towards SW started at 31 August. In the first days of September some summer visitors arrived at the east coast of Britain.

In the night of 2/3 September a low moved from Northern Italy towards the Southern North Sea. Between the high above Scandinavia and this low, easterly winds occurred. Weather above Scandinavia was clear, whereas the frontal system of the low caused rain over the Low Countries and England. In the early morning mass arrivals occurred at Vlieland (the Netherlands), whereas later in the morning mass arrivals were noticed on coast of Suffolk (England), along a stretch of about 40 km coast, with an estimated 0,5 million birds been grounded. Arrivals at the Dutch coast were just ahead of the start of the rain, whereas at the English east coast the arrival coincided with the heaviest rain and a shift of the wind from N to SE after the frontal passage over Suffolk.

The main species involved in this exceptionally big fall were Wheatear, Whinchat, Redstart, Garden Warbler, Willow Warbler and Pied Flycatcher. Field observations suggest that most birds had left after a few days. Only a few trapped birds had unusually low weights, most of them were above the limit of exhaustion (Davis 1966). On the Suffolk beaches, victims have been found.

October 1973 (Prins 1974), see § 5.9.

October 1982 (Walker & Venables 1990), see § 5.9.

October 1988 (Walker & Venables 1990), see § 5.9.

October 1991 (Anonymous 1992) , see § 5.9.

5 Patterns of falls in different databases

5.1 Beached bird surveys

Since January 1965, the North Sea coast has been visited 4782 times, covering 33,275 km. With these visits, stranded birds have been recorded in 340 different months (82% of a total of 414 months). A total number of 9141 owls, pigeons, swifts and passerines were recorded of which 211 (2.3%) could not be identified on at least genus level. The main groups of the remaining were pigeons (21.8%, n = 8930), thrushes (57.2%), Starling (13.7%), and crows (4.5%) (Table 5.1). Overall densities were generally quite low (<0.5 per km surveyed), but high numbers could be found in spring and particularly in autumn (Figure 5.1)). Monthly numbers are summarised in Appendix KC1, and months in which more than 0.5 birds per km were classified as 'mass strandings', possibly indicating a fall or wreck of passerines at sea (Table 5.2). Homing pigeons dominated summer strandings (May-Sep) when overall numbers of non-seabirds were rather low, thrushes predominated autumn strandings (Oct-Nov), and both spring and winter strandings were rather a mixture of groups (Figure 5.2). From the list of mass strandings, four events were selected for a more detailed discussion in § 5.9:

November	1973	(97% thrushes)
October-November	1978	(>80% thrushes)
October-November	1982	(>90% thrushes)
October-November	1988	(>75% thrushes and starlings)

These events were outstanding because of the densities of corpses encountered and because the same event was either published (1973) or was witnessed during any of the other programmes at sea (Meetpost Noordwijk observations 1978 and 1982, ship-based surveys 1988; see below).

Figure 5.1
Seasonal pattern of owls, pigeons, swifts, and passerines on the beach (monthly densities ± 1 SD, 1965-1999)

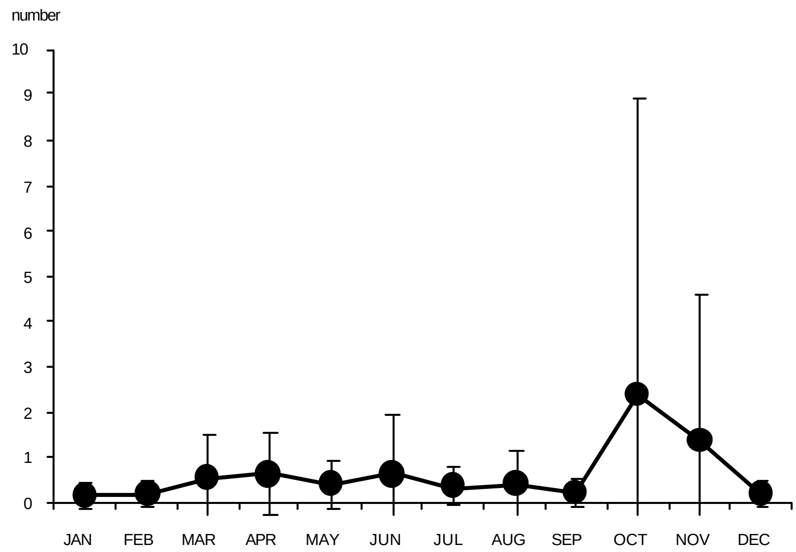


Table 5.1

Relative abundance (%) of owls, pigeons, swifts and passerines at sea, from counts at Meetpost Noordwijk (MpN; 1978-1984), ship-based surveys (at sea; 1985-1999), and beached bird surveys (beached; 1965-1999).

relative abundance	MpN	at sea	beached
doves & pigeons	0.5	2.3	21.8
owls	0.1	0.1	0.4
swifts & swallows	1.0	1.9	0.1
larks	4.1	5.1	0.7
pipits & wagtails	13.0	3.5	0.4
small thrushes	0.3	0.7	0.1
thrushes	22.8	17.9	57.2
warblers	0.5	0.7	0.2
tits	0.0	0.0	0.0
starlings	52.0	55.4	13.7
crows	0.2	0.2	4.5
sparrows, finches & buntings	5.5	12.2	0.9
subtotal	29923	15096	8930
unidentified	2129	213	211
total	32052	15309	9141

Figure 5.2

Relative abundance (%) of pigeons and selected passerines (common groups only) in monthly beached bird surveys (mean values, 1965-99).

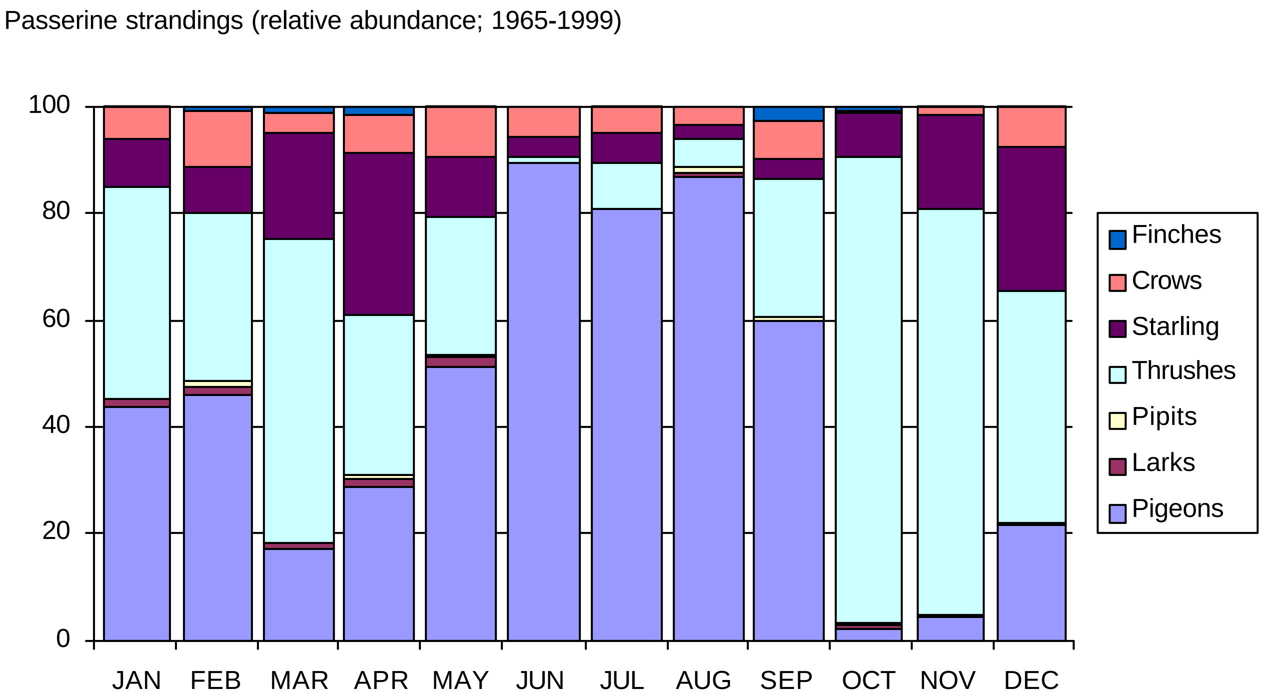


Table 5.2

Mass strandings of owls, pigeons, swifts, and passerines on the beach (>0,5/km) since January 1965 (see Appendix KC1) indicating a wreck or fall. The proportion of each of four main groups is presented next to the overall density (n/km), the total fraction 'explained' by these groups and a note of another dominant group if less than 25% were explained by pipits, thrushes, starlings or finches. The Table is sorted per year and month, to give a chronological review of mass-stranding.

month	year	n/km	%pipits	%trushes	%starlings	%finches	remarks	%explained
4	1968	0.6	0.0	36.4	45.5	0.0		81.8
4	1971	0.6	0.0	60.0	20.0	0.0		80.0
11	1973	8.1	0.0	97.3	0.0	1.0		98.3
12	1973	5.7	0.0	20.0	10.0	5.0		35.0
5	1977	1.2	0.0	23.3	20.0	3.3		46.7
12	1977	0.5	0.0	60.7	21.4	0.0		82.1
3	1978	1.0	0.0	52.4	23.2	1.2		76.8
10	1978	2.7	0.0	85.2	3.5	2.8		91.5
11	1978	4.7	0.0	80.1	11.8	1.2		93.1
3	1979	0.6	0.0	31.4	25.7	0.0		57.1
4	1979	0.6	0.0	26.0	14.0	2.0		42.0
6	1979	0.9	0.0	0.0	8.3	0.0	pigeons	8.3
8	1979	1.9	0.0	5.6	5.6	0.0	pigeons	11.1
11	1979	0.8	0.0	39.6	41.7	0.0		81.3
4	1980	0.7	0.0	14.1	35.9	3.1		53.1
8	1980	0.5	0.0	0.0	0.0	0.0	pigeons	0.0
10	1980	2.9	0.3	88.0	4.7	1.1		94.1
7	1981	0.5	0.0	2.6	2.6	0.0	pigeons	5.3
10	1981	2.0	0.4	86.3	8.5	0.0		95.2
11	1981	1.0	0.0	79.6	12.7	0.8		93.1
1	1982	0.7	0.0	9.1	3.8	0.0	pigeons	12.9
2	1982	0.6	0.0	8.5	5.8	0.0	pigeons	14.3
4	1982	0.8	0.0	25.4	27.1	0.0		52.5
5	1982	0.8	1.4	31.0	9.9	0.0		42.3
6	1982	0.6	0.0	0.0	0.0	0.0	pigeons	0.0
7	1982	0.5	0.0	8.6	8.6	2.9	pigeons	20.0
10	1982	16.1	0.8	94.2	3.6	0.7		99.4
11	1982	2.3	0.0	91.0	5.2	0.0		96.2
6	1983	0.5	0.0	0.0	8.3	0.0	pigeons	8.3
7	1983	1.4	0.0	0.0	40.0	0.0		40.0
6	1984	0.5	0.0	14.3	14.3	0.0		28.6
7	1984	0.8	0.0	22.2	0.0	0.0	pigeons	22.2
3	1985	0.5	0.0	30.6	43.5	0.0		74.1
4	1985	0.6	0.0	22.5	45.0	2.5		70.0
4	1986	0.6	0.0	46.4	21.4	0.0		67.9
6	1988	3.0	0.0	0.0	0.0	0.0	pigeons	0.0
10	1988	1.7	0.0	72.8	13.0	2.2		88.0
11	1988	1.5	0.0	80.8	16.5	0.0		97.3
10	1989	0.6	0.0	10.8	67.6	0.0		78.4
8	1990	0.6	0.0	0.0	0.0	0.0	pigeons	0.0
3	1994	2.3	0.0	91.1	7.1	0.3		98.6
6	1995	0.6	0.0	0.0	0.0	0.0	pigeons	0.0
3	1997	1.0	0.0	51.5	45.5	3.0		100.0
4	1997	0.6	0.0	16.7	50.0	0.0		66.7
11	1998	0.8	0.0	63.3	32.9	1.3		97.5
4	1999	2.4	0.0	83.3	8.3	0.0		91.7

5.2 Platform observations

The main set of platform observations was derived from sea watching sessions performed by the Club van Zeetrekwaarnemers between 1978 and 1984 at Meetpost Noordwijk (10 km off the coast near Noordwijk aan Zee). In all, in 23 months of a total of 84 possible months in these years (27%) the island was manned for at least a couple of days (Appendix KC2). During these counts, 32,052 owls, pigeons, swifts and passerines were recorded in 1398.5 hours of observation, 2129 of which were not identified to a least genus level. Of the remainder (n = 29,923), 4.1 % were larks, 13.0% pipits, 22.8% thrushes, 52.0% Starlings, and 5.5% were finches, sparrows or buntings (mainly Chaffinch) (Table 5.3). Large numbers of passerines (>10 per hour of observation per month) were recorded in 11 of these months, with Oct-Dec 1978, Sep-Nov 1981, and Oct 1982 as the most outstanding situations (Table 5.4)

The records in 1978 were dominated by Starlings, the event in autumn 1981 had a rather wide spectrum of species in the beginning, but was increasingly dominated by Starlings in October and November, whereas the sightings in October 1982 were a mixture of pipits, thrushes and Starlings. The overall relative abundance of the main groups of passerines and pigeons is shown in Fig. 5.3. From the list in Appendix KC4, two events were selected for a more detailed discussion in § 5.9:

October-November 1978 (>80% Starlings)
October 1982 (mixture of species)

These events were outstanding because of the numbers of passerines observed and because apparently the same events were witnessed during beached bird surveys, indicating a wreck or fall. It should be noted that the autumn 1981 events were also connected with mass strandings of passerines on the beach (see appendices).

Table 5.3
Selected months with the largest numbers of owls, pigeons, swifts, and passerines recorded at Meetpost Noordwijk (monthly mean >10 per hour), 1978-1984 (see Appendix KC2). The proportion of each of four main groups is presented next to the overall density (n/hour), the total fraction contributed by these groups in the total number and a note of another dominant group if less than 10% were explained by pipits, thrushes, starlings or finches. The Table is sorted per year and month, to give a chronological review of events.

month	year	n/hour	%pipits	%trushes	%starlings	%finches	%contributed
10	1978	24.5	2.1	1.0	51.5	8.6	63.2
11	1978	17.9	0.0	0.2	96.2	0.1	96.5
12	1978	40.5	0.0	1.2	97.5	0.0	98.8
11	1979	14.3	1.1	27.7	69.5	0.1	98.4
3	1981	11.0	17.0	4.2	75.2	0.0	96.4
9	1981	11.2	11.2	0.0	3.8	0.6	15.6
10	1981	56.5	7.9	6.8	59.9	5.2	79.8
11	1981	44.3	0.2	0.6	92.0	0.0	92.8
10	1982	126.8	23.6	47.9	23.5	1.8	96.8
1	1984	30.9	0.0	86.9	1.1	0.0	88.0
3	1984	23.1	2.2	0.7	67.8	27.2	97.9

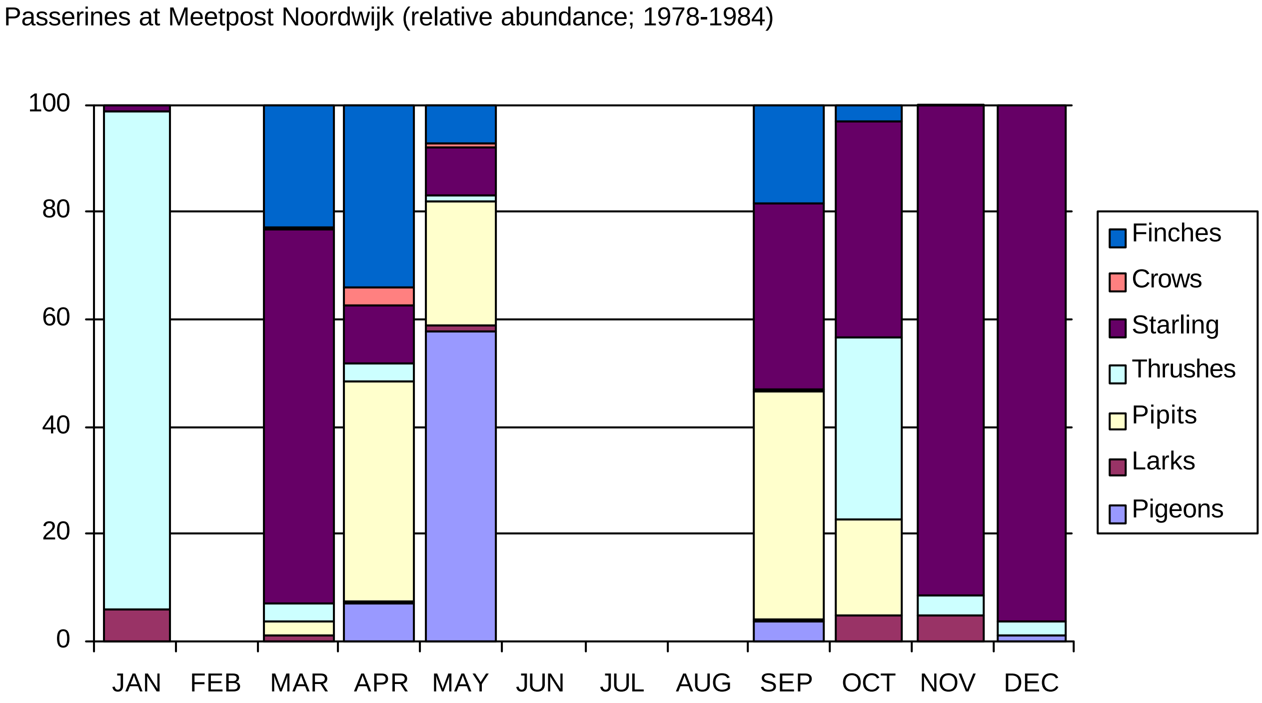
Further north in the North Sea, observations were conducted on two gas platforms during 15 consecutive days in December 1984 (5-19 December) and during 14 consecutive days in January 1985 (9-22 January). Substantial numbers of passerines were recorded on only three dates (7.6 hours of observation on each day):

	14 December	16 December	17 December

Pipits	2	0	0
Thrushes	1159	57	121
Starling	22	2	33
Finches & buntings	1	0	2
n per hour	154.5	7.7	20.3

Figure 5.3

Relative abundance (%) of pigeons and selected passerines (common groups only) at Meetpost Noordwijk, 1978-1984.



In all, the results at these gas platforms included five groups of non-seabirds: owls (0.1%), pipits (0.2%), thrushes (95.1%), Starling (4.3%), and finches or buntings (0.4%; n = 1421).

5.3 Ship-based sightings at sea

Ship-based surveys in the Dutch sector of the North Sea since 1987 were conducted on 717 days (16.4% of a total of 4380 days). At least some information was collected in 104 of 144 possible months (72%) in this period. A total of 15,309 owls, pigeons, swifts and passerines were recorded, of which only 413 individuals could not be identified to at least genus level. Of the remainder, 5.1% were larks, 17.9% thrushes, 55.4% Starlings and 12.2% finches, sparrows or buntings (n = 15,096).

Table 5.5

Selected months with the largest numbers of owls, pigeons, swifts, and passerines recorded during ship-based surveys at sea (monthly mean >0.25 per km sailed), 1987-1999 (see Appendix KC3). The proportion of each of four main groups is presented next to the overall density (n/h), the fraction contributed by these groups in the total number and a note of another dominant group if less than 10% were explained by pipits, thrushes, starlings or finches. The Table is sorted per year and month, to give a chronological review of events.

month	year	n/km	%pipits	%thrushes	%starlings	%finches	%contributed

10	1987	0.54	2.5	31.3	34.7	8.5	77.1
3	1988	0.65	0.3	30.5	66.5	0.4	97.7
10	1988	1.08	2.7	20.7	71.5	1.3	96.2
10	1989	1.04	2.2	18.5	63.8	3.5	88.1
1	1990	0.28	0.0	84.6	0.0	0.0	84.6
10	1990	1.60	3.8	35.6	57.2	1.1	97.7
11	1990	2.34	0.0	0.5	20.2	72.1	92.8
3	1991	1.79	0.2	5.4	84.3	8.5	98.3
11	1992	1.13	0.0	30.0	66.0	0.0	96.0
11	1994	5.28	0.0	2.2	96.2	0.6	99.0
11	1997	0.47	2.4	43.3	52.4	0.5	98.6

Figure 5.4

Seasonal pattern of owls, pigeons, swifts, and passerines during ship-based surveys (overall monthly mean)

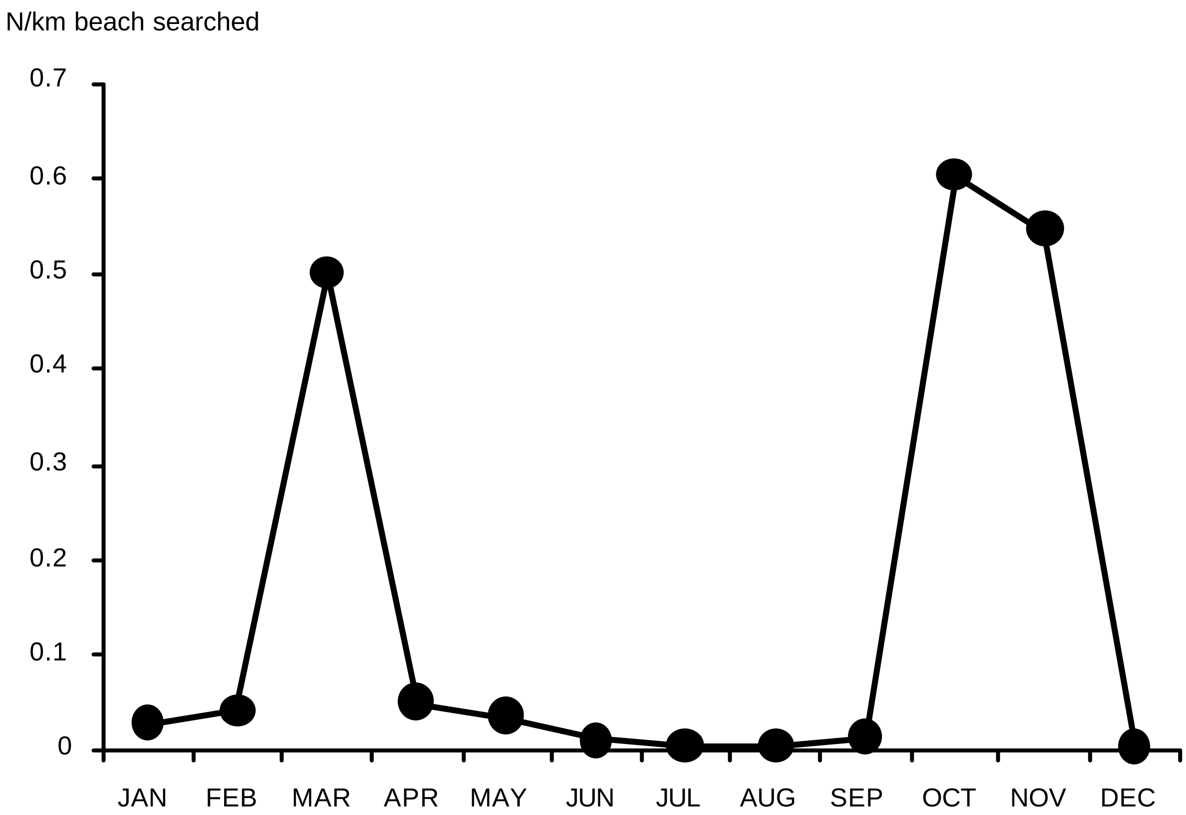
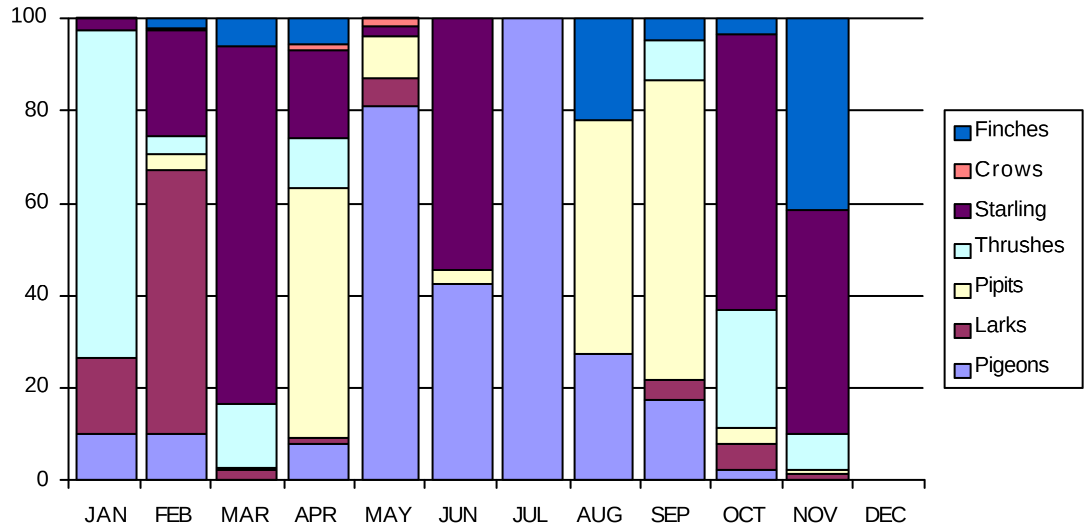


Figure 5.5

Relative abundance (%) of pigeons and selected passerines (common groups only) at sea, ship-based surveys 1987-1999.

