Baseline studies North Sea Wind Farms: Lot 5 Marine Birds in and around the future sites Nearshore Windfarm (NSW) and Q7

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Dit rapport beschrijft de zeevogelgemeenschap die zich in de loop van het jaar bevindt in een zeegebied voor de Noord-Hollandse kust, waar in de nabije toekomst twee windmolenparken gebouwd zullen worden, de zogenaamde *Nearshore Windfarm* (NSW) en het windmolenpark *Q7*. Om deze "T-nul" situatie te kunnen vastleggen zijn de zeevogels gedurende acht weken, verspreid door het jaar, geïnventariseerd vanaf een speciaal daartoe ingezet schip. Er werd hierbij steeds een gebied geïnventariseerd dat ruimschoots groter was dan de beide toekomstige windmolenparken samen. Hierdoor konden de vogelaantallen binnen en buiten de contour van de windmolenparken worden vergeleken, rekening houdend met de ruimtelijke patronen die zeevogelverspreidingen in het gebied laten zien. In de nul-situatie, dus nog voordat er windturbines in gebied staan, is niet gebleken dat de aangewezen gebieden voor de turbines qua vogelbevolking afwijken van de omgeving. T-één studies (na de bouw) zullen moeten uitwijzen of dat in de toekomst zo zal blijven. De aantallen vogels, aanwezig in een relatief klein gebied zoals nu bestudeerd, kunnen van dag tot dag, week tot week en jaar tot jaar sterk variëren, zoals in deze studie werd vastgesteld aan de hand van langer lopende dataseries. Dit maakt dat een directe vergelijking van aantallen nu en straks minder zinvol is, dan een vergelijking van de aantallen binnen en buiten een windpark, op hetzelfde moment gemeten.

Trefwoorden:, T-nul situatie, verstoring, verspreidingspatroon, windmolens, zeevogels

ABSTRACT

This study describes the seabird community in Dutch North Sea waters where in the near-future two marine windfarms will we built (*Q7* and *Nearshore Windfarm;* NSW).
To document the current situation ("T_{zero}"), ship-based seabirds-at-sea counts were conducted during eight dedicated surveys, distributed over the year. The study area was considerably larger than the future windfarm areas. This made comparisons possible between bird densities within and outside the contours of the future sites, after correction for location (northing and depth). In this "before impact" situation, seabird densities at the future windfarm sites were mostly statistically similar to those in the immediate vicinity. Future ("T_{impact}") studies will be conducted to asses if the impacted areas will have changed after the wind turbines have been put into place. Seabird presence is be highly variable in time and place as a result of migratory movements, weather conditions, seasonal and diurnal patterns. Apart from studying just the small future sites for windfarms, we also consulted existing long-term databases on seabird presence (aerial surveys) and passage (seawatching data) to enhance our understanding of existing variability. Seabird numbers in an area the size of a future windfarm may vary by at least an order of magnitude. This flaws direct comparisons of numbers present in a T_{zero} and a T_{impact} situation. Therefore, densities at the windfarm site should be compared to densities at sea in the immediate vicinity, measured simultaneously.

Keywords: before impact study, distribution modeling, disturbance, offshore windfarm, seabirds at sea

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SUMMARY

This study describes the "T-zero" situation for seabirds in an area on the Dutch continental shelf, where in the near-future two offshore windfarms will be built. Seabird distribution and abundance was assessed during eight dedicated ship-based surveys, distributed over the yearly cycle (Table 2). During each survey, ten equidistant, E-W running transect lines were sailed, while seabirds were counted on both sides of the vessel, by two teams of two observers each. Most transect lines were sailed twice during each survey. Eighteen species of seabirds were seen in sufficient numbers to warrant further examination (Table 5). Distribution patterns within the study area (some 900 km^2 off the Dutch mainland coast, encompassing both future windfarms; see Figure 2) were described for each of the 18 species by plotting all positive and negative observations (corrected for way-length, as n/km). For mapping densities (n/km^2) throughout the study area, only birds seen within two 300m wide counting strips (see Figure 1) were used.

The study area has clear nearshore-offshore gradients in seabird distribution patterns. At one extreme, Great Crested Grebes were only seen in a narrow strip immediately adjacent to the coastline and were thus never encountered at the future windfarm sites. At the other extreme were offshore species such as Northern Fulmars and Kittiwakes that were mainly found to the west of the windfarm locations, although some ventured into nearshore waters, including the future windfarm locations. Most other birds had intermediate distributions and the future windfarm sites were part of their normal range. Distribution patterns showed seasonal trends in most species and in some (e.g. gulls) were clearly linked to fishing activities in the area. Such ship-following behaviour would make the distribution pattern rather unpredictable in terms of geogragpy. Many distribution patterns followed gradients in water temperature and salinity, that in turn were linked to bottom topography (with the orientation of the smoothed -20m isobath used as a proxy). Distribution and density patterns were generally in agreement with patterns found in earlier ship-based (Camphuysen & Leopold 1994) and aerial surveys (Baptist & Wolf 1993) in the area, although some remarkable and recently developed patterns were found. During the April survey several species that were hitherto considered as having mainly nearshore distributions, i.e. occurring mainly in waters on the landward side of the windfarm sites (divers, Little Gull, Sandwich, Common and Arctic Terns) were found throughout the study area, from the shore to some 20 nm offshore. Great Cormorants have recently taken residence in the area, operating from two growing colonies on the mainland, just east to the study area. These birds were found to utililize offshore gas platforms at roosts and temporary bases for offshore foraging and it might be predicted that, should the turbines and associated equiptment provide a base for roosting, these birds will quickly colonise the windfarm locations as well.

Seabird behaviour, including flying heights, flying directions, several different foraging and feeding behaviours, association behaviour (to fishing vessels, marine

mammals, offshore platforms, hydrographical fronts, etc) were noted for the birds seen. The aim of this was two-fold: to find the most vulnerable birds with respect to collissions to turbine rotors and to help explain some obvious anomalies in distribution patterns. The latter is considered very important to understand aspects of clumped distribution patterns, that might otherwise (wrongly) be attributed to turbine presence in future.

The results from the eight dedicated surveys are compared to other data-series on seabirds collected in the region, in two desk studies. The aim of these comparisons was to examine how representative results from single surveys might be, considering that there would be variation in seabird presence on different time scales. Aerial survey data suggested that such variation is likely to be large between years, although available sample sizes were small. Seawatching data, collected at an offshore platform situtated at a distance from the coast that is comparable to that of the future windfarm sites, suggested the same, for within-month variation. Advancing weather systems might greatly influence seabird presence in a study area that in fact is very small when seen in relation to seabird ranges and movements. Some species of seabirds that were seen in very low numbers during the surveys (e.g. petrels and storm-petrels) will fly through the area in seisable numbers under particular meteorological conditions. However, under such (stormy) conditions, seabird surveys from either ship or plane are not normally conducted. The implication of such variations in seabird presence in the study area is, that only a particular T-zero situation could be described, while many more T-zero states will exist.

The main aim of the study was therefore, to examine seabird distribution patterns in relation to the future windfarm sites. Even when there is considerable temporal variation in seabird distribution, there should be no effect of location (windfarms site). We developed a distribution model, that predicted seabird presence for each location (250x250m grid cells) in the study area, based on all available counts from the dedicated survey (per species, per month) and that took the distance to the -20m isobath (for X-direction) and latitude (for Y-direction) into account. This model could only be applied for species/month combinations, for which at least 20 counts with positive observations (densities > 0) were available. In the T-zero situation no effect of either windfarm site was to be expected, and this was also found. Apparently aberrant concentrations of seabirds could usually be explained as temporal deviations caused by either fishing activities or the presence of a hydrographical front that temporarily attracted concentrations of certain birds.

In the future T-one studies (turbines present), fisheries will be banned from the windfarm locations and ship-linked associations of scavenging seabirds will no longer occur here. The probability of finding large, fishery-related concentrations of seabirds within the present contours of the Q7 and NSW windfarms will thus chance. Moreover, the turbines might either deter or attract seabirds and the deviations from the general pattern should be the principal subject of future, T-one studies.

INTRODUCTION

Large, offshore wind facilities (windfarms) are currently being built or planned in the North Sea by several European countries. Because of their scale and foreseen future developments, offshore windfarms are considered as an extensive technical development in marine habitats and there is a general concern that windfarms may have effects on wildlife. The United Nations Law of the Seas and the establishment of Exclusive Economic Zones gives coastal states extensive rights but also obligations over marine areas, including the licensing of parts of the seabed to windfarm developers and the assessment of potential effects of windfarms on the marine environment. The Ministry of Transport and Public Works, as manager of the seabed within the Dutch EEZ keeps a check on developments in The Netherlands and has commissioned a wide-ranging study into the state of an area of sea, where in the near future windfarms will be built.

Birds, both resident seabirds (at any time of year) and migrating land- and waterbirds seem particularly vulnerable in that they may suffer the ultimate consequence of wind turbines being erected at sea: death. While it may be argued that all birds passing over an offshore windfarm site are at risk, seabirds are not only at risk during migration, but at all times, as the sea is their home. Seabirds are highly mobile animals that not only engage in long distance migratory flights, but also in daily foraging trips, responses to advancing weather systems, compensation flights for tidal displacements and ad-hoc responses to sudden, localised feeding opportunities. Compared to other marine organisms, only seabirds can potentially collide with the turbines and be killed. Seabirds, although of no direct commercial value, are much appreciated by the general public, as the most visible representative of the marine food web. Seabirds often breed at specially protected breeding sites and have received increasing protection away from their colonies at sea as well, for instance under the EU Bird Directive. Effects of future developments in offshore waters should therefore be accompanied by proper Environmental Impact Assessments (EIA's) and in the case of offshore windfarms, this is particularly true with respect to seabirds.

Effects on seabirds may be far more subtle than deadly collisions, and may vary from slight deviations from flight paths, to habitat degradation or even habitat loss at the windfarm sites. Habitat degradation occurs when seabirds are scared off by wind turbines at sea so that they can no longer, or to a lesser extent, utilize areas where wind turbines are operational. On the other hand, positive effects are also possible if windfarms provide better feeding conditions locally, for instance because fish are attracted to the turbine bases or if the closure of fisheries within the area prevents depletion of local food stocks. Either effect (negative or positive) can, in principle, be measured by comparing seabird densities at windfarm locations with densities away from these sites, both in time (before, after placement) and in place (inside, outside a windfarm).

Currently, windfarms can only be developed in nearshore, shallow waters for technical and logistical reasons. However, these coastal waters support high densities of seabirds, both in the breeding, migration, moulting and wintering seasons and large parts of nearshore waters are considered to be prime seabird habitats throughout the North Sea (Skov *et al.* 1995). With increasing numbers of windfarms getting towards the building phase, seabird studies to assess seabird presence and usage of future windfarms are currently called for in several North Sea countries (e.g. Camphuysen *et al.* 2004; Garthe & Hüppop 2004).

Whether or not seabirds will be affected at a windfarm site will be dependent on the species of seabird concerned and related to its vulnerability to disturbance. The significance of habitat loss or habitat degradation will be dependent on parameters such as the local or bio-geographical population size of the species concerned; its European threat and conservation status and the amount of comparable habitat available to that species. Because of this latter concern, species that are confined to coastal waters, such as divers or seaduck may be more at risk than species that occur over the entire North Sea, such as for instance Guillemots *Uria aalge*. This follows from the limited amount of coastal waters that is available in the North Sea, compared to the more extensive offshore zone. Habitat loss within the limited coastal strip may therefore be relatively important and it is here, that the first generation of North Sea offshore windfarms is being planned.

Within the framework of the commissioned "Baseline Studies North Sea Wind Farms", a specific study is dedicated to the seabirds (Lot 5 of the full framework). The present report deals with the reference or T-0 situation (the situation in which only the future location of a windfarm is known but in which no wind turbines are yet in place). In this situation, the study aims to quantify the following, for an area where two windfarms will become operational in the near future:

- Occurrence and distribution of marine birds
- Density of marine birds
- Foraging behaviour of marine birds
- Daily flight patterns of marine birds
- Altitudes used in flight

To this end, eight dedicated cruises were conducted to describe the year-round seabird presence before the first turbines are erected. The surveys were timed to cover the full seabirds' calendar, taking into account important features such as breeding, moulting, migrating and wintering of the various species using this area throughout the year. Obviously, the study does not deal with effects of wind turbines on seabirds, as no turbines were in place at the time of this T-0 study. However, but examining the existing seabird distribution pattern in a "before" situation possible risks can be assessed and a base-line is given for the next phase, the T-1 study.

METHODS

Counting seabirds at sea

Bird counts were conducted from ships, sailing at 10 knots (ca. 18.5 km/h), using a strip-transect methodology as outlined in depth in Tasker *et al.* (1984); Komdeur *et al.* (1992) and Camphuysen & Garthe (2004). In brief: all birds present in a strip of 300 m wide perpendicular to the ship are counted, as the ship passes them by. All swimming birds (including birds touching the water only briefly, e.g. during plunge-diving) were assigned to a distance class (sub-strip adjacent to the vessel; Figure 1). Relative numbers seen in the sub-strips AB (0-100 m perpendicular), C (100-200m) and D (200-300m) were later used to evaluate missed observations, in relation to perpendicular distance of swimming birds, using the Distance theory (Buckland *et al.* 1993). For flying birds passing through the 300 m strip a so-called snap-shot method was used (Tasker *et al.* 1984). At a ship speed of 10 knots, the ship covered a distance of 300 m per minute. Flying birds were only counted as "in transect" if they:

1) Flew by at a perpendicular distance of no more than 300 m on the side of the ship (portside or starboard where the count was conducted;
2) did so no further than 300 ahead of the observers, and
3) did so at the start of a full minute (snap-shot).

This snap-shot method is needed to get the correct densities for flying birds in the airspace above the area surveyed. Consider that the ship would be moving at indefinite slow speed, in other words, would take forever to cover 300 m of transect length. In that hypothetical case, an indefinite number of flying birds would pass through the square of 300x300 m (that would be covered in one minute at the normal speed of 10 knots) and if all these birds would be classed as "in transect" the resulting calculated density would be infinite per km^2. The correct density would only be achieved (if all birds passing through the 300x300 m square would be counted) if the ship would travel at the speed of light. Alternatively, flying birds could only be noted at the onset of each subsequent counting period (5 minutes in the present surveys), while all birds passing through the 300x300 m square at other moments (later) should be ignored. This would be correct but impractical, as the way-length of an entire count (1500 m) would make detection, identification and correct position (within or without the box of 300x1500 m) too difficult. Hence, the total count for flying birds is broken up into 5 one minute sub-counts and only those birds flying over an area of 300x300 in front of and to the side of the ship at the start of each minute, were noted as "in transect" and these, with the birds swimming within 300 m perpendicular distance, were the ones used for estimating bird densities.