Passerines at sea (relative abundance; 1987-1999)



5.4 Constant effort site Castricum at the Dutch coast

Patterns in bird abundance for 27 species are based on 2213 trapping days at Castricum in 14 years, 1.e. 43% of all possible days. The seasonal pattern in numbers of birds ringed per trapping day is given in Figure 5.6. Average totals are highest between July and November, with a distinct peak in September and October. Medium-sized passerines (thrushes) peak somewhat later in the autumn (Oct-Nov) than small ones (Aug-Oct), while the 'tiny' species are more evenly spread. The relatively high numbers of medium-sized passerines in January-February are caused by trapping activity being confined to frost and snow days, when cold-rushes of Fieldfare (and sometimes Redwing and Skylark) may occur; means for this period are therefore severely biased upwards. The low numbers ringed in spring are partly due to reduced trapping intensity, but also to winter mortality and the lack in spring of a concentration effect on migrants caused by the coastline.

Table 5.6 gives the proportion of trapping days on which 2, 3, 4 or 5 times the baseline number of birds were caught at Castricum, by month or (for the autumn migration period) by half-month. Days with twice the baseline number are fairly common in September and October, but days with three times this number occurred only 26 times in 14 years, with a maximum probability of 5% of the days in early October (Table 5.6). Six of these days are from late September/early October 1996 and qualify because of a large invasion of coal tits along the Dutch coast. There were 10 days with more than four times, and four days with more than 5 times the baseline number. It must be borne in mind that the number of birds trapped shows a satiation effect when the number of birds present or passing through becomes very large. Thus, on days on which three or four times the baseline number is caught, the actual number present may well have been 10-20 times the 'normal' level or even more.

The data show that days with (very) large arrivals at Castricum are virtually confined to the period September-October, and cold spells during winter. As already explained, the probability of high numbers in January-February is biased upwards, probably by a factor 4-5 (based on coverage). In spring, this probability is likely to be biased downwards due to the lower number of mist nets employed; however even if a trapping intensity of 1/3rd of that in autumn is assumed, there are no days that qualify as large arrivals (now in column x1, Table 5.6). It is unknown whether all large arrivals at Castricum would constitute a 'fall' on an offshore island; in some cases it could concern birds which have stopped at the coast to make a landfall before dawn, and which would not have appeared on an island.

Table 5.7 summarises the composition of large arrivals in terms of size and species, for details see Table 5.8. For this, days with 2 times the baseline number were selected. The large majority of birds involved in large arrivals are small (10-20 g) or tiny (<10 g) passerines, with medium sized birds (thrushes, 50-100 g) important only in (late) October and in the winter months. The latter category poses the greatest risks to aircraft, the more so because they fly both by night and day. The list of species contributing more than 5% on large arrival days contains 14 species, with blackcap and robin occurring most often. Note however that the composition of mistnet catches does not necessarily reflect numbers present. E.g., larger birds are generally less likely to be caught in mistnets than small birds, and species reacting strongly to song broadcasts are probably over-represented after 1987.

Figure 5.6

Average number of birds ringed per day (24 selected species, total and separated according to size) at Castricum, by month (n=14 years in 1980-1999).

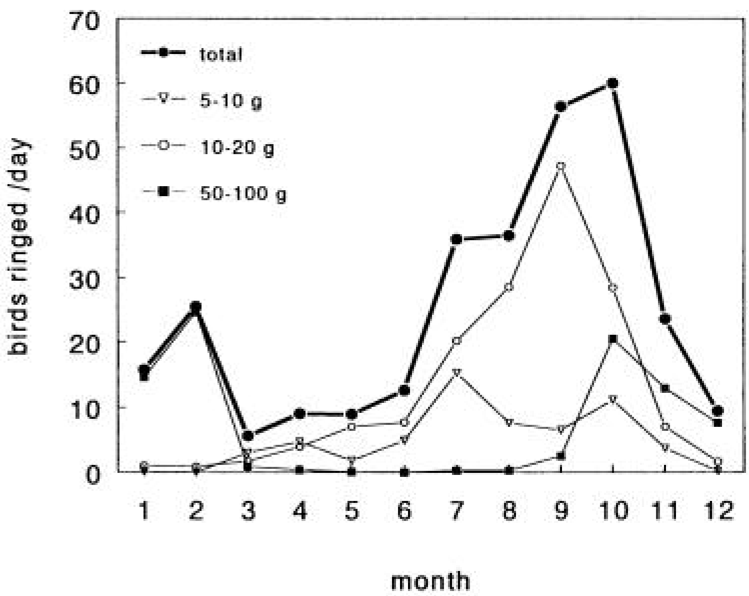


Figure 5.7

Numbers of birds ringed per day at Castricum, by year in 1980-1999. Nocturnal song broadcasts were introduced in 1987.

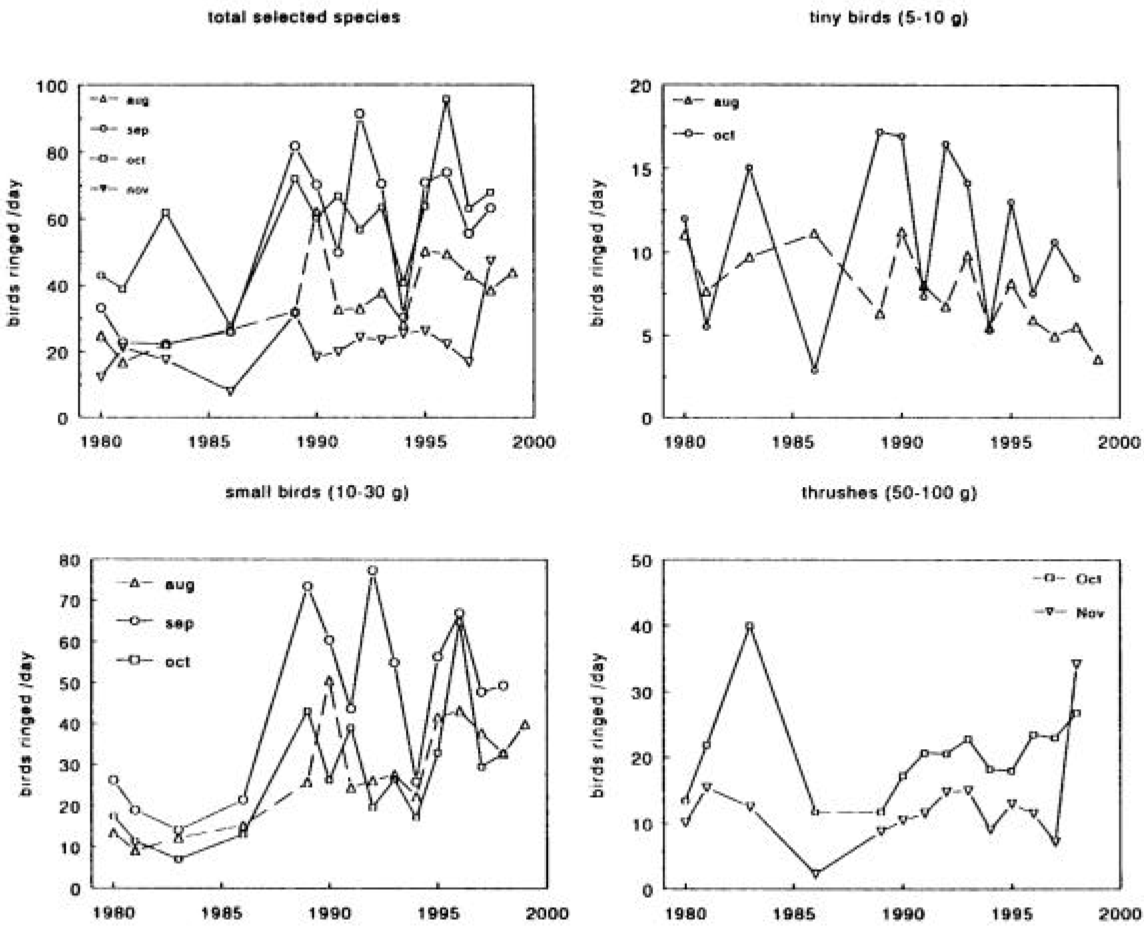


Table 5.6

Number and probability of days with multiples (x2-x5) of the baseline number of birds ringed at Castricum during 1989-august 1999. Base number = 33 before 1988, 65 thereafter.

	no. of cases x						probability (%)				
month	Ndays	x1	x2	x3	x4	x5	y1	y2	y3	y4	y5
Jan	58	4	1	1	0	0	6.9	1.7	1.7	0.0	0.0
Feb	51	6	5	1	0	0	11.8	9.8	2.0	0.0	0.0
Mar	108	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
Apr	202	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
May	193	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
Jun	29	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
jul1	29	1	0	0	0	0	3.5	0.0	0.0	0.0	0.0
jul2	153	29	0	0	0	0	19.0	0.0	0.0	0.0	0.0
Aug1	185	44	2	0	0	0	23.8	1.1	0.0	0.0	0.0
Aug2	191	35	1	0	0	0	18.3	0.5	0.0	0.0	0.0
Sep1	159	40	12	3	1	0	25.2	7.6	1.9	0.6	0.0
Sep2	169	88	19	5	1	0	52.1	11.2	3.0	0.6	0.0
Oct1	178	78	25	9	2	1	43.8	14.0	5.1	1.1	0.6
Oct2	171	69	18	7	6	3	40.4	10.5	4.1	3.5	1.8
Nov1	139	21	1	0	0	0	15.1	0.7	0.0	0.0	0.0
Nov2	98	4	0	0	0	0	4.1	0.0	0.0	0.0	0.0
Dec	100	5	0	0	0	0	4.8	0.0	0.0	0.0	0.0

Table 5.7

Size and species composition on days with large arrivals of nocturnal migrants at Castricum, by half-month.

month	N	n/day	5-10g	10-20g	50-100g	species contributing >5% of total
jan-feb	6	220	0%	0%	100%	fieldfare, redwing
aug	3	90	41%	58%	1%	willow w., reed w., whitethroat, blackcap
sep1	12	170	11%	88%	1%	blackcap, garden w., chiffchaff, reed warbler
sep2	19	170	9%	87%	4%	blackcap, coal tit, robin, garden warbler
oct1	25	167	16%	66%	18%	coal tit, robin, blackcap, goldcrest, songthrush
oct2/nov1	19	147	16%	26%	58%	redwing, goldcrest, blackbird, robin, fieldfare

Table 5.8

Listing of all days with very large arrivals of nocturnal migrants at Castricum, more than 3 times baseline number, only data available for 1980, 1981, 1983, 1986 and 1989-98.

date	total	robin	black-bird	field-fare	song thrush	red-wing	reed wbl.	garden wbl.	black-cap	chiff-chaff	willow wbl.	gold-crest	coal tit
12-10-1996	436	16	0	0	9	5	2	0	13	2	0	3	366
13-09-1995	304	14	1	0	2	0	20	32	118	33	34	0	0
30-09-1996	302	0	0	0	1	0	0	0	1	1	1	0	295
22-10-1983	289	5	3	0	3	253	0	0	0	0	1	19	0
15-10-1989	258	4	3	0	2	3	1	0	4	0	0	51	157
28-09-1996	249	7	0	0	0	0	1	3	8	0	0	0	227
26-09-1992	236	47	6	0	5	0	1	4	128	11	0	4	0
03-10-1996	236	15	1	0	13	13	0	2	10	6	1	1	155
05-10-1996	233	2	0	0	0	1	1	0	13	3	0	0	198
12-01-1999	220	0	0	220	0	0	0	0	0	0	0	0	0
04-02-1996	219	0	0	218	0	1	0	0	0	0	0	0	0
05-10-1991	216	42	9	0	11	2	0	3	101	5	0	0	0
06-10-1996	216	16	5	0	10	4	1	2	3	7	0	1	127
21-10-1995	214	8	4	3	11	152	0	1	14	1	0	12	0
12-09-1990	211	93	1	0	4	0	6	17	46	10	6	3	0
17-09-1990	208	91	0	0	1	0	11	10	84	5	0	1	0
14-09-1990	204	57	2	0	3	0	5	10	108	7	2	3	0
17-09-1993	198	43	0	0	10	0	5	27	23	4	64	0	2
15-10-1993	197	56	20	0	9	28	2	0	12	13	0	31	1
20-10-1983	194	0	2	0	0	170	0	0	0	1	0	20	0
16-10-1981	178	5	3	123	5	16	0	0	3	2	0	5	0
25-10-1983	151	5	5	1	2	117	0	0	0	0	0	21	0
12-10-1980	137	24	4	0	32	9	0	1	6	1	0	34	0
21-10-1983	135	4	2	1	2	72	0	0	2	0	0	27	0
29-10-1983	132	8	7	1	2	43	0	0	0	0	0	68	0
15-10-1981	116	12	9	23	12	16	0	0	9	1	0	12	0

5.5 Constant effort site Helgoland

On Helgoland, on the vast majority of days, at least some birds have been caught and even days with >100 birds trapped were rather common. It should be noted, that although birds need to land on Helgoland to get caught, not every bird landing constitutes a true fall in that bird landings on the island are not exceptional. Only days with exceptionally high numbers present on the island may be seen as an indication that a fall took place. Days exceeding 200 catches were far less common and could be judged to be indicative of 'falls'.

Table 5.9

Number of days within a year with >5 % of the yearly total, during 1989-98 on Helgoland.

	Mar	Apr	May	Aug	Sep	Oct	Nov
No. falls (>200 birds trapped)	2	12	5	1	18	19	1
Dunnock	1	1			4		
Robin		9	3		15	9	
Redstart			5		6		
Ring Ouzel		1			1		
Blackbird	2	7				6	1
Redwing		1			4	9	
Song Thrush		12	4		16	19	1
Garden Warbler			2	1	4		
Blackcap		1	1		4	6	
Common Whitethroat			2		1		
Willow Warbler			3	1	2		
Chiffchaff		1					
Pied Flycatcher				1	2		
Chaffinch		1			1		

Figure 5.8

Seasonal distribution of days with moderate (101-200 ex.), good (201-500 ex.) and very good (>500 ex.) catches on Helgoland.

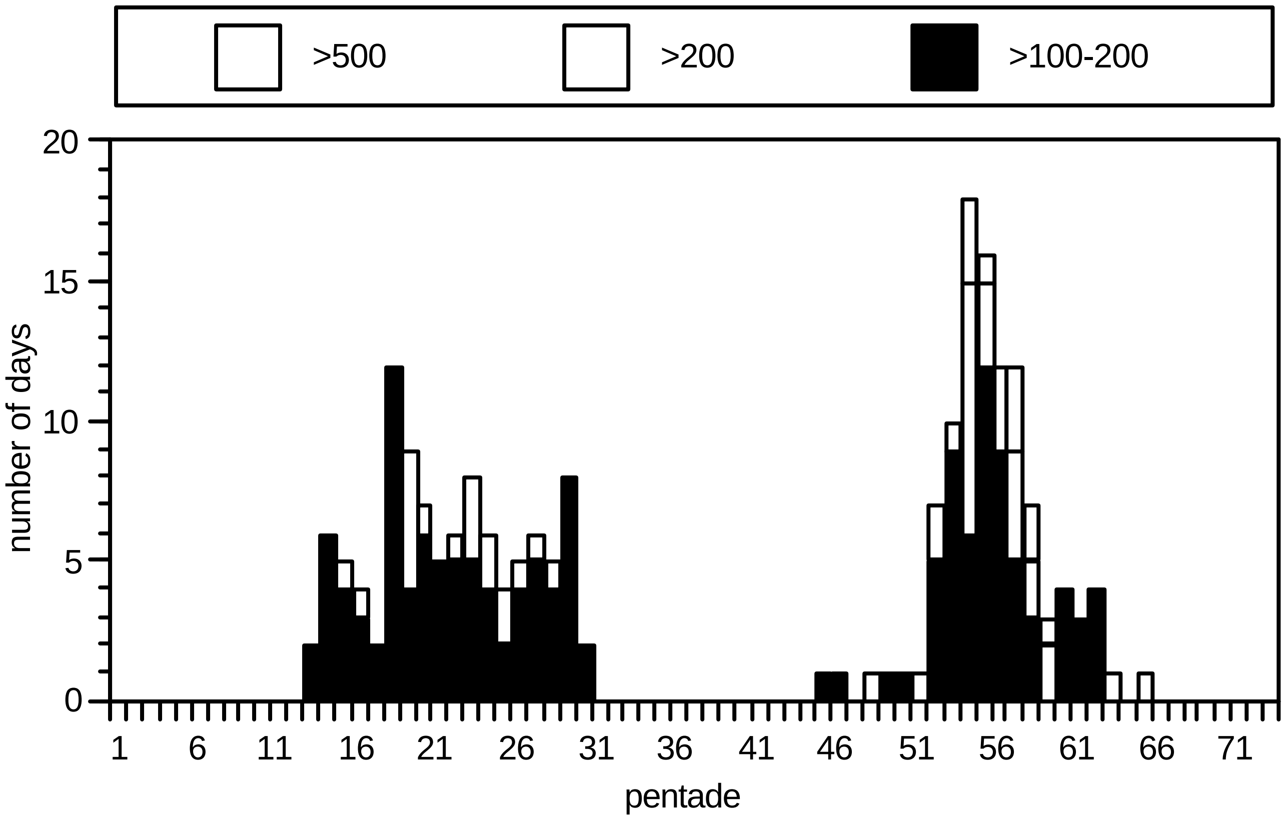


Table 5.10

Birds involved in 'falls' at Helgoland, during 1989-98, species composition on fall days with >500 birds trapped.

	14-oct-93	09-oct-93	30-sep-98	13-oct-93	25-sep-89	26-sep-93	09-oct-89	20-oct-95	09-oct-98	24-sep-93
Sparrowhawk		4		1		1		2		
Water Rail								1		
Woodcock								1		
Woodpigeon									1	
Long-eared Owl					1					
Cuckoo						1				
Meadow Pipit	3	8		3			3		1	1
Wren	17	2	1	3	1	1			1	1
Dunnock	13		12	1	4	5	2		3	
Robin	26	34	8	51	368	371	8		9	78
Redstart		4		1	25	4	1			9
Whinchat					2					
Ringouzel	5	3		2	7	2		1	6	3
Blackbird	20	18	2	137	5	1	21		2	1
Fieldfare	1			2			1			
Song Thrush	296	397	484	212	94	204	500	330	366	585
Redwing	92	16	1	143		11	95	346	320	83
Reed Warbler		1								1
Garden Warbler		2	1		9	1			1	5
Blackcap	5	19	12	10	25	9	2	1	8	8
Whitethroat					6					3
Willow Warbler			1		14					1
Chiffchaff	10	7	3	2	4				1	
Wood Warbler										1
Goldcrest		1			5		5			
Firecrest							1			
Pied Flycatcher					14	2				
Red-breasted Flycatcher			1							
Spotted Flycatcher										2
Reed Bunting								1		
Chaffinch	8	20	8	11	28	1	6	1	8	35
Brambling	3	3	1					3	2	4
Greenfinch	4									
Siskin	1									
total	508	535	536	578	613	613	647	685	729	821

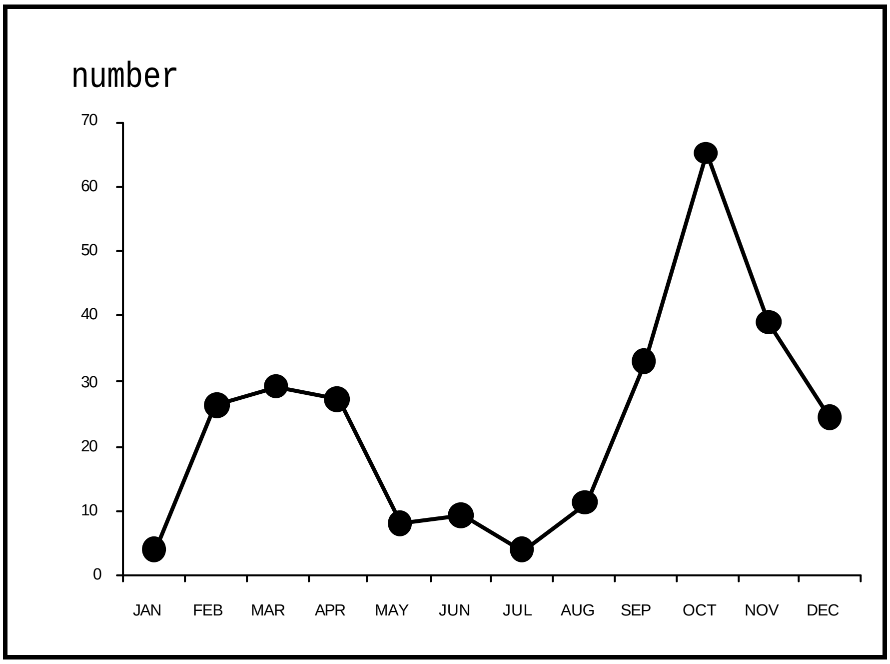
Figure 5.9 shows the seasonal distribution of the days with large numbers of birds caught. The species involved (i.e. species partitioning with >5% in the total of birds trapped during a certain 'fall') are listed in Table 5.8. Species that are also very numerous on the island at times but are less prone to catching and hence missed in these statistics are: Meadow Pipit, Fieldfare, Wheatear and Starling (Birding logs, Vogelwarte Helgo-land).

The data show, that potential falls (days with over 200 birds caught per day) occur both during spring and autumn migration, but not during periods in between. Furthermore, days with high bird numbers occur over a slightly longer time period during spring compared to autumn, but actual bird numbers per day reach higher values during the latter season. During 1989-98 very high numbers of birds (i.e. over 500) were caught on 10 days, all from the end of September into October. The dates and the species involved are listed in Table 5.9, with thrushes, Robin, Chaffinch and some warblers as the main species .

Seven of the ten dates mentioned in table 5.10 coincidence with a frontal passage over this North Sea island. On 24-09-93, 26-09-93, 9-10-89 the frontal passage from the south(west) was accompanied by eastern winds ahead of the front. During the passage wind turned south followed by west. So migration circumstances in the areas of origin were perfect. On 9-10-93, 13-10-93, 9-10-98 and 20-10-95 the wind ahead of the front was already westerly. High trapping numbers on 14-10-93, 25-09-89 and 30-09-98 were on days with calm weather, with wind from (north)east. The strong migration of Song Thrushes on 30-09-1998 above the German bight was previous to a fall of this species the next day in the Netherlands (§ 5.9).

Figure 5.9

Seasonal pattern of parcels sent in by four light vessels, located offshore the Dutch coast (1958-1971).



5.6 Light vessels

Numbers of parcels sent in from the light vessels showed distinct peaks in spring (February through April) and in autumn (September through January). In autumn most parcels were sent in October, when about twice as many parcels were sent in compared to any of the other peak months (Figure 5.9).

In terms of bird species * parcel combinations, thrushes were present in 27% of all cases involving birds of the species considered in this study, followed by warblers (14.7%), larks (10.3%) and rails/gallinules (10.2%): see Table 5.11.

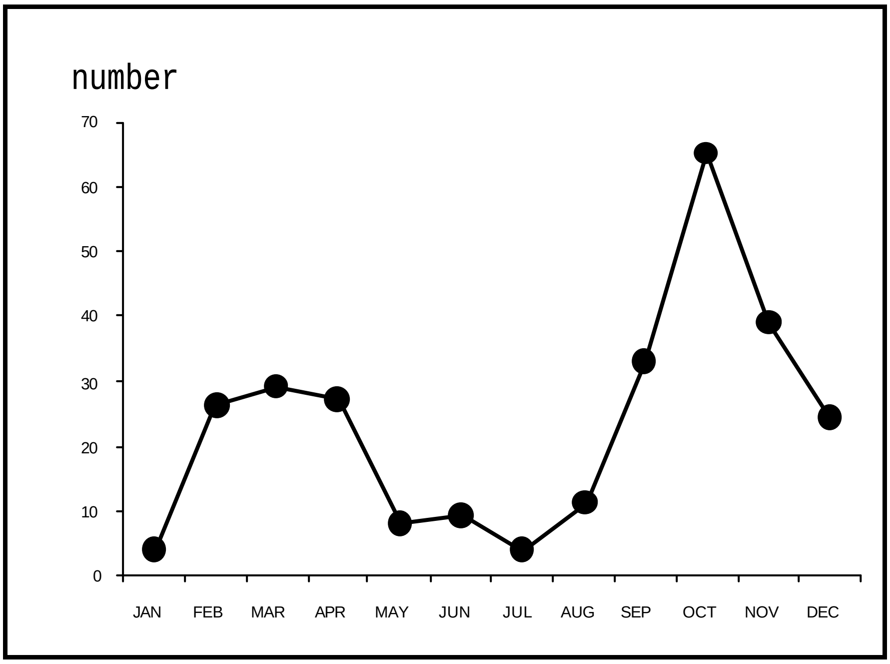
Table 5.11

Number of parcels from light vessels, for different species groups

	Terschelling	Texel	Noord Hinder	Goeree	Total	Total-%
rails/gallinules	4	61	33	14	112	10,2
waders	7	43	15	12	77	7,0
doves & pigeons	0	0	0	0	0	0,0
cuckoos & owls	0	0	3	0	3	0,3
woodpeckers	1	0	2	0	3	0,3
swifts & swallows	1	1	4	0	6	0,5
larks	14	54	39	7	114	10,3
pipits & wagtails	9	31	20	3	63	5,7
small thrushes	13	37	23	9	82	7,4
thrushes	23	170	73	31	297	27,0
warblers	16	55	86	5	162	14,7
tits	0	0	2	0	2	0,2
starlings	7	54	20	8	89	8,1
sparrows, finches & buntings	12	43	34	3	92	8,3

Figure 5.9

Seasonal pattern of parcels sent in by four light vessels, located offshore the Dutch coast (1958-1971).