Seabirds were counted simultaneously in two parallel strips, each 300 m wide (Figure 1), at either side of the ship. These counts were made by two independent teams of two observers that had their clocks (for snap-shots) synchronised to ensure that birds flying across the bow could not be double-counted as "in transect". This procedure doubled the sample size compared to the traditional methods in which only one such counting strip is being watched (Tasker *et al.* 1984) and also allowed for a better between-observers comparison of data collection efficiency (compare to van der Meer & Camphuysen 1996). Spatial resolution was also increased by using 5 minute intervals for separate subsequent counts (compared to the standard 10 minute counts as proposed by Tasker *et al.* 1984).

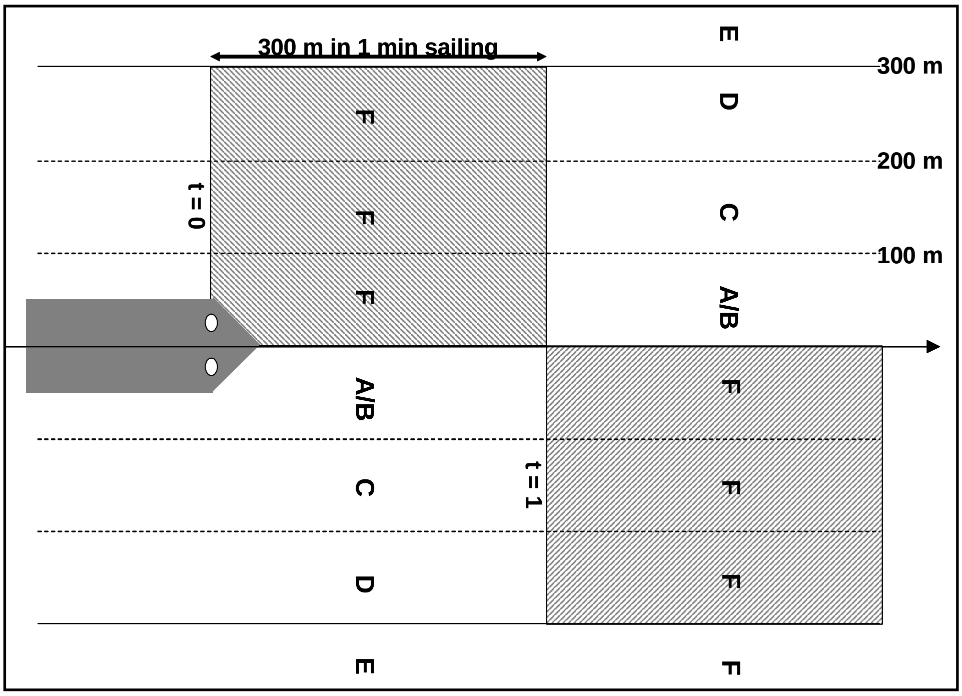


Figure 1. Schematic overview of the two counting strips to the left and right of the sailing vessel (not drawn to scale). The two shaded 300x300 boxes are the areas used for snap-shots of flying birds. The first box (to the left of the ship's course line, represented by the central arrow) is used for the first snap-shot of the bird count, at t=0. A similar box is used for a snap-shot by the starboard team, also at t=0. After one minute, at t=1 (minute) the next snap-shot is performed within the same count (each lasting 5 minutes in the present surveys), again simultaneously to the left and right of the vessel (only starboard box is drawn here). All birds seen flying are noted as "F" on the field sheets, and later in the database. Swimming birds are noted as swimming in one of four sub-bands on either side of the ship: AB (0-100 m perpendicular), C (100-200m), D (200-300m), W (anywhere from 0-300 m perpendicular, but no further data) or E (outside the counting strip at more than 300 m perpendicular distance). Note that only the birds seen in A/B, C and D plus those in W and F when "in transect" were used for density calculations, while all birds seen (including those in E and F "outside transect") were used to map distributions. The approximate positions of the two observer teams on the top of the bridge of the ship are given as two white ovals.

All birds detected during the counts were noted, including those seen swimming or flying beyond 300 m perpendicular distance (assigned to sub-band E or to category F, respectively) and birds flying through the 300x300 m squares that were primarily watched, but at other moments than the onset of full minutes (the snap-shot moments). Records of such birds, all noted as "outside transect" provided additional information on distribution and larger sample sizes on categories of behaviour, age, sex, plumage etc. Note however, that only birds seen "in transect" were used to estimate ***densities***, but that all birds (in and out) were used to depict a first map of ***distributions***.

In addition to data on distribution and density, information was gathered on behaviour of the birds seen (following Camphuysen & Garthe 2004, using a standard coding protocol) and on altitudes of birds seen in flight. Flying birds were assigned to altitude classes, following methods used for standard counts of birds migrating over land (LWVT 1985; Lensink 2002), as (Table 1):

Table 1. Altitude classes used to describe the flying height (in meters above sea level) for birds seen in flight (after LWVT 1985; Lensink 2002).

Altitude Class	**Altitude range (m asl)**
1	0-2
2	2-10
3	10-25
4	25-50
5	50-100
6	100-200
7	> 200

Counts of active fishing vessels

Since the presence of fishing vessels in the vicinity of the transect line may influence local bird densities (particularly of ship-following scavengers such as gulls), the density of active (trawling, hauling, net-cleaning or discarding) was measured during the 2003 and 2004 surveys (Leopold 2003). To this end, the officer on watch on the bridge was asked every ten minutes to make a radar reading, recording the number of ships within a pre-set, two mile radius. This figure was then reported by radio to the observers on the top-deck, who inspected each recorded ship within this 2 mile radius. If such ships were active fishing vessels, they were recorded and the numbers seen for each ten minute interval was stored in the database. Maps of densities of active fishing vessels were drawn from these data (Figure 5), and compared to distribution patterns of gulls.

Ships used and position recording

Three different ships were used, the Research Vessels *Mitra* and *Zyrphaea*, owned by the Ministry of Transport and Public Works for the two 2002 surveys, and the *Orca I*, a commercially rented offshore survey and standby vessel (Table 2). All three ships were about 60 m long and their size allowed counting seabirds up to seastate conditions of about 6 Beaufort. However, during truly stormy conditions or very poor visibility (mist, heavy rain) the surveys had to be terminated. Ship groundspeed was kept at approximately 10 knots and this was constantly monitored by a portable GPS (large deviations that would make adjustment necessary of the snap-snot method did not occur). Ships positions were logged every 5 minutes and mid-positions of individual 5 minutes calculated. This was done by first calculating the mid-position of the ship between onset and end of each 5 minute count, and then offsetting the position from the trackline by 150 m to the left and right, for the portside and starboard team, respectively.

Timing of surveys and data collection at sea

Eight separate surveys were conducted, keeping in mind the avian calendar (Table 2). Note that the shorter days and more windy conditions in autumn and winter surveys resulted in relatively little coverage (total area surveyed).

Table 2. Timing of the eight individual surveys, ships used in each survey and the total area surveyed for each survey within the primary study area.

Season	Survey period	Ship used	Area surveyed
Spring migration	7-11 April 2003	Orca I	486 km^2
Egg phase;	19-23 May 2003	Orca I	401 km^2
Chick phase	23-27 June 2003	Orca I	454 km^2
Dispersion of young phase	11-15 Aug 2003	Orca I	454 km^2
Early Autumn migration	23-27Sept 2002	Mitra	418 km^2
Autumn migration	21-25 Oct 2002	Zyrphaea	239 km^2
Late Autumn migration & early winter dispersal	4- 7 Nov 2003	Orca I	315 km^2
Midwinter	16-19 Feb 2004	Orca I	367 km^2

Variation in seabirds presence

Describing seabird presence and abundance for a given area, requires also insight into the temporal variation in order to weigh the data found during the study period. It must be realised, that *the* T-0 situation does not exist, in that seabirds show considerable variation in their numbers and distribution at any one place. Thus, in an area where later a windfarm will be realised, seabird presence also shows variation, or in other words, there are many different states of the T-0 situation. A study that compares a single T-0 measurement with another single T-1 (windfarm in place) measurement runs a severe risk that large between-years differences are found that cannot be attributed to the presence/absence of the windfarm but that are instead related to other sources of variation. It is therefore important to come to grips with the amount of variation in the presence and densities that seabirds show in the study area, even without a windfarm being included into the equation. A T-0 study, that covers only a small site, where only during one year data are collected, cannot, by definition, cover the full scale of variation in seabirds occurrence. The situation is even worse if within that single year fieldwork has to be limited to a selection of months, weeks and days within that year, and to periods of reasonably good weather. If seabird presence shows large temporal variation on any of these time-scales, or changes markedly under e.g. very stormy conditions, such variation will not be detected. We have therefore chosen a survey design that best deals with some of these sources of variation and the T-0 fieldwork was put into context by additional desk studies of existing long-term datasets on seabird presence in the general area. Different types of variation include:

1. spatial variation: the seabird community and distribution patterns of individual species, are related to area, particularly along a nearshore-offshore gradient. Such variation can be dealt with by including relevant environmental/geographical parameters into the distribution models;
2. long-term, year to year variation (trends). Populations of seabirds may not be stable but show increases or declines. The same is true for some of their food species, resulting in large-scale changes in distribution patterns of seabirds in their total range of occurrence. Such clinal variation can be made visible by examining

long-term datasets on seabird distribution at fixed sampling plots. We used the RIKZ bi-monthly aerial seabirds surveys over the years 1991-2002 in the present study area to examine such trends (desk study).

3. long-term, year to year variation (erratic variation). Apart from on-going trends, there will be other, more erratic variation between years. We used the same RIKZ data (point 2) to examine this.
4. mid-term variation in seabird presence (on the scale of weeks or days, e.g. within-month variation). Our surveys, each lasting 5 days, are considered indicative for e.g. the month or season in which they were conducted. However, a period of 5 consecutive days does not cover a whole month or season and if seabirds presence varies greatly between weeks within such a longer period, a highly biased picture may result. Such variation can only be examined if long, on-going watches of seabirds presence can be made, covering whole months at least. Such fieldwork was not possible within the framework of this study (Lot 5) and for this reason we consulted other data (desk study). A dataset of intensive seawatching, performed on "Meetpost Noordwijk"and adjacent coastal seawatching posts (IJmuiden, Zandvoort, Noordwijk, Katwijk and Scheveningen) in the years 1978-1984 was used to examine this variation.
5. short-term, within-survey variation. As seabirds at sea are constantly on the move, there will be also variation between surveys days (within-week variation) and even within days. The latter may results from seabirds responding to temporal or spatial variation in food sources (discarding trawlers, rising fish schools, changes in the tide that provide of shut off feeding opportunities etc) or from intrinsic daily rhythms (birds flying out to sea in the morning and returning in the evening), but also to factors operating at larger geographical scale such as changing weather. We dealt with this by designing the surveys in such a way, that different sectors within the study area were covered more than once within the survey, and at different times of the day and of the week (see below).

Survey design and spatial and temporal variation in seabird presence

1. Spatial variation: size and shape of the study area and transect orientation

Two different approaches are being used to assess the (relative) importance for seabirds of a future windfarm site. The future site may be directly compared to a neighbouring reference area of the same size and physical and biological characteristics. This approach has been followed in several German offshore windfarm EIA's (Hüppop *et al.* 2003) This set-up has the advantage that a minimum of space needs to be studied and that comparisons seem straightforward and statistical testing or modelling can be kept simple. However, choosing a reference area that is in all respects (but exact location) similar to the future impact size, is difficult if not impossible and a wrong choice may jeopardize future comparisons. For this reason more than one reference area should preferably be chosen (Underwood 1994; Paine 1996) and these should be followed for a considerable time period, including pre- and post-construction periods.

Given the uncertainty on spatial variation around the sites of the future windfarms, we have chosen to follow a different approach. A study area, considerably larger than the area covered by the future windfarm (Figure 2) was selected to be surveyed in detail. This allows the usage of several reference areas within the total study area, as well as an evaluation of trends in bird presence within the windfarm areas, in relation to a larger, surrounding area. Reference areas have been provisionally assigned in advance, but may also be re-designed (post-hoc stratification), should available data or the final placement of the wind turbines dictate this. Note that the precise placing of the turbines was not known when the survey design had to be made, making the choice of reference areas even more difficult. Also, the range over which wind turbines, once in place, may deter seabirds is not yet known, making the size of both the impact area and the matching reference area unknown. The study area should therefore be large enough to provide space for reference areas that are not impacted by future turbines, but that is small enough to be reasonably homogeneous. Environmental homogeneity can be assessed by examining several physical factors that are likely to be related to seabird distribution patterns. These include: water depth, distance from the shore line or any other feature within or outside the study area, such as water temperature, salinity, etc. By including these co-variates into distribution models, a better understanding of the patterns observed during the surveys can be gained. Most importantly, distribution patterns found can be related to such environmental factors and deviations from such patterns may then be examined in relation to additional factors, such as the presence of wind turbines in the future.

The study area is situated in the eastern North Sea, directly west of the Dutch mainland coastline and covers an area between the coast and about 18 nm offshore (out to nearly 4°E), and from about 52°30'N (IJmuiden) to about 52°45'N (Hondsbossche Zeewering). The size of the study area was nearly 900 km^2, which is some 15 times the surface area of the two future windfarms that will be built centrally in the area examined (Figure 2). Ten equidistant (1.33 nautical miles or 2.47 km apart) transect lines (A-J; Figure 2; Appendix 1), running from East to West over the full width of the study area, were sailed during each survey. On each run, counts were done simultaneously in two parallel strips, each 300 m wide, at both sides of the ship, and if time and weather allowed, all transects were sailed twice during a full survey. This quadrupled the effort compared to a single passage, single transect approach and made that a large relative surface area was studied in relation to the total study area (Table 4). Transect orientation was deliberately chosen to be perpendicular to the main physical and ecological parameters, such as distance from the coast, water depth, temperature and salinity and from that, seabird community parameters. This, with the rather even coverage of the study area, should facilitate later spatial modelling of the results.

1b. Sea surface salinity and temperature measurements

During the 2003 and 2004 surveys, sea surface salinity and sea surface temperature were constantly measured with a Hydrolab Datasonde©3 Multiprobe Logger (Hydrolab Corporation, Loveland, CO, USA). The instrument was mounted on the hind-deck and sea water was continuously pumped through the flow-cell via a plastic hose connected to a pump that took in seawater for the engine cooling system of the ship. The Multiprobe was connected to a notebook computer that received and stored the data through a communication program (PROCOM), supplied by Rijkswaterstaat. The measurements were stored on the computer with one minute intervals. After each cruise the salinity/temperature datafile was retrieved and synchronized with the GPS-position files of the bird-counts. Before and after each survey, the conductivity probe of the Datasonde was calibrated with standard seawater (34.998 ppt). Measurements were linearly corrected for the differences of the calibration readings from 34.998. Such differences never exceeded 1 ppt. Temperature readings were not calibrated. Salinity and temperature averages for each bird-count interval (generally 5 minutes) were calculated. The results are presented as three dimensional plots of salinity and temperature against geographical position. The results have been used to fine-tune the modelling of seabird distribution patterns. An overview of the data collected is given in Appendix 2.