5.7 Migration by LWVT-data

On two coastal sites, Den Haag and Haarlem, Starling is the most numerous species during autumn migration, followed by Chaffinch and Meadow Pipit (Table 5.12). In winter Skylark and Fieldfare dominate, followed by Starling. In spring Swallow and Starling are about evenly numerous, followed by Lapwing. As a result of numerousness of species, peak days during autumn migration coincide with the main migration period of the species mentioned, i.e. between half September and half November. In spring peak days occur between March and May.

Table 5.12

Species composition of diurnal leading line migration on two coastal observations sites in spring (11-02/10-06), autumn (11-06/15-12) and winter (16-12/10-02).

	Haarlem		Den Haag		
	spring	autumn	spring	autumn	winter
observed numbers					
Lapwing	1,797	13,862	10,507	55,833	1,218
Swift	1,101	3,211	32,872	67,365	0
Swallow	4,579	2,836	65,568	6,615	0
Skylark	711	27,936	3,387	86,442	13,698
Meadow Pipit	4,696	102,124	69,560	295,237	427
Fieldfare	311	33,923	3,956	168,114	11,345
Redwing	73	20,633	405	95,893	6,951
Jackdaw	1,424	22,903	2,975	47,676	5
Starling	8,230	741,096	57,695	2171,234	6,410
Chaffinch	496	253,677	1,768	820,305	180
Brambling	117	13,536	134	48,595	5
total	31,466	1295,769	385,381	5185,455	90,714
percentage					
Lapwing	5.7	1.1	2.7	1.1	1.3
Swift	3.5	0.2	8.5	1.3	0.0
Swallow	14.6	0.2	17.0	0.1	0.0
Skylark	2.3	2.2	0.9	1.7	15.1
Meadow Pipit	14.9	7.9	18.0	5.7	0.5
Fieldfare	1.0	2.6	1.0	3.2	12.5
Redwing	0.2	1.6	0.1	1.8	7.7
Jackdaw	4.5	1.8	0.8	0.9	0.0
Starling	26.2	57.2	15.0	41.9	7.1
Chaffinch	1.6	19.6	0.5	15.8	0.2
Brambling	0.4	1.0	0.0	0.9	0.0

At the inland observation site Arnhem diurnal broad front migration was observed almost daily. In 1981-98 Chaffinch and Starling were the most common species, followed by Redwing, Wood Pigeon and Meadow Pipit (Table 5.13).

Up to the first half of September migration is dominated by Swallow and House Martin. Numbers are relatively low and daily totals (2.5 hours of observation) never reach the level of two times the baseline number of 450 birds. Such intensities or even higher are recorded only between half September and half November. Very good days with totals of more than ten times the baseline number are limited to October (Table 5.14).

Table 5.13

Species composition of diurnal broad front migration on the observation site Arnhem, autumn 1981-98.

species	number	proportion (%)
Lapwing	9,176	1.1
Wood Pigeon	70,542	8.4
Swallow	31,665	3.8
House Martin	14,434	1.7
Skylark	22,716	2.7
Meadow Pipit	51,216	6.1
Song Thrush	16,591	2.0
Fieldfare	21,545	2.6
Redwing	89,233	10.6
Starling	134,362	15.9
Chaffinch	230,701	27.4
Brambling	32,762	3.9
Siskin	14,423	1.7
total	842,436	100.0

Table 5.14

Number and probability of days with multiples of the baseline number observed at Arnhem during 1981-99. Baseline number is 450 birds. Standard week numbers, week 27 starts at 2 July and week 40 at 1 October.

		number			probability		
week	n	2x	5x	10x	2x	5x	10x
26	4	0	0	0	0.0	0.0	0.0
27	19	0	0	0	0.0	0.0	0.0
28	20	0	0	0	0.0	0.0	0.0
29	20	0	0	0	0.0	0.0	0.0
30	17	0	0	0	0.0	0.0	0.0
31	54	0	0	0	0.0	0.0	0.0
32	78	0	0	0	0.0	0.0	0.0
33	87	0	0	0	0.0	0.0	0.0
34	106	0	0	0	0.0	0.0	0.0
35	105	0	0	0	0.0	0.0	0.0
36	107	0	0	0	0.0	0.0	0.0
37	107	0	0	0	0.0	0.0	0.0
38	111	1	0	0	0.9	0.0	0.0
39	123	11	0	0	8.9	0.0	0.0
40	127	29	4	0	22.8	3.1	0.0
41	127	36	18	2	28.3	14.2	1.6
42	121	40	14	4	33.1	11.6	3.3
43	120	31	15	1	25.8	12.5	0.8
44	116	23	3	1	19.8	2.6	0.9
45	113	11	2	0	9.7	1.8	0.0
46	100	2	0	0	2.0	0.0	0.0
47	91	0	0	0	0.0	0.0	0.0
48	73	0	0	0	0.0	0.0	0.0
49	12	0	0	0	0.0	0.0	0.0

5.8 Radar observations

The Royal Netherlands Air Force uses radar in a bird warning system, in which the long range surveillance radar near Wier (province of Fryslân) plays a key role. Continuous measurements lead to a set of data which are fed into a bird migration warning system. In this system the Netherlands and adjacent areas in Germany and Belgium are divided in a grid. For each grid cell the migration intensity is given in an exponential 0-8 scale (Buurma 1989, 1997). For scale value 5 and 6 warnings are given to the pilots, for scale value 7 and 8 flight restrictions up to a certain indicated altitude are ordered. The chance on restrictions somewhere in the flight area, shows a pattern that is similar to the year round pattern of migration intensity over the Netherlands (Figure 5.10). Based on data from 1991-1997 these restrictions are on average possible during 35% of the 365 days of a year (data L.S. Buurma RNLAF).

With the data of the long range surveillance radar of Wier a spatial pattern of migrating birds can be produced by the ROBIN-system (Radar Observation of Bird INtensity). On these images differences in migration intensity are shown in different colours. Furthermore, below certain bird densities and out of the clutter range, the direction of moving echoes is visible, due to time lapse recording of data. From these spatial images fall related patterns can show up (pers. obs. Buurma). In these cases the stream of migrants from over the sea suddenly stops at the coast, without continuing. In figure 5.11 an example of Dutch data is given. The high bird density above the isles of Terschelling and Ameland are indicative for a fall. Nevertheless, it is possible that birds just lowered their altitude, and continued south, flying to low to be detected by the radar beam.

The bird warning system ROBIN is developed to lower the bird strike rate in the Royal Netherlands Air Force, primarily en route. Although flight restrictions are based on migration intensity, there is still a chance on a bird hit. On 11 October 1988 two Belgium fighters had a bird hit en route, in two grid cells above Germany (Buurma 1989). For these cells the highest flight restrictions were given. These events coincided with heavy (south)westward migration, as a prelude on a fall around the southern North Sea one or two days later (see § 5.9).

Figure 5.10

Chance on flight restrictions for some time, on any moment of the day, somewhere in the flight range of the Royal Netherlands Air Force, 1990-1996 (from Buurma 1997).

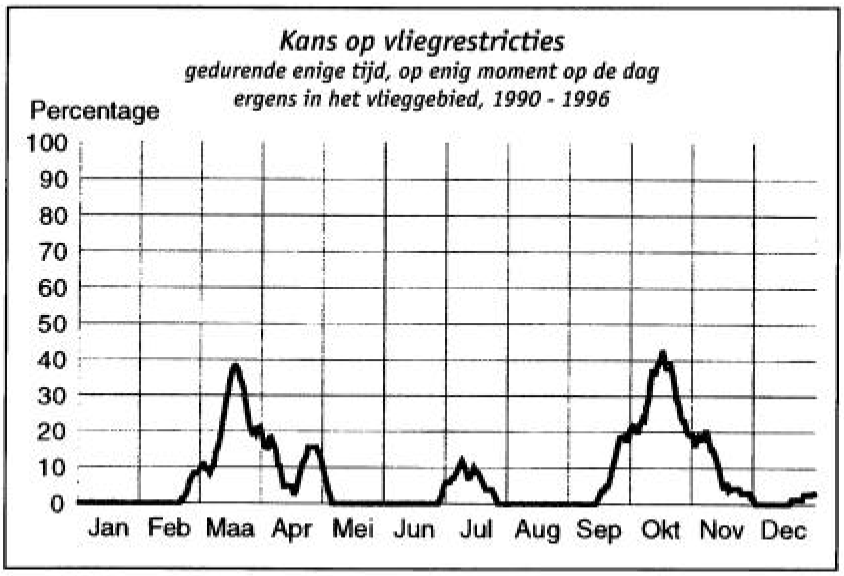
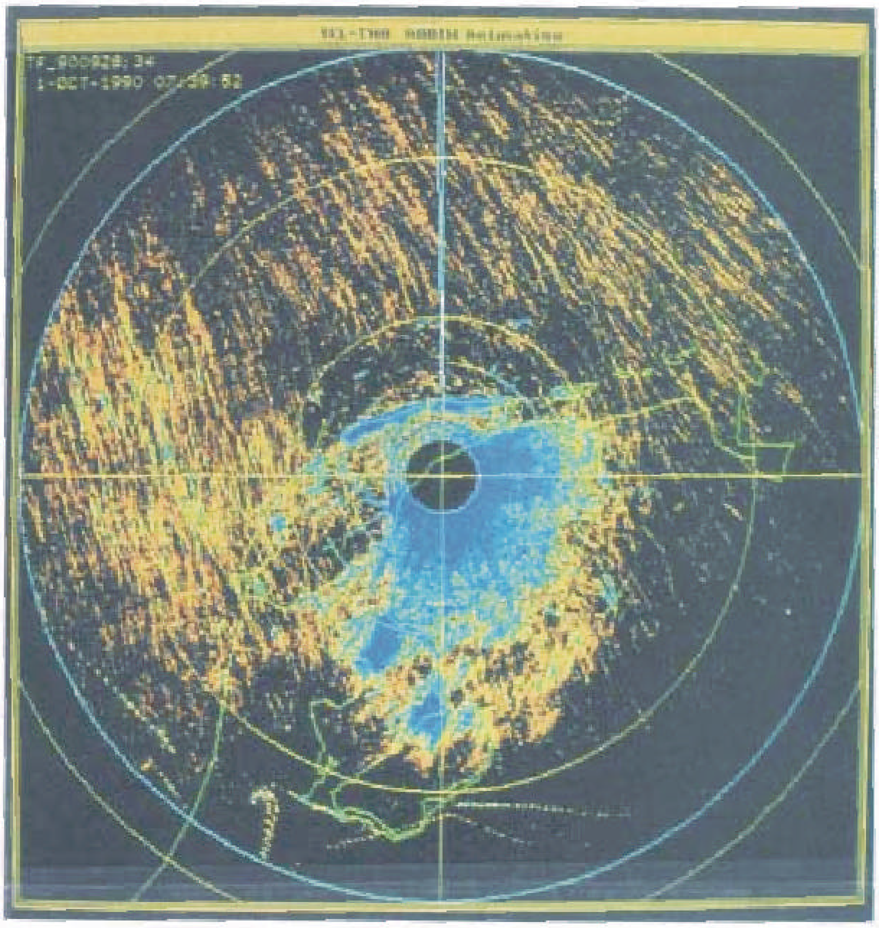


Figure 5.11

Radar image, produced by the ROBIN-system, of 1 October 1990, 7.40 hour local time. Moving birds are brown till blue (low to high reflectivity). The blue area around the centre is ground clutter (from Buurma 1992).


1-OCT-1990 07:59:52

5.9 Case studies

From different datasets, a number of case studies is selected to show coinciding results which may, or may not, be connected and point at individual falls or wrecks (fall with associated mortality). The beached bird survey database (1965-1999) served as reference and some months with relatively large numbers were selected, if the other sets of data also produced relatively large numbers in that period. The species spectrum, dates, locations and meteorological conditions during and around the events are briefly described.

November 1973

A mass stranding of passerines was witnessed during a survey between Langevelderslag and Egmond aan Zee (36.5 km, mainland coast) on 3 November 1973. Thrushes (97.3%, n = 295), particularly Redwings (74.7%), predominated in this stranding (Table 5.15). This wreck was witnessed before any of the other data series began, but only two weeks earlier, on 15 October 1973, a massive fall was recorded at Vlieland (Wadden Sea islands) where large numbers of exhausted Redwings landed on the island (Prins 1974). The next day, during misty conditions (visibility 100m, NE 7-8 Beaufort) low-flying Redwings and Chaffinches crossed the Wadden Sea. Large numbers of these migrants fell victim to Great Black-backed and Herring Gulls. The early November stranding may well have had connections with a wreck at sea in October, possibly on or around the same dates as recorded by Prins (1974). Finches, recorded on 16 October in equal numbers as Redwings, were not found stranded.

Table 5.15

Beached pigeons and passerines in the November 1973 wreck (36.5 km surveyed)

species	n =	%	group of species
Wood Pigeon	1	0.3	pigeons
Blackbird	39	13.2	thrushes
Fieldfare	23	7.8	"
Song Thrush	5	1.7	"
Redwing	220	74.6	"
Rook	1	0.3	crows
Crow	2	0.7	"
House Sparrow	1	0.3	sparrows, finches and buntings
Greenfinch	1	0.3	"
Siskin	1	0.3	"
unidentified passerine	1	0.3	unidentified
total	295		

Halfway October 1973 a high pressure area was located above Scandinavia. From 11 October onwards, after the passage of a front, the wind came from NE. On 13 and 14 October a low moved from Bretagne (France) eastward, and the wind over the Netherlands stayed E. On the 14th in the south of the country some precipitation was noted. The next day a front with rain, linked to the low mentioned before, came across from the south to the north. Wind changed from east, over north to the south. Due to the approach of the next low, the wind changed to NE on the 16th. After a night with much fog (15-16th), clouds came in from the west and brought rain, especially in the south. The fall in October 1973 is most likely linked to the weather on the 15th and 16th, whereas birds coming from Scandinavia with tail winds, encountered a frontal system near the Netherlands.

October-November 1978

Substantial numbers of passerines were found on a number of locations and sites during October and November 1978, including: 7 October Egmond aan Zee - Bergen aan Zee (23 ex.), 18 October doorbraak - Camperduin (50 ex.), 29 October Wijk aan Zee - Castricum (60 ex), 2 November Hondsbossche Zeewering (56 ex), 5 November Hoek van Holland - Monster (111 ex), and 5 November doorbraak - Camperduin (39 ex). Smaller numbers (old corpses) were found later in November (Table 5.16). Most beached birds were thrushes (82.2%, n = 388) These data indicate a wreck somewhere in the second half of October, perhaps mid-October, plus lower levels of mortality in the beginning of October.

Table 5.16

Stranded pigeons and passerines in the October-November 1978 wreck (104 km surveyed)

species	n =	%	group of species
Homing pigeon	17	4.4	pigeons
Skylark	1	0.3	larks
Blackbird	77	19.9	thrushes
Fieldfare	60	15.5	"
unidentified thrush	61	15.8	"
Redwing	120	31.0	"
Chiffchaff	1	0.3	warblers
Willow Warbler	1	0.3	"
Jackdaw	1	0.3	crows
Crow	1	0.3	"
unidentified crow	1	0.3	"
Starling	34	8.8	starling
House Sparrow	1	0.1	sparrows, finches and buntings
Chaffinch	6	1.6	"
unidentified passerine	5	1.3	unidentified
total	388		

At Meetpost Noordwijk, Skylarks (17.5%, mainly October), Starlings (72.4%; 992 in October, 1628 in November) and Chaffinches (4.6%, mainly October) dominated the scene in 1973 (n = 3619). Thrushes were scarce on most days, so that there appears no connection between the results of these data sets and the wreck may well have occurred on days that Meetpost Noordwijk was not manned.

Early October 1978, Meetpost Noordwijk was visited by small numbers of small passerines, including pipits, small thrushes, and warblers. These species were normally only seen when landing at the platform (substantial numbers occurred at night attracted to platform lights), but hardly any of these smaller species were seen flying by.

During the first five days of October 1978 a zone with high pressure was located between the Azores and southern Scandinavia. In general the weather over the Netherlands and the southern North Sea was calm. Between 6 and 15 October the high moved to Central Europe, bringing southerly winds over the Netherlands. On the 7th and 14th there was large scale fog. From the 16th onwards the high moved further east, whereas frontal systems reached our region. They brought much rain on 16, 17 and 18 October.

October-Nove mber 1982

Large numbers of passerines, 86.2% Redwings (n = 1521) were found on a number of locations and sites in Zuid-Holland and on Texel 16-19 October 1982: 16 October Kijkduin - Scheveningen (303 ex.), 16 October Noordwijk - Langevelderslag (231 ex.), 18 October Hoek van Holland - Monster (182 ex.), 19 October Hoornderslag - Westerslag (91 ex.), 19 October De Koog - De Slufter (17 ex.), 19 October De Slufter - lighthouse (15 ex.) (Table 5.17). A survey in Noord-Holland with large numbers of passerines a few days later was clearly related to this event: 21 October Bergen aan Zee - doorbraak (354 ex.) and possibly all corpses found between Katwijk and Noordwijk on 30 October (31 ex.) were remnants of the same wreck. Large numbers of passerines found on 6 November between Callantsoog - Groote Keeten (243 ex.), again mainly Redwings), may have been an indication of further problems for passerines at sea, for it is unusual for corpses of passerines to be found on sandy beaches more than two weeks after a stranding event (Camphuysen 1989).

At Meetpost Noordwijk, a genuine fall of thrushes, however, was recorded on the afternoon of 11 October 1982 under apparently remarkably calm and clear conditions (SE-E 3-4 Beaufort, visibility moderate, complete overcast). At first hundreds of Redwings and Song Thrushes were seen moving south, later thousands of thrushes moving south and east (towards land) were seen passing by, increasing numbers of which were apparently exhausted and were either swimming by or were (successfully) attacked and killed by Larus-gulls associated with the platform. On 10 October, a front associated with heavy rain had moved south to north over the country and it is not unlikely that these thrushes have encountered the front at sea and became disorientated and exhausted and ended up in the Southern Bight. Substantial numbers of thrushes, Chaffinches, Bramblings and pipits were attracted to the platform on the night following these observations, but rather few passerines were observed on 12 October.

From 11 to 15 October, Meetpost Noordwijk was constantly manned but only insignificant numbers of passerines were observed on most days. No beached bird surveys were carried out on these days, but the sightings at Meetpost Noordwijk suggest a connection between the fall of 11 October and the wreck witnessed along the mainland coast and on Texel during beach visits between 16 and 19 October.

Over land, autumn migration in 1982 passed in several waves. In the first decade good and bad migration altered day by day, whereas the main species involved were Skylarks, Meadow Pipit, Starling and Chaffinch. On 9 and 11 October Redwing migration started, interrupted by the frontal passage on the 10th. After weak migration between 12-14 October, a second wave passed between the 15-19th, with Chaffinch, Starling, Redwing, Songthrush and Skylark the most numerous.

Around 10 october a high was located above the border of Finland and Russia. Along the south side were strong easterly winds over the Baltic, the southern parts of Scandinavia and most of the North Sea. In the first half of October an extensive low moved slowly over Italy and Northern France and became stationary over the North sea. The clouds of the accompanying frontal systems reached the southern Baltic, South Scandinavia, North Germany, and the Low Countries. It is suggested that most birds who were involved in the fall, had started their migration journey in South Scandinavia, Finland or even Russia, and drifted downwind over the North Sea. Birds seen flying (S)E in front of the Dutch coast, could be compensatory flights (cf. Buurma 1987). Since these birds met head winds above sea, with rain, a fall (and wreck) is likely.

Table 5.17

Stranded pigeons and passerines in the October-November 1982 wreck (203.1 km surveyed)

species	n =	%	group of species
Homing Pigeon	4	0.3	pigeons
Wood Pigeon	1	0.1	"
Skylark	1	0.1	larks
unidentified pipit	10	0.7	pipits and wagtails
Blackbird	40	2.6	thrushes
Fieldfare	40	2.6	"
Song Thrush	31	2.0	"
unidentified thrush	1	0.1	"
Redwing	1311	86.2	"
Mistle Thrush	2	0.2	"
Goldcrest	1	0.1	warblers
Firecrest	1	0.0	"
Jackdaw	3	0.2	crows
Crow	1	0.1	"
unidentified crow	1	0.1	"
Starling	60	3.9	starling
House Sparrow	1	0.1	sparrows, finches and buntings

Chaffinch	8	0.5	"
unidentified passerine	4	0.3	unidentified
total	1521		

Table 5.18

Stranded pigeons and passerines in the October-November 1988 wreck (223 km surveyed)

Species	n =	%	group of species
Homing pigeon	1	0.3	pigeons
Wood Pigeon	1	0.3	"
Skylark	1	0.3	larks
Blackbird	70	20.3	thrushes
Fieldfare	32	9.3	"
Song Thrush	21	6.1	"
unidentified thrush	101	29.3	"
Redwing	49	14.2	"
Jackdaw	1	0.3	crows
Crow	1	0.3	"
Starling	53	15.4	starling
Brambling	1	0.3	sparrows, finches and buntings
Reed Bunting	1	0.3	"
unidentified passerine	12	3.5	unidentified
total	345		

October-November 1988

Mass strandings of passerines were recorded at two locations only, between Egmond aan Zee and Bergen aan Zee (84) on 31 October 1988 and between Westerslag and De Koog on Texel (240), 20 November 1988 (Table 5.18). The separation in space and time (several transects were checked in between with few passerines reported) suggests that perhaps two wrecks were involved rather than a single incident. On Texel in November, all stranded passerines were thrushes (83.3%) or Starlings (16.7%; n = 240). In Noord-Holland between Egmond and Bergen three weeks earlier, 12 different species were recorded, including crows (2.4%), buntings and finches (2.4%), thrushes (77.3%), Starlings (13.1%) and others (4.8%; n = 84).

Ship-based surveys in October 1988 revealed rather large numbers of passerines on several days, with the most outstanding examples being 13 October (732 ex.), 17 October (106 ex.), 18 October (40 ex.), 19 October (402 ex.), and 24 October (199 ex.). The largest numbers of passerines between 13 and 24 October at sea were recorded in the following grids (centre positions): 52.62°N, 4.25°E (402), 52.87°N, 4.25°E (302), 52.12°N, 3.25°E (254), 52.62°N, 4.75°E (129), 52.37°N, 4.25°E (106), 53.12°N, 4.75°E (84), 52.12°N, 3.75°E (62), all just off the mainland coast in and around the area where an offshore island with runways is now proposed. If the mainland coast wreck was somehow connected to these larger numbers of low-flying passerines at sea, the event took place mid October 1988 (Table 5.19). The species spectrum of passerines at sea was slightly wider than that on the beach (as usual), with as most important difference the 72.9% Starlings of the total of passerines recorded (n = 1479).

Table 5.19

Pigeons and passerines at sea, ship-based surveys, 13-24 October 1988

species	n =	%	group of species
Wood Pigeon	1	0.1	pigeons
Skylark	23	1.6	larks

Meadow Pipit	16	1.1	pipits
Water Pipit	1	0.1	"
Robin	6	0.4	small thrushes
Blackbird	18	1.2	thrushes
Fieldfare	146	9.9	"
Song Thrush	13	0.9	"
Redwing / Song Thrush	6	0.4	"
Redwing	139	9.4	"
Mistle Thrush	2	0.1	"
Blackcap	1	0.1	warblers
Willow Warbler	1	0.1	"
Starling	1078	72.9	starling
Chaffinch	1	0.1	sparrows, finches and buntings
Brambling	10	0.7	"
Linnet	1	0.1	"
Reed Bunting	2	0.1	"
unidentified passerine	14	0.9	unidentified
total		1479	

According to daily observations of visible bird migration near The Hague, autumn migration along the coast passed in five waves , 28/9-5/10, 11-18/10, 21-31/10, 3-5/11 and 16-17/11. In between migration intensity was low. The main species recorded were Starling (S), followed by Chaffinch (C), Skylark (L), Meadow Pipit (M), Fieldfare (F) and Redwing (R). Relative high numbers were recorded at 13 October (S, C, M), 14 October (L), 15 October (S), 18 October (S, M), 22 October (S), 24 October (R, F) and 29 October (S). The first days of November the thrushes and Starling were dominant, halfway this month Chaffinch too (Table 5.20). In the observed migration along the coast small passerines are more numerous than in the data on beached birds and ship based surveys.

By incidence, employees of Bureau Waardenburg have been out on sea on 20 and 21 October, 43 miles WNW of Scheveningen, near the Bruine Bank. During both days weather here was cloudy with drizzle and wind from S-SE 2B (Rahder 1989). On both days there was a lot of migration, and especially small passerines landed on the ship but even Lapwings were recorded resting.