1c other environmental variables
Each individual count was later characterised in space by: geographical position (X,Y), water depth (taken from an existing GIS database based on a 100x100 m grid size with a vertical resolution of 0.1 m); and the distance to the major -20 m isobath (taken from those gridded depth data).

2 & 3. long-term trends and year to year variation: aerial survey data
In the present study, the fieldwork for the description of the T-0 situation was to be restricted to one year. We know, however, that certain aspects of seabird presence have changed markedly in the general area, over the last 10 or 20 years, both from our own at-sea surveys (Camphuysen & Leopold 1994) and from on-going seawatching data of the Dutch Seabird Group. In order to see what (in any) trends in seabird presence might be apparent within the current study area, we re-analysed the RIKZ bi-monthly aerial seabirds surveys (desk study). For this, we selected the available counts for the years 1991-2002 that were made within the perimeter of the study area (Figure 3). The aerial surveys followed more or less the same tracks through the study area during each survey, resulting (in theory) in more or less equal coverage between surveys. The data were separated into nearshore (over waters less than 20 m deep) and offshore (>20 m) locations and average densities were calculated for each stratum and each survey.

4. within-month variation in seabird presence
In a second desk-study within the framework of this report a dataset of intensive seawatching, performed on the offshore platform "Meetpost Noordwijk (*ca.* 52°17'N, 04°17'E) was computerized. Data had been collected on this offshore platform, situated some 10 km offshore from the Dutch mainland coast at about 35 km south of NSW and Q7, during some 1500 hours of seawatching in the years 1978-1984. These data were compared to data collected on the same days at adjacent coastal seawatching posts (IJmuiden, Zandvoort, Noordwijk, Katwijk and Scheveningen, collectively taken as "Zuid-Holland mainland") and examined for within-month variation. Table 3 summarises the effort realised at both Meetpost Noordwijk and at the Zuid-Holland mainland sites. Note that a month has about 300

hours during which seawatching is possible, and that seawatching was not performed during all hours of the months mentioned. Note also that five mainland posts could have been manned at hours when seawatchers were active at Meetpost Noordwijk, resulting in sometimes higher cumulative effort on the mainland sites.

Table 3. Effort, in hours spent seawatching, at Meetpost Noordwijk (upper panel) and adjacent Dutch mainland posts, for the years 1978-1984 (lower panel). For the mainland sites, only hours during which seawatchers were active at Meetpost Noordwijk have been selected from the Dutch Seabird Group seawatching database.

Meetpost	1978	1979	1980	1981	1982	1984	**Total**	%
Jan						20	**20**	1.3
Mar			72	15		76	**163**	10.7
Apr	127			141		26	**294**	19.2
May	70	68		40			**178**	11.6
Aug					33		**33**	2.2
Sep		70		73	131		**274**	17.9
Oct	79	21		89	115		**304**	19.9
Nov	95	54		99			**248**	16.2
Dec	2					13	**15**	1.0
Total	**373**	**213**	**72**	**457**	**279**	**135**	**1529**	
Mainland	1978	1979	1980	1981	1982	1984	**Total**	
Jan						20	**20**	1.0
Mar			65	36		63	**164**	8.2
Apr	171			129		63	**363**	18.1
May	318	99		40			**457**	22.8
Aug					82		**82**	4.1
Sep		148		49	118		**315**	15.7
Oct	108	68		97	101		**374**	18.7
Nov	64	95		40			**199**	9.9
Dec	19					9	**28**	1.4
Total	**680**	**410**	**65**	**391**	**301**	**155**	**2002**	

Seawatching is done by noting all birds flying past per clock hour, using powerful binoculars mounted on a tripod. Birds are identified to the lowest possible taxon and noted as flying either north or south, or as being stationary (e.g. around the platform). For a more extensive description of seawatching methods and –sites, we refer to Camphuysen *et al.* (1982); Camphuysen & van Dijk (1983); den Ouden & Camphuysen (1983); den Ouden & van der Ham (1988); van der Ham (1988); and Platteeuw *et al.* (1994). A decisive difference of the offshore, Meetpost Noordwijk data with with other offshore seabird data, such as ship-based or aerial strip-transects is, that the observers at Meetpost Noordwijk were present for a relatively long time span at the same location, and that they conducted their observations in all kinds of weather, including severe gales. This makes that variation in seabird presence can be examined as a function of weather or clock hour, without an interaction with location. From moving platforms, this is nearly impossible, although the effects of movement can be minimized by careful planning of the survey (see next point).

5. within survey temporal variation: order of transects sailed

A final source of variation examined here is short-term variation, on the scale of hours. In coastal waters in particular, some birds show systematic temporal variation, if they go out to sea during the day to feed, and return to land to sleep at night.

Along-shore movements in response to tidal replacement of swimming birds may be another factor influencing seabird movement in nearshore waters. In order to best cope with these sources of variation in the dataset, the different transect lines were sailed in a particular order. Starting at one end, e.g. in the north of the study area, the first transect (A, see Figure 2) was sailed from the shore outward, and the return trip was made over the third transect line (C), hence temporarily skipping the second (B). Next, transects E, G, I and J were sailed, thus crossing over the entire study area in only half the time that would have been needed if all transects were sailed from A,B,C…to J. With the first half-coverage completed, the ship would then return via lines H, F, D, B (second half coverage; see Figure 1) and this whole procedure would be repeated (third and fourth half coverages) but from another starting point which was chosen in response to the variation in Beaufort seastates met during the first full set of transect lines. Thus, if a particular line had to be sailed under unfavourable conditions in the first hours of one of the early survey days, we would attempt to sail this line again during relatively favourable weather and at another time of day, if possible. This strategy ensured that different parts (e.g. inshore vs nearshore, or north *vs* south) were not systematically surveyed at different times of the week or different times of day, but that any spot would be visited under a mixture of conditions and clocks hours .

6. Daily flight patterns

Seabirds show different activities over the day. Offshore (mornings) and onshore (evenings) movements can often be seen in gulls and cormorants that roost on land during the night. Alongshore movement (often seen as migration) is usually strongest in the early hours of the day (data Dutch Seabird Group). Our at-sea surveys were not specifically designed to record such movements as the observation platform did not remain at the same place. Rather, we normally started the day from an inshore location, moving west (with the rising sun in our backs), only to return to nearshore waters some 4 hours after sunrise, when the second leg of the day was completed. Likewise, we aimed to sail the last transect of the day going east, with the setting sun in our backs, to optimise observation conditions over the day. Daily flight patterns are best studied from all-day watches from a fixed station, in this study Meetpost Noordwijk.

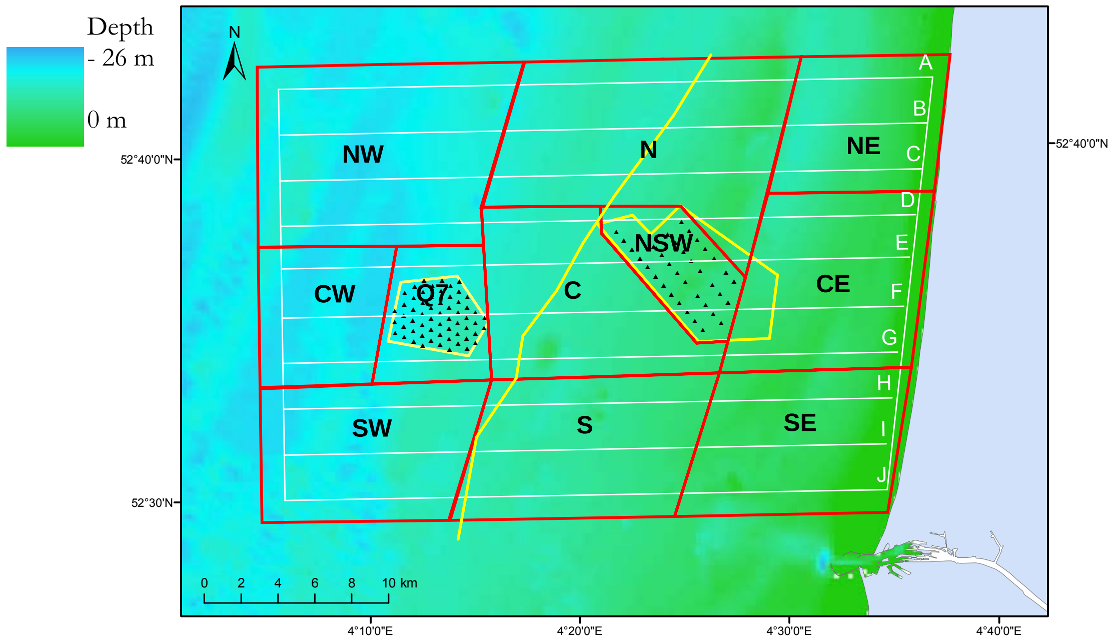


***Figure 2**. Map of the primary study area (within outer red contour), with contours of the two search areas for offshore windfarms (NSW & Q7, in yellow polygons), the presumed positions of the future wind turbines (yellow symbols), the -20 m isobath used in the distribution models (thick yellow line), the transect lines sailed (white, marked A-J) and the sub-areas used for the RIKZ Database (Red-lined polygons with light blue lettering). These sub-areas used as a basis for the estimation of total numbers of birds present in different months. Note that the location, shape and surface area of each DONAR sub-areas is different. Geographic system: ED-50; Projection: UTM zone 31N. The surface areas of the DONAR sub-areas (Blocks) are given in Table 4.*

***Table 4.** The surface areas of the DONAR sub-areas (Blocks), with the amount of effort realised in each survey month, as the total surface area of all strips watched (all figures in km^2).*

Block	Area	Feb	Apr	May	June	Aug	Sep	Oct	Nov
C	**128.32**	51.02	48.15	40.03	43.80	42.94	43.92	25.28	34.15
CE	**84.00**	46.80	56.55	41.67	51.75	46.35	47.01	25.33	45.91
CW	**128.68**	28.03	36.85	24.14	26.49	29.60	26.90	14.64	16.81
N	**93.09**	48.83	58.36	58.04	57.91	61.29	55.21	27.91	42.30
NE	**41.11**	29.03	33.07	33.84	35.01	35.81	28.29	18.49	21.45
NSW	**51.11**	16.61	19.14	16.47	17.12	16.12	15.85	10.89	17.50
NW	**33.78**	41.10	79.47	65.37	69.19	72.73	64.65	35.07	34.86
Q7	**84.61**	19.51	25.07	18.31	21.57	20.66	20.43	9.93	14.12
S	**62.90**	28.67	44.49	36.82	43.84	43.44	39.92	26.89	30.42
SE	**85.10**	27.02	43.21	30.35	39.93	38.74	35.16	19.36	27.02
SW	**92.89**	30.45	41.75	35.68	47.12	46.57	40.33	24.02	30.16
Total	**885.60**	367.05	486.10	400.71	453.72	454.25	417.66	237.82	314.70

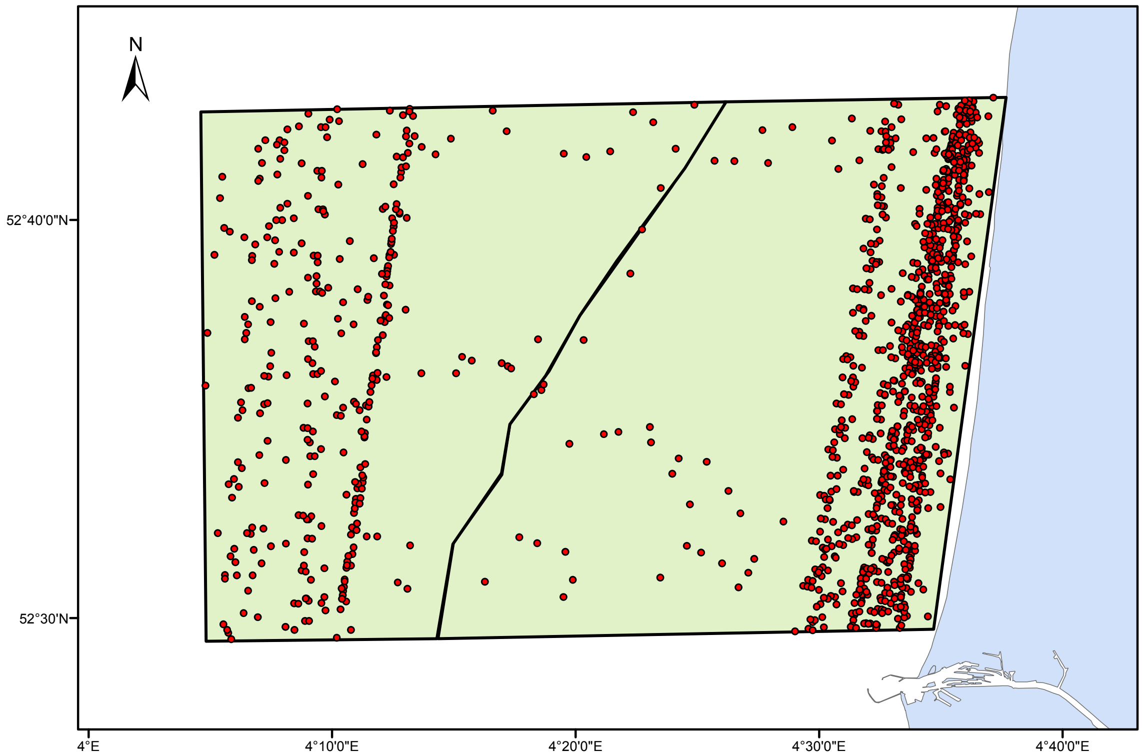


Figure 3. Contour of the primary study area with the positions of individual, aerial seabird strip-counts available for the years 1991-2002 (all seasons combined, data RIKZ). For analysis, these data were separated into a set of nearshore counts (between the coast and the -20 m isobath used in the distribution models (diagonal line), and a set of offshore counts. Average bird densities were calculated for each species, season, year and stratum (Appendix 3).