Table 5.20

Numerousness and proportion of the total migration during daily observations of visible bird migration over The Hague (full daylight period) and Haarlem (first 2,5 hours) between 1 October and 15 November 1988.

species	The Hague	%	Haarlem	%
Skylark	15328	3,7	1317	2,2
Meadow Pipit	18072	4,4	5883	9,9
Fieldfare	10359	2,5	2757	4,6
Redwing	6896	1,7	1599	2,7
Jackdaw	4953	1,2	2813	4,7
Starling	292161	70,6	34095	57,4
Chaffinch	41301	10,0	9518	16,0
Brambling	1333	0,3	583	1,0

In Britain, October 1988 has become known as a month with a megafall, with the highest number of arrivals on 12 and 16 October (Walker & Venables 1990). During most of the month a high was located above Scandinavia, whereas a low pressure systems tried to come in from the south-west. Across the southern parts of Fenno-Scandinavia and the low countries winds were easterly. The clouds of the low reached over the North Sea, England, Holland, Germany and the southern Baltic. It is suggested that most of the migrants that arrived in Britain, had started their journey in southern Fenno-Scandinavia, or even Russia (thrushes, starling) (Walker & Venables 1990). When birds headed west they had the advantage of tail wind. Above the North Sea they encountered clouds, rain and fog, with a wind turning S till SE. The fall in October 1988 seems to not only be linked to frontal systems with tail winds ahead of the front and head winds afterwards (18-21 October), but also to fog (11-17, 22-24 October).

25 October 1991

Numbers of passerines attracted to offshore installations can be immense. Up to 75,000 Redwings with the same number of Fieldfare (150,000 thrushes in total) were seen circling anticlockwise around the Buchan A platform in the central North Sea on an October morning in 1991 (57°54'N, 00°01'E; Anon. 1992). At the more northerly Thistle A (61°22'N, 01°35'E), 3000 Blackbirds arrived that same day (North Sea Bird Club Bulletin 64:4). In line with earlier studies, massive numbers of thrushes arriving at ships, offshore installations and lighthouses, do not easily settle (Mörzer Bruyns 1939), potentially causing immense problems for flight safety at offshore islands. Sightings at offshore installations between 1986 and 1997 (North Sea Bird Club Bulletin in serie) indicate that mass-arrivals of at least 10,000s of thrushes are near-annual events, particularly in autumn, and may occur anywhere in the North Sea.

In October 1991 heavy migration of thrushes over the southern North Sea and the adjacent parts of the continent started at the 20th (LWVT). Then, a huge number passed over the Netherlands.. The high numbers of birds at both platforms mentioned above, do not coincidence with strong migration over the Netherlands.

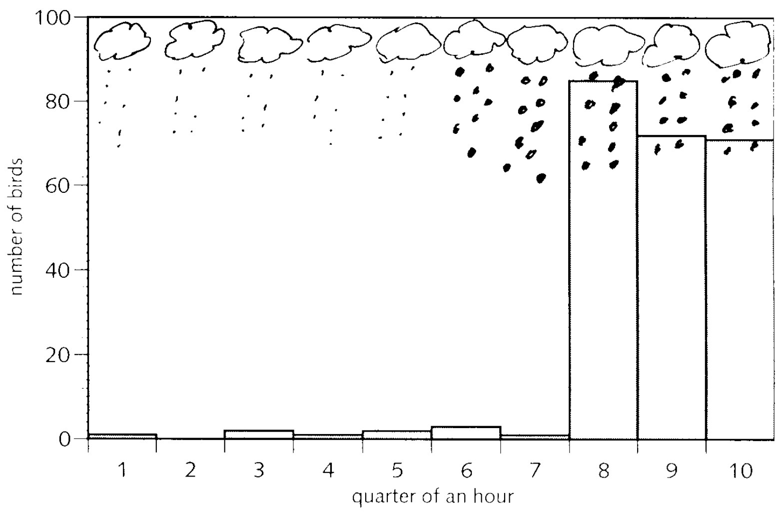
Between 21 and 25 weather over the Netherlands and the adjacent parts of the North Sea were determined by a strong high near Ireland. Wind over the North Sea came from northerly directions, but was calm. During nights fog could occur. On the 26th a high developed over Poland, causing winds from SE over the Netherlands. Further north above the North Sea wind turned W.

1 October 1998

In autumn 1998 the observation site Arnhem (inland, 100 km from the coast) was manned daily from half an hour before sunrise till 2,5 hours later. In the early morning of 1 October the weather was calm, with a light wind from ENE and a light drizzle. The wind in the higher airlayers was S. During the first one and a half hour hardly any visible bird migration was observed. Thereafter, when drizzle became rain, Song Thrushes passed by, one flock after the other, mainly to the S (Figure 5.12). At the end of the observation period 236 ex. had been noted, while migration still continued. Compared to other days and other seasons, this was a large number of Song Thrushes (Lensink 1996).

Figure 5.12

Number of Song Thrushes per quarter of an hour over the observation site Arnhem on 1 October 1998. Intensity of precipitation is indicated.

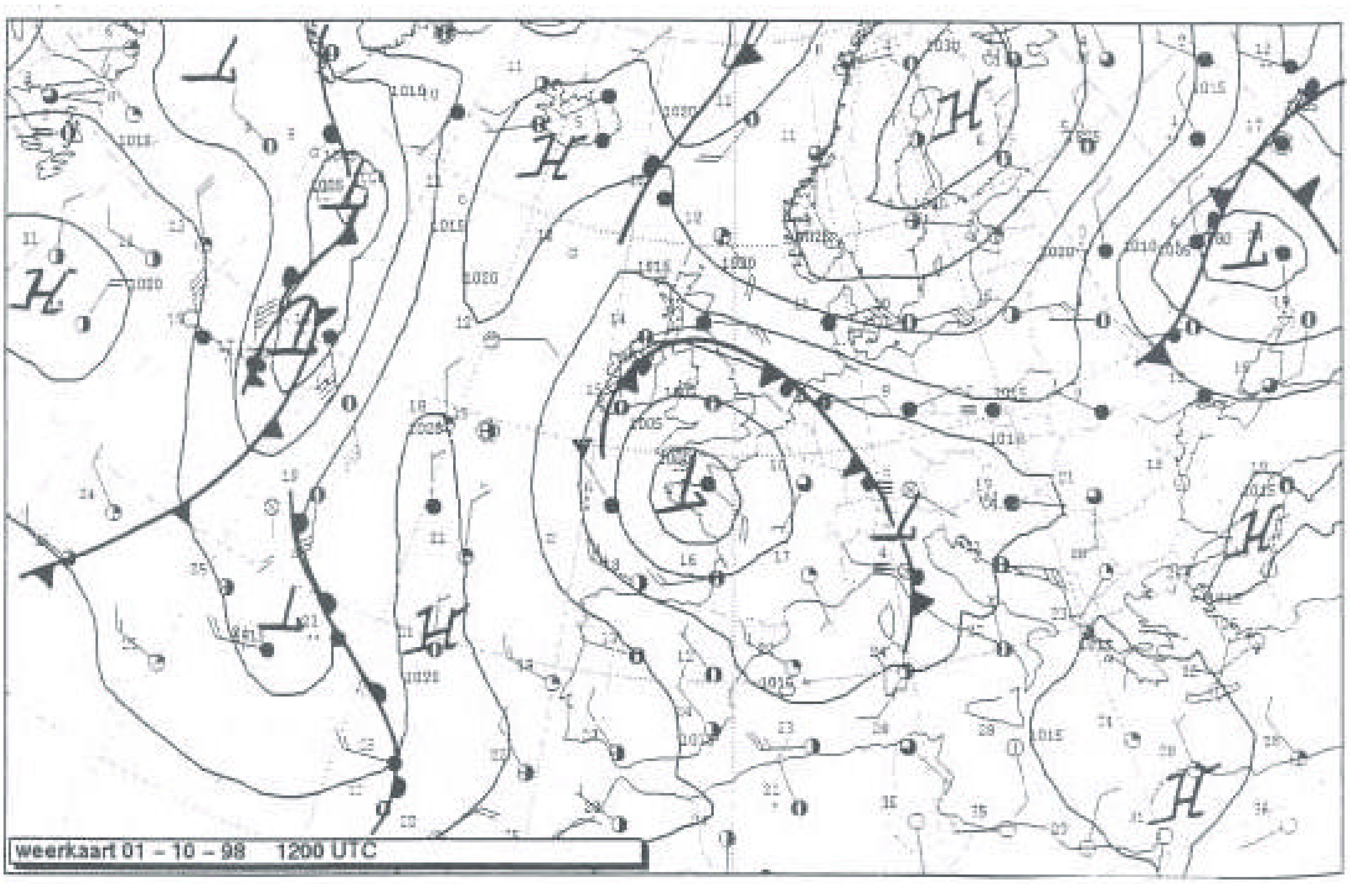


Of the 236 Song Thrushes observed, 198 passed over a front of 200 m wide. If Song Thrush migration was evenly distributed in space, as could be expected in inland broad front migration, around 1000 birds passed over a front of 1 km, which is 10,000 birds over 10 km. Since migration continued after the observation period, the real number has been far higher.

At the end of September 1998 a high was located above Scandinavia, with easterly winds along the southern side. On 29 September a deep low moved into the Channel and became stationary for a few days. The frontal system moved over the Netherlands from south to north on 1 October and became stationary as well across the northern provinces for some days (Figure 5.13). The heavy Song Thrush migration over Arnhem coincided with the passage of the rain front. From other sources it is known that during the first days of October 1998 the Wadden Islands were crowded with thrushes (pers. obs. Camphuysen & Leopold). All these birds probably had departed from Scandinavia with tail wind, and got stuck in the rain above the Wadden Islands and landed consequently. Because they met the adverse weather near or above the Wadden Sea area, only a few beached birds were reported in the next weeks.

Figure 5.13

Synoptic weather report of 1 October 1998 (source: KNMI, De Bilt).



6 Patterns of falls in different species groups

6.1 Herons, spoonbills, storks, rails, gallinules

Beached bird surveys: Not included in the analysis. Herons, storks and spoonbills are occasionally found dead on beaches, but in small numbers only. Severe winters may drive large numbers of Coot *Fulica atra* to coastal waters and smaller numbers of Waterrail *Rallus aquaticus* and Moorhen *Gallinula chloropus*. Cold-rushes of Coot may include large groups of birds in flight, but most individuals soon settle and starve to death in coastal waters.

Platform observations: Not included in the analysis. Some Grey Herons are seen on migration, particularly on offshore installations near the coast (<15 km). Coot, rails and Moorhen are rarely seen.

Ship based sightings: Not included in the analysis. Some Grey Herons are seen on migration, particularly short distances from the coast (<15 km). Coot, rails and Moorhen are rarely encountered.

Light vessels: Of this group, only rails, particularly Water Rail, and gallinules, particularly Moorhen were reported. Water Rail and Moorhen were found on all four light vessels and were the most commonly reported birds among the non-passerines.

Helgoland trapping: no data on this group.

Castricum: At Castricum, recent attempts to attract migrating rails at night by broadcasting calls, revealed substantial migration of Waterrail (with small numbers of Moorhen and Spotted Crake) along the Dutch mainland coast between August and November, with peak numbers occurring in October. Up to 66 Water Rails were caught in a single night, indicating that at least hundreds of birds may have passed.

6.2 Swans, geese and ducks associated with fresh water

Beached bird surveys: Not included in the analysis. Severe winters may produce substantial numbers on dead (starved) waterfowl on beaches. Many of these waterfowl wash ashore and have apparently died offshore. All species of swans, geese, dabbling and diving duck are found. Waterfowl wrecks following bad weather have been reported very rarely (on clear cut event, a Wigeon mass stranding in autumn/early winter on Texel in 35 years). Waterfowl most commonly found on beaches (1977-99 > 2000) were Shelduck *Tadorna tadorna* and Scaup *Aythya marila* (NZG/NSO *unpubl. material*).

Platform observations: Most species of waterfowl can be seen from platforms in the southern North Sea. There is no evidence for offshore wrecks for any of these species. The capacity to alight on the water and to sit out adverse conditions probably reduces the vulnerability of these birds. Waterfowl don't normally land on offshore installations, but they may rest on the water on the leeward side.

Ship based sightings: Most waterfowl are common migrants in coastal waters and in severe winters numbers may increase (Camphuysen & Van Dijk 1983). Most species of waterfowl can be encountered occasionally during sip-based surveys. There is no evidence for large scale wrecks offshore for any of these species. The capacity to alight on the water and to sit out adverse conditions probably reduces the vulnerability of these birds.

Light vessels: Not a single fresh water swan, goose or duck was sent in, indicating that these birds land on water rather than on a ship if they meet adverse conditions.

Castricum: / Helgoland trapping: no data on this group.

6.3 Waders

Beached bird surveys: Not included in the analysis. Wader species most commonly (> 1000, 1977-99) encountered on the beach are Oystercatcher *Haematopus ostralegus*, Dunlin *Calidris alpina*, Curlew *Numenius arquata*, and Redshank *Tringa totanus*. Mass-strandings are usually cold weather induced. Small numbers of Woodcock *Scolopax rusticola* wash ashore in similar conditions as most autumn strandings of thrushes and these waders may be involved in falls. Waders have a very limited capacity to swim at sea and are therefore more vulnerable to bad weather conditions than waterfowl.

Platform observations: Not included in the analysis. The occasional wader (usually sandpipers) may be found on platforms, but although many species of waders are regular migrants across and along the North Sea, very few seem to be involved in falls. Head winds may force migrants to fly at low altitudes.

Ship based sightings: The occasional wader (usually sandpipers) may be found onboard ships, but although many species of waders are regular migrants across and along the North Sea, very few seem to be involved in falls. Head winds may force migrants to fly at low altitudes. The species most commonly encountered offshore are Golden Plover *Pluvialus apricaria*, Grey Plover *P. squatarola*, Lapwing *Vanellus vanellus*, Knot *Calidris canutus*, Dunlin, Bar-tailed Godwit *Limosa lapponica*, Whimbrel *Numenius phaeopus*, Curlew, and Redshank.

Light vessels: Waders were reported from each light vessel. Lapwings (14 parcels), snipes (3 species; 28 parcels) and Dunlins (15 parcels) were most commonly reported.

Castricum / Helgoland trapping: no data on this group.

6.4 Birds of prey

Beached bird surveys: Not included in the analysis. Kestrels *Falco tinnunculus* wash ashore regularly. Other species are rarely encountered.

Platform observations: Not included in the analysis. Offshore installations are regularly visited by falcons and sparrowhawks (occasionally other birds of prey), which may stay several days and hunt passerines associated with the installation.

Ship based sightings: Not included in the analysis. Ships at sea are regularly visited by falcons and sparrowhawks (occasionally other birds of prey), which may stay hours or even days and hunt passerines associated with the vessel.

Light vessels: Surprisingly, not a single bird of prey was reported. Since records of live birds of prey on ships are not uncommon (SASBASE; reports in Sea Swallow), this probably indicates that birds of prey that land on ships can successfully feed there, as opposed to all other birds (their victims), and as a result, do not end up in a museum.

Castricum / Helgoland trapping: no data on this group.

6.5 Doves and pigeons

Beached bird surveys: Racing pigeons *Columba domestica* are commonly found beached, particularly in the summer months. Most birds found dead are ringed and have been released for pigeon racing.

Platform observations / Ship based sightings: Pigeons and doves are commonly attracted to offshore installations and moving vessels, through the year. Street pigeons and Collared Dove *Streptopelia decaocto* are the most common species.

Light vessels: No birds of this group were ever sent in. As feral pigeons in particular have been observed at ships regularly (SASBASE), this indicated that such pigeons are either fed by the crews and survived, or were not considered worthwhile to be shipped off to the museum.

Castricum / Helgoland trapping: no data on this group.

6.6 Owls, cuckoos and woodpeckers

Beached bird surveys: Small numbers of owls (mainly Long-eared Owl *Asio otus* and Short-eared Owl *A. flammeus*) are found dead on beaches in winter. Cuckoos, parrots, parakeets and woodpeckers are very rarely found.

Platform observations: Offshore platforms are regularly visited by Short-eared and Long-eared Owls, which may stay several days and hunt passerines associated with the installation.

Ship based sightings: Ships are regularly visited by Short-eared and Long-eared Owls, which may stay several days and hunt passerines associated with the vessel.

Light vessels: no data on this group.

Castricum / Helgoland trapping: no data on this group.

6.7 Swifts and swallows

Beached bird surveys: Swifts and swallows are rarely found dead on the beach.

Platform observations: Common Swifts *Apus apus* and all swallows are frequently seen from offshore installations, particularly in spring. Swifts are common at sea during the entire summer

Ship based sightings: Regular sightings of Common Swifts from ships, mainly between April and October and with the vast majority in May. Vulnerable to bad weather (Offringa 1996). Swallows are frequently seen at sea during spring migration.

Light vessels: Swifts and swallows were only rarely found dead at any light vessel. Swifts were sent in once from light vessel Texel and twice from Noord Hinder. The only species found was the House Martin: two parcels from Noord Hinder contained this species and one from Terschellinger Bank.

Castricum / Helgoland trapping: no data on this group.

6.8 Larks

Beached bird surveys: Small numbers of Skylarks *Alauda arvensis* are found beached. Numbers are smaller than expected from overall numbers moving across the North Sea, despite their body size (most corpses arrive as pairs of wings and should be found; gulls don't tend to swallow Skylarks entirely).

Platform observations: Skylarks are common migrants, frequently seen from platforms, particularly with head wind or adverse weather, when birds tend to fly low. Main passage in October/November and February/March.

Ship based sightings: Skylarks are common migrants, frequently seen or heard from ships at sea, particularly with head wind or adverse weather, when birds tend to fly low. Main passage in October/November and February/March.

Light vessels: The Skylark was the only Lark-species reported, but overall it was one of the most frequently reported birds: it was reported yearly from light vessel Terschellinger Bank and Texel (in 14 and 54 parcels respectively); in all years but one from Noord Hinder (39 parcels) and the majority of years with data from Goeree (7 parcels).

Helgoland trapping: no data on this group.

Castricum: Skylarks are caught during diurnal migration at Castricum, using the clap nets. Autumn migration is concentrated between 1 October and 15 November with a peak in mid-October. Trapping at night revealed substantial nocturnal migration on some occasions. In reaction to winter snowfall, Skylarks may perform massive cold weather movements, in some cases lasting 2-3 days. In the 18 winters between 1978 and 1996, 12 such cold rushes were observed at this trapping station.

6.9 Pipits and wagtails

Beached bird surveys: Pipits and wagtails are sparsely found dead on beaches. Pipits are small passerines and wrecked individuals are swallowed entirely by gulls before corpses may reach the coast.

Platform observations: White Wagtails *Motacilla alba*, Yellow Wagtails *M. flava*, Meadow Pipits *Anthus pratensis*, Tree Pipits *A. trivialis* and Rock/Water Pipits *A. spinoletta* are common migrants at sea, mainly seen in March/April and September/October.

Ship based sightings: White Wagtails, Yellow Wagtails, Meadow Pipits, Tree Pipits and Rock/Water Pipits are common migrants at sea, mainly seen in March/April and September/October. Yellow Wagtails are mostly seen in May.

Light vessels: Five species of pipit were recorded, of which the Meadow Pipit was the most common species. Like the Skylark, Meadow Pipits were sent in almost yearly from all vessels and often more than once each year, with the exception of Goeree, from which Meadow Pipits were sent in only once. Wagtails were rare, only Yellow Wagtails were sent in occasionally.

Helgoland trapping: no data on this group.

Castricum: Like Skylarks, pipits and wagtails are caught with clap nets during diurnal migration, Meadow pipit migration is concentrated between late September and mid-October, with strong return passage behind warm fronts in April. Whereas Yellow Wagtails are mainly on their way from Northern Europe to Africa and vice versa, recoveries suggest the migration of White Wagtail (mainly September and March-April) partly involves Icelandic birds crossing the North Sea towards southern Europe and back.

6.10 Wren, Robin and small thrushes

Beached bird surveys: Because these species are very small and because most individuals wrecked at sea are immediately swallowed by gulls, very few reach land.

Platform observations: Robin *Erithacus rubecula*, Garden Warbler *Sylvia borin*, Blackcap *S. atricapilla* and Wheatear *Oenanthe oenanthe* are examples of species that are frequently encountered on offshore installations, mainly in September/October and April/May. Many of these birds arrive at night, attracted to lights, or in misty conditions.

Ship based sightings: Robin, Garden Warbler, Blackcap and Wheatear are examples of species that are frequently encountered on ships, mainly in September/October and April/May. Some of these birds arrive at night, attracted to lights, or in misty conditions.

Light vessels: Members of this group were commonly found and sent in yearly, but less frequently than the large thrushes. No species was sent in yearly from any light vessel. Most common overall were Wheatear, Robin and Redstart.

Castricum: Members of this group are commonly caught and one species, the Robin is among the top-three of most numerous species, i.e. they sometimes occur in excessive (fall-like) numbers from August through October.

Helgoland trapping: Dunnock, Robin and Redstart are species that have sometimes been caught in high numbers on Helgoland, both in spring and in autumn. Of these, the Robin was most often involved.

6.11 Thrushes

Beached bird surveys: Thrushes are the main group of passerines found dead on beaches and wrecks of these birds are recorded every autumn, in some winters and occasionally in spring (mainly March). Commonest species are Redwing *Turdus iliacus* and Songtrush *T. philomelos*, Blackbird *T. merula* and Fieldfare *T. pilaris*. The highest numbers are found in October and November, coinciding with the main period of autumn migration. During spring migration, mainly in March, lower numbers are found.

Platform observations: Commonly seen from platforms, sometimes in large numbers. Thrushes attracted to offshore installations have a tendency to continue flying circles. This behaviour leads to many more casualties (collisions with lights, individuals burned in flares) than for example with Starlings *Sturnus vulgaris*. Up to 75,000 Redwings were seen circling anticlockwise around Buchan A field (57.54'N, 00.01'E) on 25 October 1991 with an equal number of Fieldfare (North Sea bird Club 11th Annual Report, 1992). A flock of 3000 Blackbirds was seen from Thistle A (61.22'N, 01.35'E) that same autumn (North Sea bird Club Bulletin 68:4).

Ship based sightings: Thrushes are commonly seen from ships and may be attracted in adverse conditions (drizzle, fog). Large numbers are seen in October/November, smaller numbers in March and during winter. Redwings, Blackbirds and Fieldfares are normally most abundant.

Light vessels: Thrushes comprised the most commonly found group on board of the light vessels. Blackbird, Fieldfare, Songthrush and Redwing each were sent in yearly and commonly from Texel, while Noord Hinder, Goeree and Terschellinger Bank sent in birds from this group as a whole in each year. Rarely, other large thrushes, i.e. Mistle Trush and Ring Ouzel were found.

Castricum: The Redwing is the first species of this group to appear in sometimes very large numbers (first half of October). In the second half of October, Blackbirds, Redwings and Songthrushes may be caught in massive numbers. Fieldfares, and sometimes Redwings, are caught in large numbers during cold spells in winter.

Helgoland trapping: Ring Ouzel, Blackbird, Redwing and Song Thrush were all involved in days with very high catches on Helgoland, both in spring and in autumn. Of these, Song Thrushes were most often involved. Fieldfares may also occur in high numbers on the islands during falls, but are less likely to be caught in the Helgoland trap.

6.12 Warblers

Beached bird surveys: Because these species are very small and because most individuals wrecked at sea are immediately swallowed by gulls, very few reach land.

Platform observations: Chiffchaff *Phylloscopus collybita*, Willow Warbler *P. trochilus* Goldcrest *Regulus regulus* are examples of species that are frequently encountered on offshore installations, mainly in September/October and April/May. Many of these birds arrive at night, attracted to lights, or in misty conditions.

Ship based sightings: Chiffchaff, Willow Warbler and Goldcrest are examples of species that are frequently encountered on ships, mainly in September/October and April/May. Some of these birds arrive at night, attracted to lights, or in misty conditions.

Light vessels: Again, although members of this group were commonly found and sent in yearly, no species was sent in yearly from any light vessel. Most common overall were Blackcap, Garden Warbler. Remarkably, several warbler species, like Grasshopper Warbler, Sedge Warbler, Reed Warbler and Willow Warbler was rather commonly reported from Noord Hinder, but to a far lesser extent from the other ships.

Castricum: Members of this group are commonly caught and two species, the Blackcap and Garden Warbler are the second and third of the top-three group of most numerous species (with the Robin of the former group), i.e. they are sometimes occur in very large (fall-like) numbers. The Blackcap is a special case within this group, as most of the migrants apparently arrive from directions between S and E, rather than from northerly directions. This migration direction leads to relatively many birds crossing the North Sea towards W ad NW, and also to associations between weather and migration intensity that may differ from other species. Several other warbler species are sometimes very numerous: Reed and Willow Warbler, Goldcrest and Chiffchaff. Birds of this group are mainly caught from the first half of August until the first half of October; Goldcrests into the second half of October.

Helgoland trapping: Six species, Garden Warbler, Blackcap, Common Whitethroat, Willow Warbler, Chiffchaff and Pied Flycatcher have been involved in days with high bird numbers caught. The Blackcap was involved most often and for the longest period of time, ie into October, while the other warbler species were only numerous in September, and in April/May.

6.13 Tits

Beached bird surveys: Rarely found in the beach.

Platform observations: Tits (mainly Great Tit *Parus major* and Coal Tit *P. ater*) are occasionally seen from platforms, particularly on installations near the coast.

Ship based sightings: During ship based surveys very rarely encountered.

Light vessels: Tits were rare, with in total only one parcel containing a Great Tit and one containing a Coal Tit, both from Noord Hinder.

Castricum: One species, the Coal Tit, is sometimes caught in massive numbers, particularly in the second half of September and in the first half of October. Ringing recoveries have shown that such influxes also involve birds crossing the North Sea.

Helgoland trapping: Tits were never identified as a major species in the catches.