Statistical analysis of the ship-based survey data

1. Resolution and corrections for missed birds

The unit for counting, or the counting resolution, was a 5 minute time period. Within this time span, the ship steamed a distance of 1.543 km (at 10 knots),and with a standard transect width of 300 m, the surface area counted, on one side of the ship, was 0.463 km^2. Uncorrected bird densities were derived by dividing the sum of all birds (of a given species) within the transect band, and for flying birds, within the snapshots (see Tasker *et al.* 1984), by this area. In all likelihood however, some birds will have been missed by the observers and the probability of missing birds generally increases with increasing perpendicular distance (Buckland *et al.* 1993). This is particularly true for single or small groups of swimming birds and for observations in increasing seastates. Ideally therefore, a method should be developed that considers: observer, seastate, perpendicular distance of the sighting, group size of the sighting and possibly also additional factors such as local bird density, sun glare and time of day (as a measure of observer alertness). In reality however, such a model is only feasible for a selection of the observed species, given the available sample sizes. Correction factors were therefore calculated for all species treated in full in this report, but by pooling all data across the different surveys and weather situations. It is generally agreed that such correction factors are most important for birds that are relatively inconspicuous (dark and/or small), and swimming singly in small groups (Skov *et al.* 1995; Stone *et al.* 1995; Garthe 2003). No or very small corrections are usually applied for highly conspicuous species (very large birds such as Gannets *Morus bassanus* or Greater Black-backed Gulls *Larus marinus*) for species that were smaller but still very conspicuous and that often occurred in very large groups (other gulls, seaduck) and for species that usually touched the water only briefly, in flight (Little Gull *Larus minutes* and terns). Also rare birds (fewer than 25 encounters in any survey) were not analysed in full and for these no corrections factors were calculated either. All this resulted in correction factors being calculated for: Red/Black-throated Divers, Great Crested Grebes, Great Cormorants, Guillemots and Razorbills.

Correction factors were thus calculated for observer and perpendicular distance (all seastates combined) by combining all available data per observer team (regardless of trip (month), seastate or whether the observations were made within the primary study area or en route between this area and one of the home ports of the various ships). This was done in order to optimise sample size and this was possible because the same principal observers manned the portside and starboard sides of the ship throughout the surveys. The correction factors thus take into account the effect of observer and distance, and are derived by using the relative total numbers of birds (of a given species) seen in the equally wide sub-bands AB, C and D; the relative numbers seen in AB, C and D summed, compared to the total numbers seen on the Water without an assigned sub-band (noted as W) and those in flight; and (3) the relative numbers seen by the "best" team compared to the other team (only paired observations used, i.e. those counts for which both a portside and a starboard team was active at the time).

The correction factors are derived as follows (see Figure 4, using actual data for Guillemot Uria aalge as an example). Combined over the surveys when counts were carried out on both sides of the ship simultaneously, each observer team watched a total area of strips of 1424 km2 (equal to total way length sailed when on effort, times the strip width of 300 m). On the starboard side (to the right of the trackline), a total of 863 Guillemots were spotted "inside transect", which would result into a density of 863/1424 = 0.61 birds per km2. However, from the distribution of sightings on the starboard side (Figure 4) it is clear that many more birds were spotted near the transect line (414 birds in sub-band AB, from 0-100 m perpendicular distance) than in the equally wide bands C (from 100-200 m: 156 birds) and D (from 200-300 m; 264 birds). If we assume that all Guillemots were seen in the first band, than some (414-156) and some (414-264) or 258 and 150 Guillemots respectively, must have been overlooked in bands C and D (with a small complication that 8 birds were seen in "W", anywhere from 0-300 m and another 21 flying over the transect band on snap-shot moments). For the starboard side, the density may thus also be calculated as: (414+156+264+258+150)+8+21/1424 = 0.89 birds per km2 (ignoring a correction for the 8 and 21 animals seen in W and F, respectively). A similar argument can be given for the portside observations. However, from the total numbers of Guillemots observed on this side (i.e. 281 in A/B; 103 in C; 116 in D; 9 in W and 9 in F), compared to the total numbers observed at the starboard side, it is clear that more birds were missed at portside. This may be corrected by scaling all numbers up to 414 per sub-band (the hatched bars in Figure 4). A simple way of calculating densities would thus be: ((6*414)+8+21+9+9)/(2*1424) = 0.89 animals per km2 (over all surveys). The correction factor $C_{perp,obs}$ for perpendicular distance and observer is thus: expected numbers divided by numbers actually seen or (sub-units given from left to right as in Figure 4): $C_{perp,obs}$ = (6*414)/(116+103+281+414+156+264) = 1.86. The Guillemots seen in W at either side of the ship combined, may be incorporated as follows: For (834+500) or 1334 Guillemots the perpendicular distance (AB or C or D) was known, and for (47) Guillemots this was not known. Perpendicular distances were thus known for 97% of all porpoises. The best estimate for $C_{perp,obs}$ is therefore: =(0.97*1.86)+(1-0.97) = 1.83.

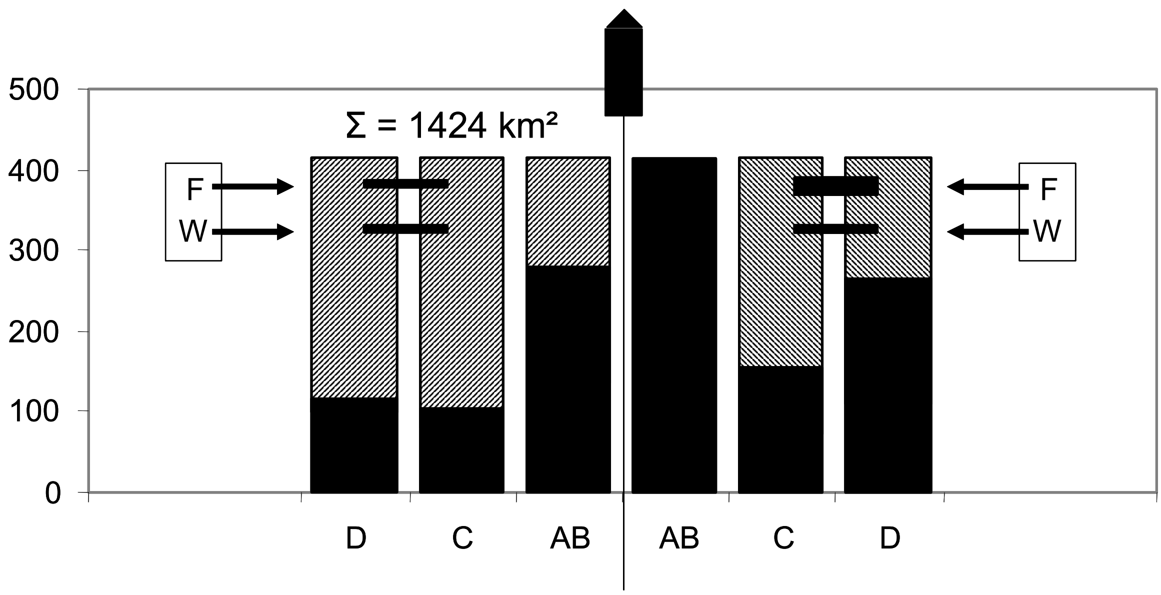


Figure 4. Total numbers of Guillemots seen during all surveys, while two platforms (portside and starboard) were manned simultaneously. On each side of the ship a total surface area of 1424 km2 of strip-transects were watched. Total numbers of Guillemots seen at either side, per sub-strip of 100 m wide (AB, C and D) are given as black bars; numbers assumed to have been missed, compared to the numbers seen in sub-strip AB on starboard, are superimposed in the barred rectangles. Numbers seen beyond 300 m perpendicular distance (not used in density estimations) are excluded from this Figure; numbers seen within 300 m perpendicular distance but without a more precise distance estimation, are given as " W", and numbers seen flying inside the transect are given as "F". The ship's course line (0 m perpendicular distance) is represented by the central vertical line and ship symbol on top.