6.14 Crows

Beached bird surveys: Jackdaw *Corvus monedula* and Rook *C. frugilegus* are common migrants crossing the North Sea. Wrecked specimens are mainly found in spring and autumn. Black Crow *C. corone* are largely residents and casualties found on beaches have usually died on the spot.

Platform observations / Ship based sightings: Crows (mainly Rook and Jackdaw) are mainly seen in October/November and March/April. Crows usually don't settle on offshore installations or ships, or very briefly.

Light vessels: Crows were not reported.

Castricum / Helgoland trapping: no data on this group.

6.15 Starlings

Beached bird surveys: Starlings *Sturnus vulgaris* are second commonest group of passerines, immediately following thrushes. As one of the commonest migrants crossing the North Sea and as a bird that cannot usually be swallowed completely by gulls, this is in line with expectation. High numbers may be found in October/November, February/March, or occasionally in winter. During summer migration, hardly any are found dead.

Platform observations: Common migrants, mainly October/November and March (no observations conducted in summer). In contrast to thrushes, Starlings attracted to offshore installations usually alight on the installation and stop flying around. Large flocks of Starlings may virtually cover offshore platforms under misty or rainy conditions.

Ship based sightings: Common migrants, mainly October/November and March, very few in summer. Starlings commonly land on vessels and large flocks of Starlings may virtually cover ships under misty conditions in autumn.

Light vessels: Starlings were regularly reported, with the main period with victims October/November and March.

Castricum / Helgoland trapping: no data on this group.

6.16 Sparrows, finches and buntings

Beached bird surveys: Despite the strong migration of this group across the North Sea, they are only occasionally found. Most wrecked birds are apparently eaten by gulls before they reach the coast.

Platform observations: Chaffinch *Fringilla coelebs* and Brambling *Montifringilla montifringilla* are common migrants, particularly in autumn. Substantial numbers may be attracted to offshore installations and may land on platforms

Ship based sightings: Chaffinch and Brambling are common migrants, particularly in October/November and March/April.

Light vessels: Like in other multi-species groups, members of the sparrows, finches and buntings were sent in (almost) yearly from most vessels. Most common were Chaffinch and Reed Bunting. Light vessel Goeree sent in remarkably few birds of this group, with only two parcels containing Chaffinch.

Castricum: no data on this group.

Helgoland trapping: The Chaffinch was listed once in spring (April) and once in autumn (September) as a species involved in a day with large numbers of bird catches on the island.

7 Occurrence of common species above the Southern North Sea

In this section the occurrence of the most numerous migrants over the North Sea is discussed, mainly based on the review of Lensink & van der Winden (1997). Details about timing and amount of migrants are given in Table 7.1.

7.1 Herons, spoonbills, storks, rails, gallinules

Spoonbills often take the short-cut from North-Holland to Belgium across the North Sea on autumn migration (CvZ).

Coot, Moorhen and Water Rail are mainly nocturnal migrants, and substantial numbers cross the North Sea to winter in Britain. The main passage is in October and March/April.

7.2 Swans, geese and ducks associated with fresh water

Substantial numbers of waterfowl depending on fresh water habitat, cross the North Sea, with the Mallard being the most numerous. Passage of the different species is between August and November and February and May with the main movements in October/November and February/March. During cold spells extensive winter movements can take place, especially from continental staging area, towards Britain.

7.3 Waders

Along the southern shores of the North Sea some major staging and wintering areas for waders are located, i.c. the Wadden Sea, Southwest-Netherlands (both mainland Europe), and along the British east coast the Wash, the Dee, the Firth of Forth among others. For this reason there is an extensive wader migration along and across the North Sea. In July/August there is mass migration towards African winter grounds, with the return movement in May. Later in autumn, especially October, movements are mainly directed towards wintering areas in Western Europe. These birds return (north)eastward in March and April.

In some winters extensive cold weather movements could occur with Oystercatcher, Dunlin and Curlew as the main species, especially with a sudden cold spell (Camphuysen & van Dijk 1983, Platteeuw *et al*. 1994).

The Lapwing is the most numerous wader. Since this species prefers inland, fresh water habitats, their migration routes partly differs from the species staging in coastal sites.. After the breeding season the Lapwing shows two migration periods, i.c. June/July and October/November. In both periods large number could cross the North Sea from the continent to Britain. The return movement is mainly in March.

7.4 Birds of prey

Raptor migration across the North Sea is quite scarce, so the numbers involved are very low. Nevertheless, sometimes these species are found on oil rigs, or seen flying offshore.

Since they are hardly found dead on beaches, they seem to survive, even after adverse weather circumstances.

7.5 Doves and pigeons

Among the doves, only the Turtle Dove is known as a regular, but rare migrant across the North Sea. Both Wood pigeon and Rock Pigeon hardly cross the North Sea. Nevertheless pigeons sometimes can be quite common. These birds mainly concern Her Majesty's Postal Pigeons (airfowl).

7.6 Owls, cuckoos and woodpeckers

None of the species in this group is numerous as a migrant above the North Sea. Among the owls Long-eared Owl and Short-eared Owl are regular migrants towards Britain.

Among the Woodpeckers only the Great Spotted Woodpecker shows irregular movements from Northern Europe into West-Europe. However, the numbers are low.

7.7 Swifts and swallows

Migration of Swifts mainly takes places in May and July/August. Their numbers above the North Sea are hardly known. Furthermore, this species can show extensive bad weather movements. Due to their dependence on aerial plankton for feeding, they avoid adverse weather systems. Instead, they move clockwise around low pressure systems, feeding in front of the frontal zones (Offringa 1996).

Swallows return to Europe in April/May. In August/September they move to Africa from Europe. All swallows are aerial feeders, and they can feed everywhere. Nevertheless, swallows are known from some major crashes due to adverse weather (Alerstam 1990, Berthold 1996).

7.8 Larks

The Skylark is a numerous winter visitor to Britain. Large numbers cross the North Sea, especially in October/early November and March/April. Together with the thrushes, it is one of the most numerous short distance migrants.

7.9 Pipits and wagtails

Summer visitors to West and North Europe are Yellow Wagtail and Tree Pipit, with the main migration in April/May and August/September. In September/October Meadow Pipit and White and Grey Wagtail migrate towards (south)west respectively south-west Europe. The return passage is in April. Migration of Grey Wagtail across the North Sea mainly consist of the British subspecies, which winters in Southern-Europe and North-Africa.

7.10 Wren, Dunnock, Robin and small thrushes

Even these small birds cross the North Sea, of which the Robin is the most numerous. The main passage is in October and April. Redstart, Wheatear and Whinchat are summer visitors to Europe. They return to their wintering grounds in August/September and return in April/May. Wheatears also show an extensive migration across the North Sea to and from Iceland and Greenland.

7.11 Thrushes

Among the thrushes Redwing and Fieldfare are the most numerous, followed by Songthrush and Blackbird. The Ring Ouzel and Mistle Thrush also cross the North Sea, but are far less common. Redwing mainly migrate in October with the return movement in March, Song thrush in October and April and the Fieldfare and Blackbird in October/November and February/March. In winter Redwing and Fieldfare can show extensive cold weather movements from the low countries to Britain.

The thrushes comprise one of the most numerous groups among the autumnal nocturnal and diurnal birds that cross the North Sea, as shown by radar studies, observations from ships and oil rigs, and coastal bird observatories.

7.12 Warblers

Most Warbler species are summer visitors to Western and Northern Europe, they winter in the south of Europe and/or Africa. Of these species main autumn migration takes place in August/September and the return movement is in April/May. Migration above the North Sea consists is bird from the British Isles and North(east)ern Europe. Substantial numbers of Blackcaps migrate from Central Europe to Britain vice versa.

7.13 Tits

Species like Goldcrest and Tits migrate within Europe. Their main migration periods are in October and March, but the number of migrants might fluctuate from year to year, the most strongly in Coal Tit and the most weak in Great Tit.

7.14 Crows

The main migrants among the crows are Rook and Jackdaw, of which substantial numbers winter in East Anglia. The main passage over the North Sea is October/November and March. At irregular intervals Jays may cross the North Sea in huge numbers, the last time in 1983 (John & Roskell 1985.). These irruptions originate from Central Europe (1983) or Scandinavia.

7.15 Starling

The Starling is one of the most numerous winter visitors to Britain. Birds from the north of Europe as well as further east, migrate towards the countries around the North Sea. The main numbers pass in October/November and March. Shortly after the breeding season has finished there is summer migration towards suitable feeding sites. In June and July low numbers already cross the southern North Sea.

7.16 Sparrows, finches and buntings

Of this group the Chaffinch is the most numerous, followed by the Brambling. Each year millions of these two cross the North Sea to winter in Britain and mainland Europe. The number of migrants over the northern parts of the North Sea is quite unknown, whereas above the southern parts the Chaffinch is certainly numerous. Main passage for all species in this group is October and March/April. Snowfall leads to cold weather movements in Bramblings

Crossbills from Northern Europe and Siberia show irruptions into Western Europe, approximately every three to four years. Main movements take place in summer and autumn. During the return migration this species is far less numerous.

Table 7.1

Timing and amount of migration of numerous species across the North Sea. For a justification see Lensink & van der Winden (1997).

Column 1	Species
Column 2	Estimated number of birds (in classes) crossing the North Sea
4	10.001-100.000 ex
5	100.001-1.000.000 ex
6	1.000.001-10.000.000 ex
7	>10.000.000 ex
Column 3	Quality of the information available for the estimation
Column 4	Maximum migration

species	Estimated number of birds crossing the North Sea	Quality of the information available for the estimation	Maximum migration J	F	M	A	M	J	J	A	S	O	N	D
Great Crested Grebe	cl 4	poor			X								X	
Pink-footed Goose	cl 4	very good		X								X		
Greylag Goose	cl 4	very good		X	X		X					X	X	
Brent Goose	cl 4	very good		X									X	
Barnacle Goose	>200.000	very good			X		X					X		
Shelduck	250.000	very good			X	X		X	X			X		
Wigeon	> 300.000	very good		X	X								X	
Teal	cl 5	quite good			X	X					X		X	
Mallard	cl 6	quite good			X				X	X			X	
Pintail	cl 4	very good			X							X		
Shoveler	cl 5	quite good			X	X				X		X	X	
Pochard	cl 5	quite good		X	X				X	X			X	
Tufted Duck	cl 5	quite good		X					X			X	X	
Scaup	cl 5	quite good			X							X		
Goldeneye	cl 4	quite good			X	X							X	X
Red-breasted Merganser	cl 4	quite good			X	X							X	
Water Rail	cl 4	very poor			X							X		
Moorhen	cl 4	poor				X						X		
Coot	cl 4	quite good			X							X	X	
Oystercatcher	cl 5	quite good			X		X		X	X				

Table 7.1 Continued.

species	Estimated number of birds crossing the North Sea	Quality of the information available for the estimation	Maximum migration											
			J	F	M	A	M	J	J	A	S	O	N	D
Avocet	cl 4	very good			X	X						X		
Kentish Plover	cl 4	quite good			X		X			X	X			
Golden Plover	cl 4	quite good			X		X			X			X	X
Grey Plover	cl 4	quite good					X			X		X	X	
Lapwing	cl 6	quite good			X								X	
Knot	cl 5	very good					X			X	X			
Sanderling	cl 5	poor			X		X			X		X	X	
Dunlin	cl 5	quite good			X	X	X			X		X	X	
Jack Snipe	cl 4	very poor				X						X		
Snipe	cl 5	poor			X					X	X		X	
Woodcock	cl 5	very poor			X	X						X	X	
Black-tailed Godwit	cl 4	very good			X				X					
Bar-tailed Godwit	cl 5	very good					X			X				
Whimbrel	cl 4	very good				X	X		X	X				
Curlew	cl 5	very good			X					X			X	X
Spotted Redshank	cl 4	quite good				X	X			X	X			
Redshank	cl 5	quite good					X		X	X				
Greenshank	cl 4	poor					X			X				
Turnstone	cl 4	quite good					X			X			X	
Little Gull	cl 4	poor				X	X					X	X	
Black-headed Gull	cl 6	quite good			X				X	X			X	
Common Gull	cl 5	quite good		X	X					X				X
Lesser Black-backed Gull	cl 5	quite good				X	X			X				
Herring Gull	cl 5	poor			X					X			X	X
Great Black-backed Gull	cl 5	quite good		X	X							X	X	
Sandwich Tern	cl 5	quite good					X			X	X			
Common Tern	cl 5	quite good					X			X				
Little Tern	cl 4	quite good					X			X	X			
Black Tern	cl 5	quite good					X		X	X				
Swift	cl 5	poor					X		X					
Skylark	cl 7	poor			X	X						X		
Sand Martin	cl 4	poor					X			X				
Swallow	cl 4	poor					X			X	X			
House Martin	cl 4	poor					X			X	X			
Tree Pipit	cl 4	poor					X			X	X			
Meadow Pipit	cl 5	poor				X						X		
Yellow Wagtail	cl 4	poor				X	X			X	X			
Grey Wagtail	cl 4	poor				X					X	X		
Wren	cl 4	very poor			X							X		
Robin	cl 5	very poor				X						X		
Redstart	cl 4	poor				X					X			
Whinchat	cl 4	poor					X			X	X			
Wheatear	cl 4	poor					X				X			
Ring Ouzel	cl 4	poor				X						X		
Blackbird	cl 6	poor			X							X		
Fieldfare	cl 6	poor		X								X	X	
Songthrush	cl 6	poor				X						X		
Redwing	cl 6	very poor			X							X		

Table 7.1 Final.

species	Estimated number of birds crossing the North Sea	Quality of the information available for the estimation	Maximum migration J	F	M	A	M	J	J	A	S	O	N	D
Mistle Trush	cl 4	poor			X							X		
Barred Warbler	cl 4	poor				X	X				X			
Garden Warbler	cl 4	poor					X			X	X			
Blackcap	cl 4	poor				X	X				X			
Chiffchaff	cl 4	poor				X					X			
Willow Warbler	cl 4	poor				X				X				
Goldcrest	cl 5-6	very poor			X							X		
Collared Flycatcher	cl 4	poor					X		X	X				
Coal Tit	cl 0-4	poor			X							X		
Blue Tit	cl 0-4	poor			X							X		
Great Tit	cl 0-4	poor			X							X		
Short-toed Treecreeper	cl 0-4	poor			X							X		
Jay	cl 0-4	poor					X					X		
Jackdaw	cl 4-5	poor			X	X						X	X	
Rook	cl 4	poor			X							X	X	
Starling	cl 7	poor			X				X			X	X	
Tree Sparrow	cl 4	poor				X						X		
Chaffinch	cl 7	poor			X							X		
Brambling	cl 5-6	poor			X							X	X	
Greenfinch	cl 4	poor				X						X	X	
Siskin	cl 4-5	poor		X	X							X		
Linnet	cl 4	poor				X					X	X		
Twite	cl 4	poor			X								X	
Redpoll	cl 3-5	poor		X									X	
Crossbill	cl 0-4	poor		X	X				X				X	X
Snow Bunting	cl 4	very poor		X	X							X		
Reed Bunting	cl 4	poor			X									

8 Discussion

The main characteristic of a 'fall' or 'fallout' is that migration is interrupted, and that relatively high numbers of birds alight on land and refuse to move on. Most falls are witnessed on islands or in coastal areas. There is substantial evidence that massive falls occur at sea also, where birds may drown by the thousands in the absence of structures (installations, ships, islands) where they can seek refuge. Birds on the ground are largely ignored in most studies, but the occurrence of a fall is indicated by wrecked passerines in beached bird surveys, by large numbers of passerines at offshore installations and ships, or by unusually large numbers at constant effort sites and elsewhere along the coast. Despite all our efforts, it is quite likely that even rather substantial falls, in the absence of a published record, may have been overlooked. As a result, estimates of the frequency of falls in our area must be considered minimum estimates.

8.1 Databases consulted

Early this century, curiosity driven scientists aimed at mapping migratory patterns of birds both over land and along the coast and these observers soon found their way to light vessels, coastal vantage points or promontories (with or without lighthouses), sparsely inhabited or even uninhabited islands, the Afsluitdijk and other man-made sites after they became available (e.g. Van Heurn 1912, Brouwer & Verwey 1922, Verwey 1922, Traanberg 1923, Brouwer 1928, Brouwer 1929, Van Oordt 1929, Van Dobben & Makkink 1931, 1933, Bouma & Koch 1934, Van Dobben & Makkink 1935, Van Dobben 1936, Mörzer Bruyns 1939, Vleugel 1943, Van Dobben 1944, Bierman 1954, Belterman et al. 1960, Vleugel 1960, Jonkers 1974, Prins 1974). Their observations have greatly contributed to our present knowledge of the attraction of lights on migrating landbirds in dark nights, of migration routes in the southern North Sea, on the funnelling effects of promontories and coastlines, and most importantly our present knowledge of falls.

Table 8.1
Datasets used for this study

dataset	aspect	period
NZG/NSO	beached birds	1965-1999
NZG/platforms	sea watching	1978-1986
NZG/offshore	sea watching	1987-1999
Light vessels	dead birds	1958-1971
CES-site Castricum	trapped birds	1989-1998
CES-site Helgoland	trapped birds	1989-1998
LWVT	visible bird migration	1982-1993

In later years, bird ringing activities in so-called 'constant effort sites' in coastal areas have resulted in a vast amount of data on species and temporal variations in numbers of migrants along the coast. In this respect and for this study, data from the constant effort sites Helgoland (German Bight) and Castricum (mainland coast Noord-Holland) have been studied and compared with the available data from offshore light vessels.

Finally, in the past decades, several other research projects investigated different aspects of the bird life in and around the North Sea. None of these projects was developed to study bird falls in relation to aircraft flight safety. Most projects were simply designed to gather data on the distribution, migration, mortality, breeding performance or foraging ecology of (sea-) birds. As a side-product, however, even in projects primarily aiming to study marine birds, information on the migration and abundance of passerines and other landbirds was collected (ship-based surveys, beached bird surveys, platform observations; NZG database; Camphuysen *et al*. 1982, Platteeuw *et al*. 1985, Van der Ham 1988, Camphuysen 1989, 1995, Camphuysen & Leopold 1994).

Ship-based surveys at sea and observations on platforms have been conducted irregularly, mainly from platforms of opportunity. Nevertheless, a picture emerged of low flying passerines and other land birds over sea. It is assumed that most birds observed, except those that normally travel low over the sea (some waterfowl) were facing difficulties and were forced down rather than travelling at 'normal' altitudes, so that larger numbers observed may be indicative for a fall. To avoid confusion caused by background noise (there are always some birds to be seen), only observations of 'unusually large numbers' (compared to 'normal', i.e. during most of our surveys) were used as possible indicators of falls. Similarly, although during most beached bird surveys at least some passerines were found, only 'above background level figures' were considered to indicate that a fall had taken place (see results section). Beached bird surveys are severely biased to the winter half year and to larger species of passerines (Camphuysen 1988), and thus provide little information on the smaller 'warblers' group.

Drawbacks of constant effort sites are that these data report periods of intense migration rather than falls. In these datasets, however, the spectrum of species is much more complete and includes the smaller 'warblers'. Information obtained at light vessels (parcels sent in to the Zoological Museum of Amsterdam, ITZ) gives information about the species composition of birds involved in falls on offshore vessels (and platforms), but variations in numbers are also related to the enthusiasm of the personnel on board these vessels. Also, the number of specimens per species in a parcel is yet unknown, so information about the abundance of individual species is lacking. The relation between the number of migrating birds, the weather circumstances and the number of victims also remains to be studied.

The observations of visible bird migration by members of the LWVT give proper insight in the species composition, timing and amount of diurnal migration in the lower air layers inland and along the coast of the Netherlands. So nocturnal migrants are lacking. Along the coast there is strong leading line migration (Tinbergen 1956). It is unclear whether the stream of birds along the coast is fed by birds migrating over land, following the coast when reaching the sea, or fed by birds coming from over the North Sea, and following the coast after reaching land (cf. Buurma 1987). So, the species composition of diurnal migration along the coast and the species composition revealed from other databases consulted might differ. Nevertheless, the importance of Starling, thrushes, Skylark and Chaffinch also pops up from this database.

All results were compared with the consulted literature, in order to find overlap and/or discrepancies in conclusions that were reached from different angles. There was a general agreement in timing (spring and autumn migration), species composition (usually Starlings or thrushes, occasionally other species) and causes (adverse weather), but we could not obtain a complete idea of the scale and frequency of events (see further details below).

Falls along the coast have a distinct radar signature which is easily recognised (abrupt discontinuity in radar reflectivity; see: http://www.geocities.com/NapaValley/8596/results/radar/radar.html). Based on publications (Buurma 1989, 1992, 1995a, 1995b, 1997) and additional information (L.S. Buurma, RNLAF, *pers. comm*.), it may be expected that technically the radar of the RNLAF can produce similar results. It is overlooking a large area and is independent of the field activities of either professional or amateur observers. Because we did not make any analysis on radar data, both the frequency and scale of indications of passerine falls is still obscure.

In conclusion, the various datasets consulted, and even in combination with the explored literature, give indirect and incomplete information on the occurrence and frequency of falls. However, the observed and sometimes striking overlap in results (e.g. coinciding peak events in databases or in published accounts) indicates that the data provided are valuable and that perhaps the most dramatic events were not overlooked. Given further time, there are lots of additional data which could be analysed (Dutch ringing data, British ringing data). Still, while overseeing the entire set of data and the information obtained in libraries, it is clear that most falls are both spatially and temporally restricted, and thus easily overlooked, so that several such instruments will have to be deployed in a future monitoring programme.

8.2 Seasonal pattern in falls

One of the most striking results of this study is the seasonal pattern in relative abundance of passerines travelling at lower altitudes. Distinct peaks in migration intensity in March and October/November emerged in all sets and with very few exceptions, most documented falls occurred in the latter period. Lower levels of migration were recorded in (all) other months of the year, slightly higher levels in severe winter periods.

Autumn peaks are most likely to occur because migrants are more likely to encounter adverse weather conditions, and because numbers of migrants involved are much larger (with juveniles participating). Head winds (southwesterlies) are most likely to occur in autumn, forcing larger numbers of passerines to fly at lower altitudes which will make them more 'readily visible' in the consulted datasets.

Passerines engaged in October/November and March migration across the North Sea are mainly short distance migrants (i.e. migration within Europe, not from Europe to Africa). Most numerous are larks, thrushes, Starlings and finches (Lensink & Van der Winden 1997). In all consulted databases, thrushes and Starlings seem over-represented compared to larks and finches, which could be indicative for a greater vulnerability to fall conditions.

In August/September and April/May most intensive migration consists of small long distance migrants (i.e. Europe to Africa and vice versa), mainly warblers travelling at great altitudes during the night. The volume of this migration is probably as large as that of the short distance migrants (Lack 1959), but these migrants provide only weak signals in the consulted datasets (particularly in beached bird surveys and ship-based observations). Early autumn night migrants were most obvious during studies at coastal sites, uninhabited islands and light vessels (e.g. Brouwer & Verwey 1922), and these birds seemed to rapidly disperse and start foraging during the day. In the more populated coastal areas, such small migrants simply 'evaporate' during the day, because they forage in bushes and trees in full leaf. Strong evidence of the occurrence of nocturnal migration is also obtained at constant effort sites along coasts; again, indicating peaks in migration rather than falls.

A further explanation of the under-representation of night migrants in some of the consulted data sets is that most nocturnal migrants fly very high and over relatively great distances. When facing problems at greater altitudes, they have a greater potential to reach safe ground and disperse than the relatively low-flying flocks of diurnal migrants later in the year. Moreover, if such small birds hit the sea and drown, most will disappear because gulls swallow such small birds completely, rather than just peck on the fleshy parts. The absence of a clear record of early autumn night migrants in most datasets could misleadingly lead to the conclusion that falls do not occur or are less likely to occur in that period (but see Davies 1966, Riddiford 1988). The huge migration of this group of species is only obvious from the trapping data.

8.3 Scale and frequency of falls

Despite the shortcomings of the databases consulted, some observed events draw attention. Three out of four recorded large falls were mentioned in the literature as well. At least two (October 1982, 1988) were clearly large scale events, presumably visible in all coastal areas around the southern North Sea (Walker & Venables 1990). Most falls, however, are probably quite small scale. Early September 1965, a fall was witnessed on a 40 km coastal stretch in East-Anglia (U.K.), in which an estimated half million birds arrived and stayed for several days (Davies 1966). The chance that such small scale events show up from the databases consulted is rather limited, because observers have to be on the right place on the right time.

Numbers of passerines attracted to offshore installations can be immense. Between 5000 and 10,000 thrushes and Starlings may regularly (nearly annually) be attracted to a single site, while at times numbers build up to a stunning 150,000 passerines at a single offshore platform (North Sea Bird Club reports, 1986-1997). Up to 75,000 Redwings with the same number of Fieldfare (150,000 thrushes in total) were seen circling anticlockwise around the Buchan A platform in the central North Sea in the morning of 25 October 1991 (57°54'N, 00°01'E; Anon. 1992). At the more northerly Thistle A (61°22'N, 01°35'E), 3000 Blackbirds arrived that same day (North Sea Bird Club Bulletin 64:4). In line with earlier studies, massive numbers of thrushes arriving at ships, offshore installations and lighthouses, do not easily settle (Mörzer Bruyns 1939), potentially causing immense problems for flight safety at offshore islands. Sightings at offshore installations between 1986 and 1997 indicate that mass-arrivals of at least 10,000s of thrushes are near-annual events, particularly in autumn, and may occur anywhere in the North Sea. At an island birds probably settle more easily, though perhaps later on make further low flights in search of cover. From the point of view of flight safety, we consider a 'local fall' of at least 10,000 passerines in a few flocks as a significant threat. Such falls may be expected at least annually, while major falls (100,000-500,000 birds or more) are probably exceptions, that are likely to occur once in five years.

As shown for an inland observation site, fall like patterns can occur everywhere. If this inland site is taken as an example, the following could be valid. Outside the coastal areas and away from big waterbodies, passerine migration over the Netherlands is characterised as broad front migration (Tinbergen 1956). In this way it could be comparable with broad front migration over the North Sea. Species composition and timing are about the same as well. On an inland site migration intensity is stronger than twice the baseline number (>900 birds) on about 14 days each autumn, of which on three more than five times (>2250 birds) and once even more than ten times (>4500 birds). Of these birds on average 60% pass over a front of 200 m wide (Lensink & Kwak 1985). So, the figures mentioned become respectively 540, 1350 and 2700 birds. Such intensities are equal to respectively 25,000, 67,000 and 135,000 birds migrating over a front of 10 km.

During falls birds fly into adverse weather and want to reach land as soon as possible. If this happens above the North Sea, an island is very attractive. So, the birds mentioned above, could all land on an island. Since the island will be the only land within a large area, not only the birds flying in the front perpendicular on the main heading are involved but even from a wider area. Secondly, depending on the numbers aloft and their timing of take off, falls could last more than 2.5 hours. So, intensities of broad front migration of 540, 1350 and 2700 birds in 2.5 hours can easily lead to falls that are far bigger than 25,000, 67,000 or 135,000 birds, even twice or three times more.

It should be stressed, that the above figures were presented as an example to show how different migration intensities could generate large numbers of grounded birds. We still do not know the day to day variation in migration intensity above the North Sea and the real species composition. Furthermore, if we would know this, and thus the probability different migration intensities we still would not be finished. The relevant point is the probability of strong(er) migration in combination with fall risk weather circumstances.

8.4 Environmental conditions responsible for falls

Migration may be halted under adverse weather conditions, particularly when areas of open water have to be crossed. Fog, rain, strong headwinds (or no wind at all; Vleugel 1960) and temperatures are factors of significance. Most migrants set off under favourable conditions, and may face poor weather half way. Several documented falls occurred in coastal areas where exhausted birds just reached the shore (Prins 1974, Williamson 1966, Davis 1967, Riddiford 1988, Walker & Venables 1990). On occasions, falls were recorded under fine weather, indicating that the adverse conditions were encountered elsewhere, probably while the birds were still well at sea. An example of the latter was witnessed in October 1982 along the Dutch coast and at the offshore installation Meetpost Noordwijk (Files NZG/CvZ database). Exhausted thrushes arrived late afternoon from a westerly direction (towards land), many passerines were seen swimming and vast numbers fell victim to gulls associated with the platform. During the observations, the weather was fine, with moderate to good visibility, complete overcast, and moderate breeze (SE-E 3-4B), but the large numbers washing ashore in later days indicated that many birds were wrecked while still out at sea.

Large scale drift of migrants is a complicating factor in the analysis of falls. If there is a mass drift of birds to the west due to easterly winds, unusually high numbers might migrate over the North Sea rather than along its eastern seaboard. In autumn this is possible with a large area of high atmospheric pressure over Scandinavia. Along the southern side of the high, (strong) easterly winds over the Baltic and Southern Scandinavia are expected. In spring, large scale drift towards the North Sea is expected with strong (south) easterly winds when a high is established over Central Europe. If such synoptic weather is accompanied by a frontal system moving towards or over the southern North Sea, large scale falls might occur, because birds setting off from Scandinavia in autumn with favourable winds, meet the advancing front head on, somewhere over the North Sea (e.g. May 1985, October 1982, 1988; Riddiford 1988, Walker & Venables 1990).

If migrants meet adverse weather ahead of them, they will reconsider their heading and height. As far as we know, they do not change their direction in relevant numbers. There is some evidence that they lower their flight altitude, a least below the clouds. This implies that with the same total migration intensity the numbers will be concentrated in a smaller layer. During optimal condition birds could be flying evenly spread over heights between hundreds and thousands of meters, whereas under adverse conditions most of the birds will probably fly in the lower hundreds of meters. It could be expected, that during a fall above sea most migrants will fly in the lower airlayers. This behaviour previous to falls, should be incorporated in the analysis of falls and the risk for airtraffic.

8.5 Species involved in falls

As indicated earlier, several sources suggest that short distance migrants such as thrushes and Starlings are most vulnerable and are most commonly reported in falls. However, the slightly less conclusive data from light vessels and from constant effort sites along the coast suggest that both long and short distance migrants may be involved. Catches at Helgoland and Castricum point towards long distance migrants as being also commonly involved in falls. Since both groups of migrants are numerous above the North Sea, but in different periods, both could be expected in falls.

Among the short distance migrants, larks, Robin, thrushes (Fieldfare, Redwing, Songthrush), Starling and finches (Chaffinch) are the most abundant migrants over the North Sea. Their main breeding areas are in Northern and North-eastern Europe, their main winter quarters are in the United Kingdom.

Among the long distance migrants, small thrushes and warblers are the most numerous, especially Blackcap, Garden Warbler, Redstart, Chiffchaff and Willow Warbler. These species breed all over West-Europe and winter in Africa.

As far as we know, besides massive cold-rushes, falls of wildfowl and waders do not occur.

Different species of birds attracted to light vessels were found to behave quite species-specific. Crows, Rooks and Starlings had a great tendency to land and sit on offshore structures, forming large roosts around the attractive source of light. Even in a night when 5000 Starlings were attracted to lightvessel "Terschellingerbank', only four casualties were found dead next morning (Mörzer Bruyns 1939). In contrast, larks, thrushes and most small passerines restlessly continued their flight around the lights. Casualties among the latter groups were much more numerous and the constantly flying birds will probably pose a significantly greater threat to aircraft flight safety in the proposed situation of an offshore island and airport. On the other hand, on an island these species might land easily because of the large area of flat ground. Illuminated offshore structures and coastal lighthouses attract significantly more birds in dark nights (overcast, new moon; Brouwer 1929, Mörzer Bruyns 1939, Verheijen 1981).

8.6 Bird migration and light

Nocturnal migrants are attracted by lights (Mörzer Bruyns 1939, Sage 1979, Jones 1980, Van Franeker 1998), particularly in dark nights (poor visibility, complete overcast, new moon or phases when the moon is small; Verwey 1928, Brouwer 1929, Mörzer Bruyns 1939). It is unclear whether the attraction is the result of disorientation, or that disoriented birds are the result of the attraction towards lights.. Studies at coastal lighthouses revealed that large numbers of birds were attracted on occasions and substantial numbers were killed after collision with the structure, or by predators roaming the area (Jonkers 1974). In a detailed analysis Verheijen (1980) showed that numbers of victims are linked to the moon phase. During moonless nights more victims are found than during nights with full moon. Illuminated RTV transmitter masts in the USA are known to attract vast numbers of migrants under certain conditions (reviewed by Dirksen et al. 1998). The lights placed on such masts, attract birds mainly under adverse weather conditions, probably because their main orientation cues such as the moon or stars are no longer visible. Other examples are the Port of Felixtowe mentioned on page 22 and the famous ringing site at Ngvlia Lodge in Isavo East National Park (Kenia), where (ten)thousands of passerine migrants are attracted to the lodge lights during misty nights in November and December.

In conclusion, lights may cause large concentrations of flying birds around offshore structures or at coastal sites, particularly during dark nights. An illuminated offshore island such as the proposed airport will probably attract much larger numbers of birds than the relatively dark nearby coast, but will do so only under certain conditions and during the peak of spring or autumn migration (e.g. Aug-Nov and Mar-May).

8.7 Conclusion

Passerine falls are strongly related to the main migration periods: August-November and March-May and are generally caused by birds suddenly encountering adverse weather conditions such as poor visibility, precipitation or headwinds.

Small, nocturnal migrants predominate in late spring and early autumn events, larger migrants such as larks, thrushes and Starling are typical species in early spring and late autumn.

Large scale passerine falls (>100,000 individuals) are rare, probably occurring less than once every five years. Smaller scale events (5000-100,000 individuals) occur probably at least annually and most frequently during late autumn migration (Oct/Nov). The spatial scale of falls varies greatly, from the entire southern half of the North Sea to only on a single site (e.g. an offshore installation). Most falls are recorded at coastal sites or on offshore platforms and vessels. Falls at sea, away from land, go largely unnoticed unless the bodies later wash ashore (wrecks).

Both a better understanding of the weather conditions leading to falls and the development of an early warning system for passerine falls at the projected offshore airport require additional research, including advanced radar observations coupled with ground surveys and detailed meteorological records. The timing and species composition of passerine falls are reasonably well described on the basis of existing data (this study), but both the frequency and the mechanism of falls are poorly known. Previous radar studies in The Netherlands have not produced data on the occurrence and frequency of falls. Given the importance of the problem and the potential of radar observations as shown in foreign studies (Lack 1959, 1960, Eastwood 1967, Dingle 1996, Gauthreaux 1985, see also http://www.geocities.com/NapaValley/8596/results/radar/radar.html), further research on scale, frequency and circumstances of falls is possible and necessary. Future research should incorporate and integrate bird and meteorological data from both radar and field observ(ations)ers.

9 Further research

From this study indications emerged about the frequency and scale of falls and the weather conditions in which they occur. Detailed information about scale, size and frequency in terms of absolute values, variation and uncertainty are lacking. If known more precisely, this information together with detailed analysis of the relation between falls and weather could lead to a model which could be incorporated into a 'bird fall warning system'.

The main prerequisite for building such a model is to have data on a much larger number of falls than currently available. Because most of the hitherto existing data are from coastal sites or from an island which is in a different part of the North Sea than the envisaged airport island, information from offshore locations in the southern part of the North Sea is particularly needed. Basically, there are two ways to unearth such data: further data-mining for existing material, and new field studies (see below).

Because lights attract birds, especially under adverse weather conditions, lights on an offshore airport island are a complication, and form an unknown factor in the relation between bird migration, weather and falls. Further research on this topic is necessary.

A general problem concerning studies of falls is that they are relatively rare events. Hence, substantial observation efforts will be needed to secure useful sample sizes in observational studies. This means that data should be collected over at least several years, and preferably in many different locations. This is also an important reason why exploring existing, (preferably long-term) datasets can be very valuable. The scarcity of falls also impinges on the possibility to achieve a balanced design in field experiments: chance events may easily prevent this. There is no simple way around this problem, however, but to go ahead as soon as possible, to optimise the probability of reaching sufficient samples sizes before final go or no-go decisions need to be made.

9.1 Analysis of existing data

Along the Dutch, English and German (Helgoland) coast, birds are trapped in a standardised way on many separate locations. As shown for Helgoland, part of the 'good' trappings days are linked to bad weather coming in. These events could be interpreted as a 'fall'. Analysis of trapping data from additional Dutch, English and German stations, in a similar way as done for Helgoland and Castricum in this report, will produce a sizeable row of calendar dates with exceptional catches. The next step is to compare these calendar dates with information on weather and to fit both into a model on the relation between bird migration, falls and weather. Input from a meteorologist in the linking of data on falls and weather patterns is clearly needed in this respect.

Calendar dates emerging from a questionnaire among log-books from North Sea ships could be put into the previously mentioned model, as well as dates emerging from a investigation of bird log books of the North Sea Bird Club.

An analysis of weather data from known falls emerging from the existing data could lead to an understanding of 'fall risky' weather characteristics. The next step towards a warning system would be to assess the probability and predictability of a fall actually occurring under these conditions. For this step, only standardised observations can be used, and it will be necessary to add new, standardised fieldwork to the analysis of existing data.

9.2 Field research

It is shown that radar can detect different migration intensities (in the layers sampled by the radar beam). In this way radar could be used in warning for high migration intensities, as these are a conditio sine qua non for falls. Radar observations can produce a spatial picture as well. High or moderate migration intensities, accompanied by certain spatial patterns, could possibly be interpreted as a 'fall-signature'. If this information could be put into a system of bird fall observers, actual data on migration and local weather could be collected. As a first step, it would be necessary to examine radar records of situations where falls are known to have occurred, to confirm that known falls can be detected from radar images.

Combined research of radar and field observations during several years (spring and autumn) should lead to a model on the relation between bird migration, weather, and the scale, size and frequency of falls. At sites along the Dutch North Sea coast, it might be possible to set up a network of (volunteer) observers making standardised counts of grounded migrants along transects. These counts could be made either as frequently as possible and under any weather conditions (allowing identification of 'fall risky' conditions), or made only after an alert has been sent out on the basis of weather forecasts or radar observations (in which case they serve to assess the predictability of falls under predefined conditions).

Offshore locations in the southern North Sea warrant special attention, as it is here that the airport is envisaged. As manning a large number of platforms in this area with volunteers or professional observers on a large number of days is unpractical, it is important to try the use of automated observation techniques such as cameras or sound recording to record the presence of large numbers of birds at or around the platform. Pilot observations are needed to assess the reliability of field methods. For such both human observers and technical equipment such as radar could be stationed on a platform. There might be possibilities to join forces with oil and gas companies, which to a certain extent are also interested in the occurrence of large numbers of birds at their offshore installations (to avoid problems with gas flares). Another possibility is to use the data-recording platform 'Meetpost Noordwijk' which is located within, or at least close to the search area for an airport-islands. Experimental light/darkness situations can be provided to migrating birds on this location, making experimental work on the problem necessary. Another possibility is to make use of existing islands of semi-islands to put up a well-lit, mock-runway. Obvious candidates for engaging large-scale experimental set-ups are the Razende Bol, a sandy islet between mainland Holland and Texel and the Wadden Sea, or the Vliehors, Vlieland. The first has the advantage that it is a true island, of the right size, more or less at the right place. The Vliehors option has the advantage that radar facilities and other infrastructure (electrical power) are available.

9.3 Influence of lighting

Light is a complicating factor in the relation between weather, bird migration and falls. It is shown that light can attract passing migrants, and finally could lead to high numbers (flying around) in a small area. The mechanisms behind the attraction are poorly understood. If these mechanisms could be unravelled, recommendations on the use of light (type, colour, frequency) on the airport could be made. Important questions on lighting and bird attraction with respect to airport safety are:

- What is the magnitude of the attraction effect of light on nocturnal migrants and under which conditions does it occur?
- What is the spatial effect of lights, i.e. at what distances from the light source do birds land/stay?
- How is the attraction effect affected by intensity, colour and positioning of lights?
- How do birds attracted by lights behave during approach and after landing?

Some information on this subject can be obtained by analysing existing data, e.g. the ringing data on the effects of port lighting at Felixtowe mentioned in § 3.5. The best way to unravel the effects of light is to do field observations, including field experiments. Such experiments need to be large-scale to be of value for an airport situation. They could be conducted in poorly-illuminated coastal areas, preferably in island situations such as the Razende Bol or Vliehors as mentioned above, and/or in the building stage of an island as soon as it has emerged from the sea.

10 References

Åkesson S., L. Karlsson, J. Pettersson & G. Walinder 1992. Body composition and migration strategies: a comparison between Robins Erithacus rubecula from two stop-over sites in Sweden. Vogelwarte 36: 188-195.

Alerstam T. 1990. Bird migration. Cambridge University Press, Cambridge

Anonymous 1992. 11th North Sea Bird Club Ann. Report. North Sea Bird Club, Aberdeen.

Bahrlein F. 1991. Body mass of Garden Warblers Sylvia borin on migration: a review of field data. Vogelwarte 36: 48-61.

Berthold P. (ed.) 1991. Orientation in birds. Birkhäuser Verlag, Basel.

Berthold P. 1996. Control of bird migration. Chapman & Hall, London.

Bierman W.H. 1954. Nachttrek tijdens laaghangende mist. Ardea 42: 221.

Blokpoel H. 1976. Bird hazards to aircraft. Clarcke, Irwin & Company Ltd.

Bouma J.P. & J.C. Koch 1934. Korte Mededeelingen. Sterke trek genoteerd door het "Ringstation Wassenaar" op 23 October 1934. Ardea 23: 215.

Brouwer G.A. 1929. Overzicht van de vogels aangevlogen tegen den vuurtoren "Het Westhoofd" op Goeree gedurende de jaren 1924 t/m 1928. Ardea 18: 140-161.

Brouwer G.A. & Verwey J. 1922a. Waarnemingen van 1 Januari 1920 tot en met 30 Juni 1922. Ardea 11: 129-150.

Brouwer G.A. & Verwey J. 1922b. Vogeltrek op Rottum. Waarnemingen betreffende den vogeltrek op Rottumeroog, verzameld tijdens een verblijf op het eiland van 19 juli tot 1 september 1921. Ardea 11: 47-79.

Buurma L.S. 1987. Patronen van hoge vogeltrek boven het Noordzeegebied in okober. Limosa 60: 63-74.

Buurma L.S. 1989. Kievit wordt Robin. De vogeltrekwaarschuwingen: van bron van ergenis naar veiligheidsmaatregel op maat. Veilig Vliegen 1989 (mei): 100-103.

Buurma L.S. 1992. Zigzaggende trekvogels boven de Noordzee. Vogels 1992 (5): 24-25.

Buurma L.S. 1995a. Long-range surveillance radars as indicators of bird numbers aloft. Isr. J. Zoology 41: 221-236.

Buurma L.S. 1995b. Prediction and detection of bird flight across the control zone of airports. Paper presented to the Netherlands association of aeronautical engineers on June 8, 1995.

Buurma L.S. 1997. Bestrijd het leed dat bird hit heet. Veilig Vliegen 1997 (maart): 52-55.

Campbell B. & E. Lack 1985. A dictionary of birds. Poyser, Calton.

Camphuysen C.J. 1979. Meetpost Noordwijk Najaar 1978. Meded. CvZ 2: 19-31.

Camphuysen C.J. 1988. Dode Zangvogels op de Vloedlijn. Sula 2: 79-82.

Camphuysen C.J. 1989. Beached Bird Surveys in the Netherlands 1915-1988; Seabird Mortality in the southern North Sea since the early days of Oil Pollution. Techn. Rapport Vogelbescherming 1, Werkgroep Noordzee, Amsterdam.

Camphuysen C.J. 1995. Olieslachtoffers langs de Nederlandse kust als indicatoren van de vervuiling van de zee met olie. Sula 9 (special issue): 1-90, I-XX.

Camphuysen C.J. 1998. Vliegveld in de Noordzee: Aanvaringsrisico's en de ecologische betekenis van de kustwateren tussen Goeree en Wijk aan Zee. Werkdocument TNLI, 1 juni 1998, CSR Rapport 1998-2, CSR Consultancy, Oosterend.

Camphuysen C.J. & M.F. Leopold 1994. Atlas of seabirds in the southern North Sea. IBN Research report 94/6, NIOZ-Report 1994-8, Institute for Forestry and Nature Research, Netherlands Institute for Sea Research and Dutch Seabird Group, Texel.

Camphuysen C.J., G.O. Keijl & J.E. den Ouden 1982. Meetpost Noordwijk 1978-1981, Report no. 1 Gaviidae-Ardeidae. CvZ MpN-verslag nr. 1, Amsterdam.

Davies P. 1964. Aspects of autumn migration at the bird observatories. Bird Study 11: 77-122.

Davies P. 1966. The great immigration of early September 1965. British Birds 59: 353-376.

Dingle H. 1996. Migration, the biology of life on the move. Oxford University Press, New York.

Dirksen S., R. Lensink, G.W.N.M. van Moorsel & J. van der Winden 1999. Ecologische aspecten plaatsing zendmasten Delta Radio in de Noordzee. Twee notities. Rapport 99.28, Bureau Waardenburg bv, Culemborg.

Dobben W.H. van & Makkink G.F. 1931. De vogeltrek op Vlieland van 14 Sept. tot 19 Okt. 1930. Ardea 20: 22-45.
Dobben W.H. van & Makkink G.F. 1933a. Der Einfluss der Leitlinien auf die Richtung des Herbstzuges am niederländischen Wattenmeer. Ardea 22: 30-48.
Dobben W.H. van & Makkink G.F. 1933b. De najaarstrek 1932 der zangvogels over het Waddengebied. Ardea 22: 144-158.
Dobben W.H. van & Makkink G.F. 1934. Vogeltrek over Nederland. Orgaan der Club 6: 87-102.
Dobben W.H. van & Makkink G.F. 1935. Nazomertrek van zangvogels op Vlieland, Rottum en aan de Friese kust. Ardea 24: 111-133.
Dobben W.H. van & Morzer Bruyns, M.F. 1939. Zug nach Alter und Geschlecht an niederlandischen Leuchtturmen. Ardea 28(2-4): 61-79.
Eastwood E. 1967. Radar ornithology. Methuen, London.
Ellegren H. & T. Fransson 1992. Fat loads and estimated flight-ranges in four Sylvia species analysed during autumn migration at Gotland, South-east Sweden. Ring. Migr. 13: 1-12.
Ehnbom S., L. Karlsson, R. Ylven & S. Åkesson 1992. A comparison of autumn migration strategies in robins Erithacus rubecula at a coastal and an inland site in southern Sweden.Ring. & Migr. 14: 84-93.
Franeker J.A. van 1998. NAM ENSCO71 Flaring Project. IBN-Rapport 389, Instituut voor Bos- en Natuuronderzoek, Wageningen.
Gauthreaux S.A. jr. 1985. The temporal and spatial scales of migration in relation to environmental changes in time and space. In M.A. Rankin (ed.) Migration: mechanisms and adaptive significance. Contr. Marine Sci. 27 (suppl.): 503-515.
Gatter W. 1978. Planbeobachtungen des sichtbaren Zugs am Randecker Maar als Beispiel ornithologisch-entomologischer Forschung. Vogelwelt 99: 1-20.
Lensink R. & R.G.M. Kwak. 1985. Vogeltrek over Arnhem in 1983 met een samenvatting over de periode 191-83 en methodieken voor het bewerken van telmateriaal. Rapport, LWVT, Arnhem.
Ham N.F. van der 1988. Meetpost Noordwijk 1978-1982, verslag nr. 4, Columbidae - Emberizidae. Sula 2: 83-90.
Hansson M & J. Pettersson J. 1989. Competition and fat deposition in goldcrest regulus regulus at a migration stop-over site. Vogelwarte 35: 21--31.
Heurn W.C. van 1912. Verslag van Ornithologische waarnemingen, gedaan tijdens een zevendaagsch verblijf aan boord van het Lichtschip "Maas". Ardea 1: 92-96.
John A.G.W. & J. Roskell 1985. Jay movements in autumn 1983. Br. Birds 78: 611-637.
Jones P.H. 1980. The effect on birds of a North Sea gas flare. Brit. Birds 73: 547-555.
Jonkers D.A. 1974. Ervaringen bij de vuurtoren van Ameland. Het Vogeljaar 22: 829-830.
Kaiser A. 1993. Fat deposition and theoretical flight range os small autumn migrants in Southern Germany. Bird Study 39: 96-100.
Kaiser A. 1996. Zugdisposition mitteleuropäischer Kleinvögel: Mauser, Köpermasse, Fettdeposition und Verweildauer. J. Orn. 137: 151-179.
Karlsson L., K. Persson, J. Pettersson & G. Walinder 1988. Fat-weight relationships and migratory strategies in the Robin Erithacus rubecula at two stop-over stites in south Sweden. Ring. & Migr. 9: 160-168.
Lack D. 1959. Migration across the North Sea studied by radar part 1. Survey through the year. Ibis 101: 209-234.
Lack D. 1960. Migration across the North Sea studied by radar part 2. The spring departure 1956-59. Ibis 102: 26-57.
Lack D. 1962. Migration accros the southern North Sea studied by radar, part 3, movements in June and July. Ibis 105: 75-85.
Lack D. 1963a. Migration accros the southern North Sea studied by radar, part 5, autumn. Ibis 105: 1-55.
Lack D. 1963b. Migration accros the southern North Sea studied by radar, part 5, movements in august, winter and spring and conclusions. Ibis 105: 561-592.
Lensink R. & R.G.M. Kwak. 1985. Vogeltrek over Arnhem in 1983 met een samenvatting over de periode 191-83 en methodieken voor het bewerken van telmateriaal. Rapport, LWVT, Arnhem.

Lensink R. & J. van der Winden 1997. Trek van niet-zeevogels langs en over de Noordzee: een verkenning. Rapport 97.023, Bureau Waardenburg bv, Culemborg.
LWVT in press. Vogeltrek over Nederland 1976-93.
Laks M.H. & Bekebrede R. 1983. De trek van vogels over zee gedurende een week in oktober. Ongepubl. report V.I.-V.U., sectie biologie, 1-88 (mimeo).
Lensink R. 1996. 33 Koperwieken ZW 4. Wetenschappelijke mededeling KNNV nr. 217. KNNV, Utrecht.
Moore F.R. & W. Young 1988. Evidence of food-based competition among passerine migrants during stop-over. Beh. Ecol. & Soc. 28: 85-90.
Mörzer Bruyns M.F. 1939. Waarnemingen op het lichtschip "Terschellingerbank" in October 1937. Ardea 28: 27-38.
Offringa H. 1996. Slecht-weer-migratie van Gierzwaluw Apus apus op zee 1980-94. Limosa 69: 1-8.
Oordt G.J. van 1929. Korte Mededeelingen. "Trek uit zee". Ardea 18(1-2): 90.
Ouden J.E. den & C.J. Camphuysen 1983. Meetpost Noordwijk 1978-1981, Report no. 2 Anatidae-Scolopacidae. CvZ MpN-verslag nr. 2, Amsterdam.
Ouden J.E. den & N.F. van der Ham 1988. Meetpost Noordwijk 1978-1982, Report no. 3 Stercoraridae-Alcidae. CvZ MpN-verslag nr. 3, Alkmaar/Amsterdam.
Philips N.J. 1994. Autumn migration and weights of Blackcaps Sylvia atricapilla and Garden Warblers S. borin at an inland site in southern England. Ring. & Migr. 15: 17-26.
Platteeuw M., N.F. van der Ham & C.J. Camphuysen 1985. K7-FA-1, K8-FA-1, Zeevogelobservaties winter 1984/85. CvZ spec. publ., Amsterdam.
Prins J.G. 1974. Onfortuinlijke koperwiekentrek. Limosa 47: 160.
Rahder J.H. 1989. Vogelwaarnemingen op de Noordzee, Bruine Bank, 20 en 21 oktober 1988. Rapport 89.24, Bureau Waardenburg, Culemborg.
Raiss R. 1976. Aufenthaltdauer und Körpergewichtsverlauf von auf dem Herbstzug in Helgoland rastenden Sing-, Rotdrosseln und Amseln. J. Orn. 117: 355-352.
Richardson W.J. 1978. Timing and amount of bird migration in relation to weather: a review. Oikos 30: 225-271.
Richardson W.J. 1990. Timing of bird migration in relation to weather: updated review. In E. Gwinner (ed.) Bird migration, physiology and ecophysiology, p. 78-101. Springer-Verlag, Berlin.
Riddiford N. 1985. Grounded migrants versus radar: a case-study. Bird Study 32:116-121.
Sage B. 1979. Flare up over North Sea birds. New Scientist 82: 464-466.
Tinbergen L. 1956. Vogels onderweg, 2e druk. Scheltema & Holkema, Amsterdam.
Traanberg G. 1923. Trekwaarnemingen op het lichtschip 'Schouwenbank' van 16 tot 28 mei 1923. Ardea 12: 37-40.
Verheijen F.J. 1981. Bird kills at tall lighted structures in the USA in the period 1935-1983 and kills at a Dutch lighthouse in the period 1924-1928 show similar lunar periodicity. Ardea 69: 199-203.
Verwey J. 1922. Doggersbank. Ardea 11: 1-19.
Verwey J. 1928. Het vuurtoren vraagstuk. Versl. & Meded. 1924-1928, Nederlandse Ver. Besch. Vogels, Amsterdam.
Vleugel D.A. 1943. "Uitgestelde trek" met storm en sterke nevel. Ardea 32: 286-287.
Vleugel D.A. 1954. Kiezen vinken (Fringilla coelebs) in zeegebied een compromis-richting of wijken ze naar links af? Limosa 27: 131-134.
Vleugel D.A. 1954. Waarnemingen over de nachttrek van Lijsters (Turdus) en hun waarschijnlijke orientering. Limosa 27: 1-18.
Vleugel D.A. 1956. Waarnemingen aan verkeerde trek in het voorjaar. Ardea 44: 206-213.
Vleugel D.A. 1960. Waarnemingen over het uitvallen van in zee gaande (ultrahoge) trek, vooral aan de Hollandse kust, bij windstilte en zeer zwakke wind. Ardea 48: 150-160.
Vleugel D.A. 1974. Eerste duidelijke veldwaarnemingen over toepassing van het zonnekompas door nachttrekkers. Het Vogeljaar 22: 857.
Walker J.M. & W.A. Venables 1990. Weather and bird migration. Weather 45: 47-56.
Williamson K. 1959. The September drift-movements of 1956 and 1958. British Birds 52: 334-377.

Samenvatting

Door de Directie Noordzee (RWS) wordt, binnen het raamwerk van Ontwikkeling Nationale Luchtvaart (ONL), onderzoek geëntameerd naar de relatie tussen vogels en vliegveiligheid op een mogelijk aan te leggen eiland in de Noordzee voor een nieuw Schiphol. Om eventuele risico's in te kunnen schatten, richt het onderzoek zich primair op risico-soorten en risicovol gedrag. Een van de risicovolle gedragsaspecten is een fall van trekvogels.

Een fall is de plotselinge aankomst van grote aantallen trekvogels in een gebied, vaak op de kust of een eiland, waarbij slecht weer veelal de oorzaak is voor het neerstijken van de vogels. In de onderhavige studie worden feiten aangedragen over het risico van een fall, de omstandigheden waaronder falls optreden en de soorten die erbij betrokken kunnen zijn. Daarbij is uitsluitend gebruik gemaakt van bestaande gegevensbronnen.

De volgende databases zijn onderzocht op feiten en patronen die in verband kunnen worden gebracht met falls. Met nadruk zij vermeld dat geen van de onderzoeken achter deze datasets was opgezet om falls te bestuderen.

- NZG/NSO tellingen dode vogels op stranden 1965-1999
- NZG/CvZ trektellingen vanaf platforms 1978-1986
- SASBASE tellingen vogels op en boven zee 1987-1999
- Vangsten vinkenbaan Castricum 1980-1999
- Vangsten Helgoland 1989-1998
- Gevonden slachtoffers op lichtschepen 1958-1971
- LWVT tellingen van zichtbare vogeltrek over Nederland 1982-1993

Daarnaast is literatuur gescand op gedocumenteerde falls, en op de relatie tussen weer, vogels en falls. Vangsten van enkele andere ringplaatsen langs de Nederlandse Kust de 'bird observatories' langs de Engelse Oostkust waren beschikbaar, maar binnen de termijn van dit onderzoek niet toegankelijk. Voorts is materiaal van de Koninklijke Luchtmacht betreffende regstraties van vogeltrek met radar bekeken op de bruikbaarheid voor systematisch onderzoek aan falls.

Sterke trek vindt veelal onder gunstige weersomstandigheden plaats (helder, weinig bewolking, droog, meewind) terwijl de trek bij slecht weer minimaliseert (slecht zicht, bewolking, neerslag en tegenwind). In het synoptisch weerpatroon is de sterkste trek in het najaar te verwachten na de passage van een front en langs de oost- en zuidflank van een hogedrukgebied. Rond de zuidelijkelijke Noordzee lijken falls vooral samen te vallen met gunstig weer in het gebied van vertrek (Scandinavië) en slecht weer boven het midden of zuiden van de Noordzee. Falls kunnen plaatsvinden in een gebied met slecht weer (in het front) of goed weer (achter het front). Bij falls verkeert een variabel deel van de vogels in slechte conditie, waardoor de duur van het verblijf op de aankomstplaats ook sterk kan wisselen.

Uit de geraadpleegde data bestanden komen consistente patronen naar boven. Grote aantallen dode vogels op stranden en lichtschepen alsmede sterke trek van zangvogels over zee, zoals waargenomen vanaf platforms en schepen, zijn uitsluitend in voor- en najaar vastgesteld. Dit is de periode waarin grote aantallen vogels van hun overwinterings-gebied naar hun broedgebieden trekken vice versa; falls lijken beperkt te zijn tot de trektijd (maart-mei en augustus-november). Waarnemingen op de vinkenbanen bevestigen dit patroon, al kunnen goede vangsten hier het gevolg zijn van zowel goede trek als van een fall. Massale verplaatsingen als 'cold rushes' lijken niet tot falls te leiden.

Lijsterachtigen, Spreeuwen, Vinken en kleine zangertjes zijn de meest gemelde soorten in de geraadpleegde databases. In afzonderlijke datasets springen steeds één of meer van de genoemde soort(groep)en eruit. In strandvondsten en in waarnemingen vanaf schepen en platforms domineren de grotere soorten, op lichtschepen en op vinkenbanen werden daarnaast ook de kleinere soorten aangetroffen. Niettemin is het soortenspectrum, bij een gegeven fall, consistent. Bovendien komt het soortenspectrum overeen met wat volgens de literatuur de meest talrijke soorten in de trek over de Noordzee zijn. De kleine zangertjes (lange afstandtrekkers) domineren de trek in april/mei en augustus/september en de andere soorten (alle korte afstandtrekkers) in maart en oktober/november.

In de literatuur is een aantal falls gedocumenteerd. Hiervan zijn er drie ook uit de geraadpleegde datasets naar boven gekomen: najaar 1978, 1982, 1988. Deze falls waren hoogstwaarschijnlijk grootschalig van aard en konden rond de gehele zuidelijke Noordzee worden opgemerkt. Ze vallen alle drie samen met gunstige weersom-standig-heden boven Zuid-Scandinavië en een frontpassage vanuit het zuidwesten over de Noordzee. Ook in kleinschalige falls kunnen grote aantallen vogels betrokken zijn, zoals een goed gedocumenteerd voorbeeld voor de Engelse Oostkust en gepubliceerde waarnemingen vanaf platforms aangeven. Uit de geraadpleegde datasets zijn deze nauwelijks naar voren gekomen omdat ze in het veld alleen worden waargenomen als waarnemers op het goede moment op de juiste plaats zijn. Al met al lijken falls ieder jaar enkele malen ergens in de zuidelijke Noordzee plaats te vinden. Daarbij zijn de schaal en/of omvang in de meeste gevallen beperkt (>10.000 vogels), maar vrijwel ieder jaar is er kans op een grote fall, zowel in aantal als in schaal (>100.000 vogels).

Informatie over de treksterkte in breedfront trek over het binnenland, is gebruikt om de treksterkte over het mogelijke vliegveld eiland te schatten. Omvang en samenstelling van deze trek lijkt redelijk vergelijkbaar met die over de Noordzee. Ieder najaar mag mag op minstens 14 dagen een treksterkte van meer dan 25.000 overtrekkende vogels over het eiland worden verwacht en een enkele maal 135.000 vogels of meer. Onder bepaalde weersomstandigheden kunnen deze treksterktes leiden tot een dito aantal vogels (en waarschijnlijk een veelvoud) dat naar het eiland toetrekt. We speken dan van een kleine respectievelijk grote fall.

In een donkere omgeving kunnen verlichte objecten grote aantallen vogels aantrekken, zoals blijkt uit oude waarnemingen bij vuurtorens, op lichtschepen en vanaf platforms. Vooral in situaties met laaghangende bewolking, slecht zicht of neerslag kan dit tot omvangrijke vliegbeweging rond de verlichtingsbron leiden, waarbij op den duur ook grote aantallen slachtoffers kunnen vallen. Dit risico is het grootst in nachten rond nieuwe maan.

Voor de nabije toekomst is verder onderzoek gewenst naar de schaal en frequentie van falls in relatie tot grootschalige en lokale weersfactoren. Dit onderzoek kan ten dele op basis van bestaande datasets worden uitgevoerd. Daarnaast is nieuwe veldonderzoek noodzakelijk waarbij radar en veldwaarnemer zowel informatie over vogels als weersfactoren verzamelen. De resultaten moeten leiden tot een voorspellend model dat geïncorpereerd wordt in een vogelwaarschuwingssysteem op het te ontwikkelen vliegveld. Verlichting is een complicerende factor in het fenomeen falls, omdat licht de omvang van een fall zou kunnen versterken. Ook hieraan zal nader onderzoek moeten plaatsvinden.

Appendix KC1 *Monthly number of beach visits for beached bird surveys, 1965-98, illustrating the bias in observer effort towards the winter period. Mass strandings of passerines were easily missed in summer and (early) autumn.*

Year	J	F	M	A	M	J	J	A	S	O	N	D
65	1			3							3	2
66	3	7	2	7	2		2				1	5
67	3	2						1				3
68	6	6	1	2							1	1
69	1	12		5				2			4	3
70	3	5	19	3							1	
71	2	2	9	1							8	
72	3	10						1	1		1	1
73		13					1		1		4	2
74	5	1	1	1		1				1	1	18
75	5	2	9	12	2	1		1	1	2	3	10
76	4	12		1	2		1	1	2		2	2
77	2	9		5	3		1	2	1	4	3	5
78	10	17	12	2	1	4	4		7	10	7	6
79	23	31	10	16	3	4	8	3	7	7	10	20
80	13	23	9	12	6	1	5	10	11	22	14	56
81	108	60	33	10	12	21	11	14	11	23	46	39
82	44	58	24	20	14	3	8	13	13	11	18	49
83	74	78	55	40	11	5	2	5	29	17	38	53
84	60	66	39	18	6	4	7	2	16	14	21	47
85	40	75	58	12	7	2	7	9	4	8	48	58
86	42	37	45	12	2	2	4	5	4	7	10	17
87	38	45	20	5			2	11	2	4	15	20
88	32	35	48	7	3	3	4	5	4	7	25	59
89	46	32	25	7	3	3	4	6	10	8	20	52
90	34	60	39	12	3	4	4	9	10	10	34	35
91	45	51	30	9	9	9	4	4	5	10	13	34
92	31	29	26	9	6	2	1	4	3	10	18	20
93	22	37	15	2	1	2	3	2	2	2	3	37
94	16	30	26	5	2	3	2	4	2	6	3	15
95	23	21	9	6	4	2	3	1	6	10	22	18
96	13	26	18	3	2	3	4	1	3	8	11	30
97	14	22	8	2	1	2	4	2	14	10	9	21
98	25	19	21	5	3	1	2	7	10	14	18	58
Total	791	933	611	254	108	82	98	125	179	225	435	796

Appendix KC2 Observer effort expressed as number of hours of observation per 7-day period at Meetpost Noordwijk, 1978-82 (after Den Ouden & Van der Ham 1988).

Spring observations

Month	Weekno.	1978	1979	1980	1981	Total
March	9			14.5		14.5
	10			37		37
	11			20		20
	12					-
April	13				24	24
	14				39	39
	15				38.5	38.5
	16	32			19	51
May	17	31.5			16.5	48
	18				23	23
	19	31	37		15	83
	20					
	21	12.5				12.5
June	22		30.5			30.5

Autumn observations

Month	Weekno.	1978	1979	1981	1982	Total
August	34				28.5	28.5
	35				5.5	5.5
September	36		37		42	79
	37		33		45.5	78.5
	38			28.5	5.5	34
	39			44.5	37	81.5
October	40		38	46	28	112
	41			43	36.5	79.5
	42	40.5			42	82.5
	43				8	8
November	44		33	24		57
	45			33		33
	46	35	29	29.5		93.5
	47	35	11.5	12		58.5
December	48	26.5				26.5

Appendix KC3 *Number of days at sea in the Dutch sector during ship-based surveys since 1987 (SASBASE database).*

	J	F	M	A	M	J	J	A	S	O	N	D	
87			2	7	13	2	6	8	18	15	20	10	7
88		10	11	10	10	7	6	15	8	8	16	15	4
89		12	12	8	2	8	4		4	10	13	14	4
90		7	5	8	9	3	9	2	8	4	10	9	1
91		9	12	8	1	8	6	1		14	7		1
92		16	6	2	7	3				4	7	1	
93		7	21	5		18	1		7	8	6	1	1
94				3	6	15	5		14	11	12	4	
95	4	5			1		1						
97					7	6	4	4		4	5	4	
98		1					1	1	8	1	2		
99		1			2								

Appendix KC4 *Monthly numbers of owls, pigeons, swifts and passerines observed at Meetpost Noordwijk, 1978-1984.*
sthrush = small thrush , uniden = unidentified.

Year	Month	effort	owl	pigeon	lark	pipit	swallow	thrush	sthrush	warbler	tit	star	crow	finch	uniden	total	n/uur
1978	4	63.5	2	11	1	107	5	6	2	5		19		47	5	210	3.3
1978	5	50.5		1		1	8			7		3	1			21	0.4
1978	10	78.5	5	8	600	41		19	12	17		992		165	68	1927	24.5
1978	11	94.5	1		30			4				1628		1	28	1692	17.9
1978	12	2		1				1				79				81	40.5
1979	5	37.5	1	43	1	3	178		1	1		3		3	1	235	6.3
1979	9	70		3		7			1	2						13	0.2
1979	10	21		1												1	0.0
1979	11	52.5			7	8		208				523		1	5	752	14.3
1980	3	71.5		3	7	8		67				459		94	16	654	9.1
1981	3	15	1	2		28		7		1		124	2			165	11.0
1981	4	122	3	46	3	225		18	17	19		56	27	238	41	693	5.7
1981	5	38		4		15	54	1	7	9		1		3	7	101	2.7
1981	9	77		6	3	97	3		1	2	1	33		5	713	864	11.2
1981	10	98	2	7	65	435	24	379	4	14	1	3314		287	1003	5535	56.5
1981	11	102		2	294	9		27	1	1		4155	24	1	2	4516	44.3
1982	8	37								1					2	3	0.1
1982	9	133		13	2	138		4	17	41		170		102	53	540	4.1
1982	10	91	3	3	154	2726	25	5522	17	23	4	2710	7	207	139	11540	126.8
1984	1	20			36			537				7			38	618	30.9
1984	3	80		3	16	41	1	13	1	2		1254	12	503	3	1849	23.1
1984	4	29		3		7		8		2		12		1	5	38	1.3
1984	12	15						1				3				4	0.3
n =			18	160	1219	3896	298	6822	81	147	6	15545	73	1658	2129	32052	
%			0.1	0.5	4.1	13.0	1.0	22.8	0.3	0.5	0.0	52.0	0.2	5.5	n =	29923	

Appendix KC5 *Monthly numbers of owls, pigeons, swifts and passerines observed during ship-based surveys North Sea (NCP) 1983-1999., see also appendix KC4.*

Year	Month	effort	owl	pigeon	lark	pipit	swallow	thrush	sthrush	warbler	tit	star	crow	finch	uniden	total	n/km
1983	5	150														0	0
1984	5	22														0	0
1985	5	83														0	0
1987	2	66														0	0
1987	3	1116			4	8						106		6	2	126	0.11
1987	4	2402		22	2	77	1	4	10	9		96	4	12		237	0.10
1987	5	388					2									2	0.01
1987	6	1528		2		2	22					2			2	30	0.02
1987	7	1644		2			11									13	0.01
1987	8	4935		6		12			11	12				6	22	69	0.01
1987	9	2947				22	1	14	6	5				8	12	68	0.02
1987	10	2887	4	264	270	79	1	982	47	41		1090	6	268	80	3132	1.08
1987	11	1577			2	6		164	1	5		242		12	2	434	0.28
1987	12	805		2												2	0.00
1988	1	2085						2								2	0.00
1988	2	1383		2	28							8			2	40	0.03
1988	3	1748		6	36	5		696	5	2		1518		10	2	2280	1.30
1988	4	1453		2		2	1	2	2	4				8	18	39	0.03
1988	5	1132		2												2	0.00
1988	6	1260		2			3					12			2	19	0.02
1988	7	2240		2					1							3	0.00
1988	8	893				6										6	0.01
1988	9	1049		2					1	4						7	0.01
1988	10	1521		6	70	88	1	680	13	4		2352		44	30	3288	2.16
1988	11	1828			10	6		70				182	14	4		286	0.16
1988	12	475														0	0
1989	1	1386		4								2				6	0.00
1989	2	1613		24	12	2						8	2			48	0.03
1989	3	974			2	15					2	140		60	42	261	0.27
1989	4	119														0	0
1989	5	961		4	2		34		1	3		2	2		4	52	0.05
1989	6	402														0	0
1989	8	622							1	3						4	0.01
1989	9	994				6			2	2						10	0.01
1989	10	1717	4		379	80		660	11	20		2270	2	124	4	3554	2.07
1989	11	1330			8			6				112		2		128	0.10
1989	12	169														0	0

Appendix KC5 *Monthly numbers of owls, pigeons, swifts and passerines observed during ship-based surveys North Sea (NCP) 1983-1999, continued, see also appendix KC4 .*

Year	Month	effort	owl	pigeon	lark	pipit	swallow	thrush	sthrush	warbler	tit	star	crow	finch	uniden	total	n/km
1990	1	507			22			242								264	0.52
1990	2	539			24							4				28	0.05
1990	3	756				10		2	6			4			6	28	0.04
1990	4	1159	2	6		16		50		6		10		2	6	98	0.08
1990	5	618				2	6					2				10	0.02
1990	6	680					2									2	0.00
1990	7	329														0	0
1990	8	1215							1					2		3	0.00
1990	9	459		2												2	0.00
1990	10	1024	6		34	124		1168	18	14		1878	4	27		3273	3.20
1990	11	799			82			20		2		756		2700	184	3744	4.68
1990	12	90														0	0
1991	1	650		32								4				36	0.06
1991	2	779		6	138	24		4				74		14		260	0.33
1991	3	1012		22	22	6		194	8			3052	10	306		3620	3.58
1991	4	103			2											2	0.02
1991	5	1353		4			24		4	4						36	0.03
1991	6	1079		2			1									3	0.00
1991	7	129		4			2									6	0.05
1991	9	2020		2	6	58	5		2							73	0.04
1991	10	729	2		10	2		26				24	4	8		76	0.10
1991	12	80														0	0
1992	1	2165		2				4								6	0.00
1992	2	989		30	2							10				42	0.04
1992	3	13														0	0
1992	4	603		10		178	4	4	8	2		2	4	4		216	0.36
1992	5	287					2									2	0.01
1992	9	367				4			3	4						11	0.03
1992	10	814			2	4		96		8		326				436	0.54
1992	11	44			4			30				66				100	2.25
1993	1	577			36			12				2	2			52	0.09
1993	2	2590		2	137			18				34	2			193	0.07
1993	3	437		8	22	4						24				58	0.13
1993	5	2262		4	8	14	126		7	1						160	0.07
1993	6	104														0	0
1993	8	599		2												2	0.00
1993	9	689				6				2						8	0.01
1993	10	575			2	2		4	4	2		18		2		34	0.06
1993	11	63						16	2			6		4		28	0.45
1993	12	151														0	0

Appendix KC5 *Monthly numbers of owls, pigeons, swifts and passerines observed during ship-based surveys North Sea (NCP) 1983-1999, final, see also appendix KC4.*

Year	Month	effort	owl	pigeon	lark	pipit	swallow	thrush	sthrush	warbler	tit	star	crow	finch	uniden	total	n/km
1994	3	339										2				2	0.01
1994	4	364		2		6									6	14	0.04
1994	5	2063		12		1	17		6	11				1		48	0.02
1994	6	451					2									2	0.00
1994	8	1818							2	2						4	0.00
1994	9	997		2		2	1		1	2						8	0.01
1994	10	1963		2	12			14		6		156				190	0.10
1994	11	154			8			36	6	2		1562		10		1624	10.56
1995	1	383														0	0
1995	2	157														0	0
1995	5	31														0	0
1995	7	187														0	0
1997	4	1166		6	2	26	1		2	4						41	0.04
1997	5	1103		118			36			1						155	0.14
1997	6	470		30			4					32				66	0.14
1997	7	1021		16			31		1							48	0.05
1997	9	630		20		5			1							26	0.04
1997	10	953		2	76	90						290		20		478	0.50
1997	11	451		2	4	10		182				220		2		420	0.93
1998	1	33														0	0
1998	6	232														0	0
1998	7	46														0	0
1998	8	941		2												2	0.00
1998	9	44							2	4						6	0.14
1998	10	32						6				12				18	0.56
1999	1	23														0	0
1999	4	76				8								8		16	0.21
n =			18	706	1480	1018	341	5408	196	191	2	16712	56	3674	426	30228	
%			0.1	2.4	5.0	3.4	1.1	18.1	0.7	0.6	0.0	56.1	0.2	12.3	n =	29802	

Appendix KC6 Monthly numbers of owls, pigeons, swifts and passerines found dead, beached bird surveys North Sea coast 1965-1999, see also appendix KC4.

Year	Month	effort	owl	pigeon	lark	pipit	swallow	thrush	sthrush	warbler	tit	star	crow	finch	uniden	total	n/km
1965	1	6														0	0.00
1965	4	16.5		3								1	2			6	0.36
1965	11	24														0	0.00
1965	12	33														0	0.00
1966	1	28														0	0.00
1966	2	82			2			1				1	2			6	0.07
1966	3	16														0	0.00
1966	4	107		1				3				4	1	1		10	0.09
1966	5	16														0	0.00
1966	7	12														0	0.00
1966	11	8														0	0.00
1966	12	42														0	0.00
1967	1	24														0	0.00
1967	2	32														0	0.00
1967	8	12														0	0.00
1967	12	25														0	0.00
1968	1	93	1	1				1				2				5	0.05
1968	2	81.5		3				1				1			22	27	0.33
1968	3	8														0	0.00
1968	4	20		2				4				5				11	0.55
1968	11	4														0	0.00
1968	12	4														0	0.00
1969	1	17														0	0.00
1969	2	347.5		2	2			4				5	2	1		16	0.05
1969	4	94	1	3											14	18	0.19
1969	8	38		2												2	0.05
1969	11	91			1			6				11	3			21	0.23
1969	12	53										1				1	0.02
1970	1	25						1				1				2	0.08
1970	2	28						1				1				2	0.07
1970	3	434		9	3			7				10	3	2		34	0.08
1970	4	26										4	1			5	0.19
1970	11	15														0	0.00
1971	1	18														0	0.00
1971	2	69														0	0.00
1971	3	239		4				1				3	1		1	10	0.04
1971	4	9		1				3				1				5	0.56
1971	11	173		2				3				2				7	0.04
1972	1	6														0	0.00
1972	2	240														0	0.00
1972	8	2														0	0.00
1972	9	2														0	0.00
1972	11	2														0	0.00
1972	12	25														0	0.00

Appendix KC6 *Monthly numbers of owls, pigeons, swifts and passerines found dead, beached bird surveys North Sea coast 1965-1999, continued, see also appendix KC4.*

Year	Month	effort	owl	pigeon	lark	pipit	swallow	thrush	sthrush	warbler	tit	star	crow	finch	uniden	total	n/km
1973	2	293														0	0.00
1973	7	2														0	0.00
1973	9	2														0	0.00
1973	11	36.5		1				287					3	3	1	295	8.08
1973	12	3.5		3	1			4				2	5	1	4	20	5.71
1974	1	10														0	0.00
1974	2	1														0	0.00
1974	3	2														0	0.00
1974	4	2														0	0.00
1974	6	1														0	0.00
1974	10	2														0	0.00
1974	11	2														0	0.00
1974	12	160						2				1				3	0.02
1975	1	9.5														0	0.00
1975	2	4														0	0.00
1975	3	138														0	0.00
1975	4	78														0	0.00
1975	5	9														0	0.00
1975	6	1.5														0	0.00
1975	8	1.5														0	0.00
1975	9	2				1										1	0.50
1975	10	13						2				1				3	0.23
1975	11	28.5		1				1				1				3	0.11
1975	12	27.1										1				1	0.04
1976	1	16														0	0.00
1976	2	173						1				1				2	0.01
1976	4	5.5														0	0.00
1976	5	2.1														0	0.00
1976	7	5.5														0	0.00
1976	8	5.5														0	0.00
1976	9	7														0	0.00
1976	11	17										1				1	0.06
1976	12	26.5											1			1	0.04
1977	1	18						1								1	0.06
1977	2	170										1				1	0.01
1977	4	12.5		1												1	0.08
1977	5	26		14				7	1			6	1	1		30	1.15
1977	7	5.5														0	0.00
1977	8	7														0	0.00
1977	9	2														0	0.00
1977	10	31		2				2				1			3	8	0.26
1977	11	11										1				1	0.09
1977	12	51.5						17				6			5	28	0.54

Appendix KC6 *Monthly numbers of owls, pigeons, swifts and passerines found dead, beached bird surveys North Sea coast 1965-1999, continued, see also appendix KC4.*

Year	Month	effort	owl	pigeon	lark	pipit	swallow	thrush	sthrush	warbler	tit	star	crow	finch	uniden	total	n/km
1978	1	56.5		1								2		1		4	0.07
1978	2	191.5		2				2					1			5	0.03
1978	3	81.7	1	8	1			43				19	3	1	6	82	1.00
1978	4	16						3							3	6	0.38
1978	5	3		1												1	0.33
1978	6	16		3												3	0.19
1978	7	41		13								2	1		1	17	0.41
1978	9	37		6												6	0.16
1978	10	52		6				121		2		5	2	4	2	142	2.73
1978	11	52		11	1			197				29	2	3	3	246	4.73
1978	12	53		3				10				6				19	0.36
1979	1	118.5		3	4			25				10	1	1		44	0.37
1979	2	208.2	1	13	1	3		16				15	13		2	64	0.31
1979	3	61.5	3	11	1			11				9				35	0.57
1979	4	85.5	1	18				13				7	4	1	6	50	0.58
1979	5	21.5		3	2							2	1			8	0.37
1979	6	14		11								1				12	0.86
1979	7	27		5									1			6	0.22
1979	8	9.5		11	1			1				1	1		3	18	1.89
1979	9	62		6								1				7	0.11
1979	10	57		11				7								18	0.32
1979	11	63.5		6				19				20	3			48	0.76
1979	12	163.1		3				11				5			1	20	0.12
1980	1	96.6		1				1				2	1			5	0.05
1980	2	244.1		5				2				2	6			15	0.06
1980	3	68		1									1			2	0.03
1980	4	86	1	14	2			9	2			23	6	2	5	64	0.74
1980	5	47.5		2								1	1			4	0.08
1980	6	3														0	0.00
1980	7	52		12								2				14	0.27
1980	8	27.6		14					1							15	0.54
1980	9	61		3									1			4	0.07
1980	10	123.6		18		1		315				17	1	4	2	358	2.90
1980	11	66.5		2				8				1	2			13	0.20
1980	12	326.5		5	1			5				3	6			20	0.06
1981	1	801.1		11				4				4	8			27	0.03
1981	2	406.4		82	2	1		6				2	13	2	1	109	0.27
1981	3	212.25		29				4					7	4		44	0.21
1981	4	45.15		4				2				3	1			10	0.22
1981	5	75		6				12					3			21	0.28
1981	6	103		37				1				3	2			43	0.42
1981	7	69.5		35				1				1	1			38	0.55
1981	8	73.5		21									1			22	0.30
1981	9	49.1		20					1			1				22	0.45
1981	10	125.5		10	2	1		214				21				248	1.98
1981	11	390	1	9				300		1		48	7	3	8	377	0.97
1981	12	211.05		3	1	1		11				12	6		3	37	0.18

Appendix KC6 *Monthly numbers of owls, pigeons, swifts and passerines found dead, beached bird surveys North Sea coast 1965-1999, continued, see also appendix KC4.*

Year	Month	effort	owl	pigeon	lark	pipit	swallow	thrush	sthrush	warbler	tit	star	crow	finch	uniden	total	n/km
1982	1	256		149				17				7	7		6	186	0.73
1982	2	408	1	185	2			22				15	28		6	259	0.63
1982	3	136.5		15				6				9	1	2	2	35	0.26
1982	4	77.5		20	1			15				16	1		6	59	0.76
1982	5	86		29		1		22	2	2		7	6		2	71	0.83
1982	6	18		9									1		1	11	0.61
1982	7	68		26				3				3	2	1		35	0.51
1982	8	58.5		14			1	4				3				22	0.38
1982	9	73.6		8						1					1	10	0.14
1982	10	77		3	1	10		1165		2		45		9	2	1237	16.06
1982	11	126.1		3				262				15	6		2	288	2.28
1982	12	368	1	14				6				12	5	1	1	40	0.11
1983	1	683		14								1	7			22	0.03
1983	2	621.5		11	1	1		6					9			28	0.05
1983	3	362.5		15				3				7	3	1	1	30	0.08
1983	4	282		10				8				6	3	1		28	0.10
1983	5	80.5		12												12	0.15
1983	6	22		11								1				12	0.55
1983	7	3.5		2								2	1			5	1.43
1983	8	30.5		7		1		1				1	2			12	0.39
1983	9	188		9									1		1	11	0.06
1983	10	156.5		3				1								4	0.03
1983	11	328.2		6				5				7				18	0.05
1983	12	344.1		9				3				15	7		1	35	0.10
1984	1	438	1	5	2	1		97	1			3	6	1	1	118	0.27
1984	2	446.5		20	1	1	1	98				4	9	1		135	0.30
1984	3	287	2	9	6			23	1			6	3	1		51	0.18
1984	4	87.8		7	3	1		9				8	3			31	0.35
1984	5	31.5		1	1			2							2	6	0.19
1984	6	13		2				1				1	3			7	0.54
1984	7	53		34				10					1			45	0.85
1984	8	5.5														0	0.00
1984	9	101.5		4				28		1		2		2	6	43	0.42
1984	10	125	1	1				18				28	1			49	0.39
1984	11	122.5	1	9		1		15				12	2		2	42	0.34
1984	12	399.7		7	1			10				6	3			27	0.07

Appendix KC6 *Monthly numbers of owls, pigeons, swifts and passerines found dead, beached bird surveys North Sea coast 1965-1999, continued, see also appendix KC4.*

Year	Month	effort	owl	pigeon	lark	pipit	swallow	thrush	sthrush	warbler	tit	star	crow	finch	uniden	total	n/km
1985	1	252.5		8	1			48				12	1		1	71	0.28
1985	2	379.6	2	22	1	1		83				15	5	2	1	132	0.35
1985	3	283	3	28	1			45				64	5		1	147	0.52
1985	4	67.5		8				9				18		1	4	40	0.59
1985	5	52.5		3								7				10	0.19
1985	6	18		4												4	0.22
1985	7	58		7			1	2				1				11	0.19
1985	8	67	1	6				1								8	0.12
1985	9	37.5		5					1							6	0.16
1985	10	75		2				5		1		1				9	0.12
1985	11	306.5		15	2	1		78				48	2		6	152	0.50
1985	12	387.5	1	18	1			6				12	1		6	45	0.12
1986	1	271	1	6								3	1		1	12	0.04
1986	2	219	1	6				3				1	1			12	0.05
1986	3	228		17				37				9	7	1		71	0.31
1986	4	50	1	6	1			13				6	1			28	0.56
1986	5	10												1		1	0.10
1986	6	7		2												2	0.29
1986	7	16		2									1			3	0.19
1986	8	27		2												2	0.07
1986	9	30.5														0	0.00
1986	10	49.5						1		1		3				5	0.10
1986	11	88						5				8	2			15	0.17
1986	12	190		15								1				16	0.08
1987	1	231		7				5								12	0.05
1987	2	385		21				8				4	2			35	0.09
1987	3	107.5		4				1					1			6	0.06
1987	4	28.5	1	2		1		3				2	1			10	0.35
1987	7	6		1												1	0.17
1987	8	38		1			1					2		1		5	0.13
1987	9	7.5														0	0.00
1987	10	28.5														0	0.00
1987	11	111		1				16		1						18	0.16
1987	12	254.5	1	6				5				4		1		17	0.07
1988	1	337.75		1									1			2	0.01
1988	2	339		6	1			5						2		14	0.04
1988	3	274.2	1	6				13				6	1			27	0.10
1988	4	46.7		3				6					2		1	12	0.26
1988	5	24		1												1	0.04
1988	6	24		73												73	3.04
1988	7	32		9								1				10	0.31
1988	8	36.5		1												1	0.03
1988	9	28.5														0	0.00
1988	10	55		2	1			67				12	2	2	6	92	1.67
1988	11	168		1				206				42			6	255	1.52
1988	12	406	1	8		1		4				3	1		4	22	0.05

Appendix KC6 *Monthly numbers of owls, pigeons, swifts and passerines found dead, beached bird surveys North Sea coast 1965-1999, continued, see also appendix KC4.*

Year	Month	effort	owl	pigeon	lark	pipit	swallow	thrush	sthrush	warbler	tit	star	crow	finch	uniden	total	n/km
1989	1	275.88		9				2								11	0.04
1989	2	256		12	1			1				3	4	1	1	23	0.09
1989	3	123		7								1	2		3	13	0.11
1989	4	62		2								1	1		1	5	0.08
1989	5	24														0	0.00
1989	6	24		3												3	0.13
1989	7	29		5												5	0.17
1989	8	45.5		3			1						2			6	0.13
1989	9	47		4												4	0.09
1989	10	58						4			1	25			7	37	0.64
1989	11	141		6				10		1		28	1			46	0.33
1989	12	289.5		10				10				14	5			39	0.13
1990	1	219	1	13				6				3	1			24	0.11
1990	2	376.5	1	11	1			3					2	1		19	0.05
1990	3	211.5		8				1				1	1			11	0.05
1990	4	98.5		3				2				3	1			9	0.09
1990	5	24		2												2	0.08
1990	6	27														0	0.00
1990	7	26		1												1	0.04
1990	8	36		23												23	0.64
1990	9	48		3				1								4	0.08
1990	10	65						8	1	1		2				12	0.18
1990	11	234	1	6				3				1		1	5	17	0.07
1990	12	243		3				2								5	0.02
1991	1	281		3									3			6	0.02
1991	2	309		18		3		13					3		6	43	0.14
1991	3	182.5		11				7			1	6	1		3	29	0.16
1991	4	72.5		2											1	3	0.04
1991	5	56	1	2								1				4	0.07
1991	6	59		3												3	0.05
1991	7	27.5		1								1				2	0.07
1991	8	26.5		2												2	0.08
1991	9	30		3								6	2			11	0.37
1991	10	62.5				1		17				9				27	0.43
1991	11	87.5		3				8				6	2			19	0.22
1991	12	237	2	2				4				2	3			13	0.05

Appendix KC6 *Monthly numbers of owls, pigeons, swifts and passerines found dead, beached bird surveys North Sea coast 1965-1999, continued, see also appendix KC4.*

Year	Month	effort	owl	pigeon	lark	pipit	swallow	thrush	sthrush	warbler	tit	star	crow	finch	uniden	total	n/km
1992	1	205.6		4				5				1	1			11	0.05
1992	2	216.5		3		1						2	1			7	0.03
1992	3	155.5		3				3					1			7	0.05
1992	4	68		2				2				3	3			10	0.15
1992	5	46		9				1					3			13	0.28
1992	6	12.5		1												1	0.08
1992	7	8										1				1	0.13
1992	8	16		5												5	0.31
1992	9	13		6												6	0.46
1992	10	59	1	3				9				10	1			24	0.41
1992	11	123.5		8				23	1			23				55	0.45
1992	12	166		3				4				5			1	13	0.08
1993	1	171.75		1								1				2	0.01
1993	2	265		19	2			13				5	7	1		47	0.18
1993	3	109		4				27				6	2	1		40	0.37
1993	4	10.5		1				2								3	0.29
1993	5	8														0	0.00
1993	6	10														0	0.00
1993	7	16		1												1	0.06
1993	8	13		3												3	0.23
1993	9	11.5												1		1	0.09
1993	10	27.5														0	0.00
1993	11	23.5						1								1	0.04
1993	12	205.3		2				6				1	3			12	0.06
1994	1	103.4		1									1			2	0.02
1994	2	172.9		2				1								3	0.02
1994	3	152.9		4				319				25	1	1		350	2.29
1994	4	31.9											1			1	0.03
1994	5	12														0	0.00
1994	6	15		1												1	0.07
1994	7	12		4												4	0.33
1994	8	21.1		1												1	0.05
1994	9	10.5														0	0.00
1994	10	23.8														0	0.00
1994	11	31		2				4				1				7	0.23
1994	12	86.45		2				2				1				5	0.06
1995	1	136		1												1	0.01
1995	2	128.5											2			2	0.02
1995	3	50		3												3	0.06
1995	4	33											3			3	0.09
1995	5	26		6									1			7	0.27
1995	6	12		1									6			7	0.58
1995	7	13														0	0.00
1995	8	8														0	0.00
1995	9	24.2		1									6			7	0.29
1995	10	49.1														0	0.00
1995	11	95.95						14				12	1			27	0.28
1995	12	140.4		3				37				10	2		1	53	0.38

Appendix KC6 *Monthly numbers of owls, pigeons, swifts and passerines found dead, beached bird surveys North Sea coast 1965-1999, final, see also appendix KC4.*

Year	Month	effort	owl	pigeon	lark	pipit	swallow	thrush	sthrush	warbler	tit	star	crow	finch	uniden	total	n/km
1996	1	99.95		1				2					3			6	0.06
1996	2	202.15		3				9					6	1	1	20	0.10
1996	3	97.2		2				2					1		1	6	0.06
1996	4	15										1				1	0.07
1996	5	13		1									1			2	0.15
1996	6	16														0	0.00
1996	7	18.4		2									2			4	0.22
1996	8	8		1												1	0.13
1996	9	12.5														0	0.00
1996	10	30						1				1				2	0.07
1996	11	53.3						1								1	0.02
1996	12	184.9		1				9				6				16	0.09
1997	1	87.7						3								3	0.03
1997	2	104.6		5									1			6	0.06
1997	3	67						34				30		2		66	0.99
1997	4	10		2				1				3				6	0.60
1997	5	8		1				1								2	0.25
1997	6	12		3												3	0.25
1997	7	20		2												2	0.10
1997	8	13		5												5	0.38
1997	9	65		3				1					1	1	1	7	0.11
1997	10	55	1	3				2				4				10	0.18
1997	11	62.71		2			1	4				2			1	10	0.16
1997	12	126		2				3				1	1			7	0.06
1998	1	144.6		3												3	0.02
1998	2	92		2								2	2			6	0.07
1998	3	113.6		2				5				5				12	0.11
1998	4	30		1				1					1			3	0.10
1998	5	15		1												1	0.07
1998	6	8														0	0.00
1998	7	12														0	0.00
1998	8	36		1												1	0.03
1998	9	38.3		1					1							2	0.05
1998	10	64.25		1				10				1		1		13	0.20
1998	11	95	1					50				26	1	1		79	0.83
1998	12	272.5		12				74				23	2	1	1	113	0.41
1999	1	266.25		8				8				1	4			21	0.08
1999	2	345.1		1				4				2	6			13	0.04
1999	3	161.7		4	1			29				12	2			48	0.30
1999	4	5						10				1			1	12	2.40
n =			40	1943	61	34	6	5108	13	14	2	1224	405	80	211	9141	
%			0.4	21.8	0.7	0.4	0.1	57.2	0.1	0.2	0.0	13.7	4.5	0.9	n =	8930	

Appendices KC7 *Monthly numbers of owls, pigeons, swifts and passerines at sea, ship-based surveys 1983-1999 (SASBASE), see also appendix KC4.*

Year	Month	effort	owl	pigeon	lark	pipit	swallow	thrush	sthrush	warbler	tit	star	crow	finch	uniden	total	n/km
1983	5	150															
1984	5	22															
1985	5	83															
1987	2	66															
1987	3	1116			2	4						53		3	1	63	0.06
1987	4	2402		11	1	45	1	2	5	5		48	2	6		126	0.05
1987	5	388					2									2	0.01
1987	6	1528		1		1	15					1			1	19	0.01
1987	7	1644		1			6									7	0.00
1987	8	4935		3		6			6	6				3	11	35	0.01
1987	9	2947				11	1	7	3	4				6	6	38	0.01
1987	10	2887	2	132	135	40	1	492	24	22		545	3	134	40	1570	0.54
1987	11	1577			1	3		82	1	3		121		6	1	218	0.14
1987	12	805		1												1	0.00
1988	1	2085						1								1	0.00
1988	2	1383		1	14							4			1	20	0.01
1988	3	1748		3	18	3		348	3	1		759		5	1	1141	0.65
1988	4	1453		1		1	1	1	1	2				4	9	20	0.01
1988	5	1132		1												1	0.00
1988	6	1260		1			3					6			1	11	0.01
1988	7	2240		1					1							2	0.00
1988	8	893				3										3	0.00
1988	9	1049		1					1	2						4	0.00
1988	10	1521		3	35	44	1	340	7	2		1176		22	15	1645	1.08
1988	11	1828			5	3		35				91	7	2		143	0.08
1988	12	475															
1989	1	1386		2								1				3	0.00
1989	2	1613		12	6	1						4	1			24	0.01
1989	3	974			1	8					1	70		30	21	131	0.13
1989	4	119															
1989	5	961		2	1		26		1	2		1	1		2	36	0.04
1989	6	402															
1989	8	622							1	2						3	0.00
1989	9	994				4			1	1						6	0.01
1989	10	1717	2		191	40		330	6	10		1135	1	62	2	1779	1.04
1989	11	1330			4			3				56		1		64	0.05
1989	12	169															

Appendices KC7 *Monthly numbers of owls, pigeons, swifts and passerines at sea, ship-based surveys 1983-1999 (SASBASE), continued, see also appendix KC4.*

Year	Month	effort	owl	pigeon	lark	pipit	swallow	thrush	sthrush	warbler	tit	star	crow	finch	uniden	total	n/km
1990	1	507			22			121								143	0.28
1990	2	539			24							2				26	0.05
1990	3	756				5		1	3			2			3	14	0.02
1990	4	1159	1	3		8		25		3		5		1	3	49	0.04
1990	5	618				1	5					1				7	0.01
1990	6	680					1									1	0.00
1990	7	329															
1990	8	1215							1					2		3	0.00
1990	9	459		1												1	0.00
1990	10	1024	3		17	62		584	9	7		939	2	18		1641	1.60
1990	11	799			41			10		1		378		1350	92	1872	2.34
1990	12	90															
1991	1	650		16								2				18	0.03
1991	2	779		3	69	12		2				37		7		130	0.17
1991	3	1012		11	11	3		97	4			1526	5	153		1810	1.79
1991	4	103			1											1	0.01
1991	5	1353		2			21		2	3						28	0.02
1991	6	1079		1			1									2	0.00
1991	7	129		2			1									3	0.02
1991	9	2020		1	3	34	5		1							44	0.02
1991	10	729	1		5	1		13				12	2	4		38	0.05
1991	12	80															
1992	1	2165		1				2								3	0.00
1992	2	989		15	1							5				21	0.02
1992	3	13															
1992	4	603		5		89	4	2	5	1		1	2	2		111	0.18
1992	5	287					2									2	0.01
1992	9	367				2			3	2						7	0.02
1992	10	814			1	2		48		4		163				218	0.27
1992	11	44			2			15				33				50	1.13
1993	1	577			18			6				1	1			26	0.05
1993	2	2590		1	72			9				17	1			100	0.04
1993	3	437		4	11	2						12				29	0.07
1993	5	2262		2	4	8	121		5	1						141	0.06
1993	6	104															
1993	8	599		1												1	0.00
1993	9	689				3				1						4	0.01
1993	10	575			1	1		2	2	1		9		1		17	0.03
1993	11	63						8	1			3		2		14	0.22
1993	12	151															

Monthly numbers of owls, pigeons, swifts and passerines at sea, ship-based surveys 1983-1999 (SASBASE), final, see also appendix KC4.

Year	Month	effort	owl	pigeon	lark	pipit	swallow	thrush	sthrush	warbler	tit	star	crow	finch	uniden	total	n/km
1994	3	339										1				1	0.00
1994	4	364		1		3									3	7	0.02
1994	5	2063		6		1	12		6	6				1		32	0.02
1994	6	451					1									1	0.00
1994	8	1818							1	1						2	0.00
1994	9	997		1		2	1		1	1						6	0.01
1994	10	1963		1	6			7		3		78				95	0.05
1994	11	154			4			18	3	1		781		5		812	5.28
1995	1	383															
1995	2	157															
1995	5	31															
1995	7	187															
1997	4	1166		3	1	13	1		1	2						21	0.02
1997	5	1103		59			36			1						96	0.09
1997	6	470		15			4					16				35	0.07
1997	7	1021		8			16		1							25	0.02
1997	9	630		10		3			1							14	0.02
1997	10	953		1	38	45						145		10		239	0.25
1997	11	451		1	2	5		91				110		1		210	0.47
1998	1	33															
1998	6	232															
1998	7	46															
1998	8	941		1												1	0.00
1998	9	44							2	2						4	0.09
1998	10	32						3				6				9	0.28
1999	1	23															
1999	4	76				4								4		8	0.10
n =			9	353	768	526	289	2705	113	103	1	8356	28	1845	213	15309	
%			0.1	2.3	5.1	3.5	1.9	17.9	0.7	0.7	0.0	55.4	0.2	12.2	n =	15096	

Appendix MF1 The number of parcels sent in by light vessels, empty cells no data.

Table A. *Terschellingerbank*

	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Jan	0	0	0	0										
Feb	0	2	1	0										
Mar	0	1	2	0										
Apr	0	0	1	0										
May	0	0	0	0										
Jun	0	0	1	0										
Jul	0	1	0	0										
Aug	0	0	0	0										
Sep	0	0	1	0										
Oct	2	1	0	2										
Nov	2	1	0	0										
Dec	2	0	1	0										

Table B. *Texel.*

	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Jan	0	0	1	1	0	0	0	1	0	0	0	0		
Feb	0	0	1	4	0	0	1	0	2	0	0	1		
Mar	0	2	1	4	0	1	2	2	3	1	1	0		
Apr	0	2	3	2	1	1	1	1	0	0	0	0		
May	0	0	1	0	1	0	0	0	0	0	0	0		
Jun	0	0	1	1	0	0	1	0	1	0	0	0		
Jul	0	0	0	0	0	0	0	0	0	0	0	0		
Aug	0	2	0	0	1	1	1	0	0	0	0	0		
Sep	1	0	2	0	0	1	0	3	3	4	2	1		
Oct	3	2	4	3	5	3	2	3	8	5	5	0		
Nov	2	1	1	2	3	3	2	0	0	1	1	0		
Dec	2	0	2	2	6	1	0	0	1	0	2	0		

Appendix MF1 The number of parcels sent in by light vessels, empty cells no data, final.

Table C. *Noord Hinder.*

	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Jan	0	0	0	0	0	0	1	0	0	0		0	0	0
Feb	0	2	1	0	0	1	1	2	1	20		0	0	0
Mar	0	3	0	0	1	2	2	0	0	0		0	0	0
Apr	0	1	0	0	2	2	2	0	3	0		0	0	2
May	0	1	1	0	1	1	2	0	0	0		0	0	0
Jun	0	0	0	0	0	0	1	2	0	0		0	1	0
Jul	0	0	0	0	0	0	1	1	0	0		0	1	0
Aug	0	2	1	0	1	1	0	2	1	0		0	0	0
Sep	1	0	0	1	1	1	0	7	6	2		0	0	0
Oct	3	3	1	1	1	1	0	1	4	0		1	0	0
Nov	1	2	0	1	1	1	0	0	1	1		6	0	0
Dec	0	0	0	0	0	0	1	0	1	2		1	0	0

Table D. *Goeree.*

	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Jan	0	0	0	0		0	0		0					
Feb	0	2	0	1		0	0		1					
Mar	0	0	0	0		0	0		1					
Apr	0	2	0	0		0	1		0					
May	0	0	0	0		0	0		0					
Jun	0	0	0	0		0	0		0					
Jul	0	0	0	0		0	0		0					
Aug	0	0	0	0		0	0		0					
Sep	0	0	0	1		0	0		0					
Oct	0	0	1	0		0	0		0					
Nov	1	0	1	1		1	2		0					
Dec	0	0	0	0		0	0		0					

Colofon

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