Note that this correction factor $C_{perp,obs}$ only corrects for the effects of perpendicular distance and observer, **on the assumption that all birds present in the sub-band AB on starboard were actually seen**. There is reason to believe that this may not have been the case, because animals were clearly missed in all other sub-bands. The proportion of porpoises missed in sub-band AB by the best observer could not be estimated, as this would have required the simultaneous operation of two observer teams, watching the same strip and applying statistical mark-recapture techniques, (e.g. Hammond *et al.* 1995, 2002). On the other hand, the "best" observer may also have overestimated the numbers of birds in sub-band AB, at the expense of sub-band C (Figure 4: note that numbers in D were larger than numbers in C, contra expectation). Faulty distance estimations may have resulted from the placement of the observation boxes, which on the Orca I, the main survey ship, could not be precisely aligned with the course line. Particularly for birds noted well ahead of the ship this may have been a problem, especially for the "best" observer who tended to spot birds further ahead of the ship than the other observer. Although this issue remains unresolved at present, it is clear from the steep drop in detection probability with increasing distance, and the consistent difference in total numbers seen between the portside and starboard strips, that considerable correction factors are needed to estimate true densities for cryptic birds. Distributions of the numbers over different sub-bands for all species treated in full in this report are given in Appendix 4, with the calculated correction factors for the relevant species.

Note that correction factors have not been applied in this report. All figures and tables are based on numbers of birds actually seen. In the headings to Tables with total estimated bird numbers per DONAR sub-area, the relevant correction factor is given, where appropriate (to be used if so desired).

2. Modelling and analysis of the data

The objective of the statistical analysis of the T-0 data is to give a schematic overview of the distribution pattern of the seabirds per month, in relation to environmental parameters and with emphasis on any conspicuous deviation of bird densities in NSW and Q7 from what can be expected from the general pattern. Such deviations should be accounted for when analyzing the T1 data. Any statistical method that allows a patchy geographical distribution will fit the data. No deviating pattern in NSW or Q7 can be detected in this way. For this reason we developed a model which allows only smooth changes in densities across geographic space. We then investigated whether densities in NSW or Q7 deviated from what is expected in this smooth model.

The main density trend that is expected is with respect to some measure for distance to the coast. Several measure for this were available. Note that the Dutch mainland coastline runs more or less (but not quite!) from North to South in the study area. True distance to the coast for each count could be calculated, but also the X coordinate (Longitude, or Xfield in either RijksDriehoek or UTM coordinate system) could serve as a proxi. We choose to use the distance from the midpoint of the count to the -20m isobath instead, as this line runs more or less through the middle of the study area, and runs more or less parallel to the coastline, but also to measured gradients in sea surface temperature and (particularly) salinity (Appendix 2). Thus, the distance to this -20m contour joins all other (and highly inter-correlated) information on distance to the coast and gradients in seawater gradients in the area, while it also takes into the account the slight tilt in orientation with respect to the north-south axis.

In addition a north-south gradient is to be expected within the study area, and this is incorporated into the model by adding the term Y-Field (Latitude in the Dutch Rijksdriehoeks coordinate system). On the basis of these considerations we decided to take distance and Y-Field as the explanatory variables in our basic model, without any interaction effects. We allowed density to chance nonlinearly with distance and Y-Field by using smoothing splines. Our basic model for the density is therefore:

log (expected density) = S(distance) + S(Y-Field)

in which S() denotes a spline. The complexity of each of the splines is expressed by the number of degrees of freedom (df) A larger number of df allows for more flexibility. A spline function with df=1 is identical to a linear model (on log scale) and a spline with df=0 is equal to a model that contains only a constant. The logarithm of density opens up the restricted range of density (nonnegative) and makes the expected mulplicative effects of distance and Y-Field on density into additive effects.

This model can be fitted to the count data by the generalized additive model (Hastie and Tibshirani 1990):

log (expected count) = log(Observed Area) + S(distance) + S(Y-Field) (1)

as log (expected density) = log (expected count/(Observed Area)). The response variable of this regression model contains the observed counts. For the counts we assume a generalized Poisson distribution of which we only specify that its variance is proportional to its expected value. The proportionality constant is called the dispersion parameter. It is equal to 1 for Poissonian data and >1 for overdispersed data. The dispersion parameter is estimated from the Pearson statistic, and set to 1 if the estimate is smaller than 1 as underdispersion is extremely unlikely for these data. [We also tried to fit the model with the alternative assumption that the data are negative binomial (a common model for clustered data) but this attempt failed due to numerical problems (nonconvergence).] The calculations were carried out with (Genstat Committee 2002).

The degree of freedom (df) of each spline was determined by backward selection, starting at df = 4 for each predictor, and decreasing first the degrees of freedom for distance and then decreasing the degrees of freedom for Y-Field. The decrease in df continued for as long as it did not lead to a model that was significantly worse than the model from which the degree was dropped. Significance was judged by an F-test with P = 0.05 (5% significance level) and the dispersion parameter as denominator

The so obtained final model was used to predict bird density at each point of a 250 x250 m grid, covering the total primary study area. Deviation of the observed densities in NSW or Q7 from the model was examined by adding the term NSW or Q7 to model (1):

log (expected count) = log(Observed Area) + S(distance) + S(Y-Field) + b*NSW, or:
log (expected count) = log(Observed Area) + S(distance) + S(Y-Field) + b*Q7

in which NSW = 1 if the data point was within the NSW or the Q7contour (Figure 1) and 0 elsewhere (including respectively Q7 and NSW) and b is a regression coefficient. The significance of the extra term was examined with the above F-test. The ratio of the density in NSW or Q7 and the density as expected by model (1) is estimated by exp(b). An approximate 95% confidence interval for this ratio is calculated from the standard error of estimate of b (se_b), yielding the interval [exp(b-2*se_b), exp(b+2*se_b)].

From the standardized residuals of the model with 4 df for distance and Y-Field the autocorrelation was calculated between consecutive observation times and also the spatial autocorrelation. The spatial autocorrelation was expressed as the semivariance of observations taken with 1000m. (vario1_2). The spatial correlation is low if this semivariance is close to 1 or above 1.

3. Data collection and data storage (database format)

Data were collected and stored in standard formats. For this report, only the data collected in the study area have been analysed (area given in Figure 2), additional data have been collected along the transect routes between the ships' home ports and the study area. In addition, during the June survey, some extra survey effort was made to map Great Cormorant distribution in the nearshore waters between the study area and Den Helder. Further details can be found the in June cruise report (Leopold & Camphuysen 2003c). The data collected during the seabird counts were generally computer coded on the evening of the observation day. Routine checks and mapping were carried out to check for errors and data were initially stored in the standard European Seabirds At Sea (ESAS; Camphuysen & Garthe 2004) database format. The data were later converted into an Access database, to with extensions (such as data on wind direction, transect line and –side identities; flying heights of birds; radar counts of fishing vessels and environmental data such as sea surface temperature and salinity, and water depth) were added. The full dataset has been forwarded to the Commissioner of the project (RIKZ den Haag), with an extract in a RIKZ-specific database, DONAR. Both databases are to be public access and available from RIKZ. In addition, the dataset of Meetpost Noordwijk seawatching results has also been forwarded to RIKZ, both in Access and Donar formats.

RESULTS

All eight cruises were successfully completed and have been preliminary reported in cruise reports (Leopold & Camphuysen 2002a,b; 2003a-e; 2004). Over all cruises, over 100,000 birds, of over 100 species and several hundreds of marine mammals (3 species) were noted within the primary study area (Appendix 5), but analyses were restricted to those species that were seen within the transect bands (and for flying birds also within the snapshots) in at least 25 five-minute counts in at least one of the survey months. We also included the two most common seaduck species (Eider and Common Scoter). These ducks were sometimes seen in groups of several hundreds on the water in the study area and are known to occur in some years by the tens of thousands off the coast of Noord-Holland (Camphuysen & Leopold 1994; Camphuysen *et al.* 2002; Berrevoets & Arts 2003). For all species we present maps that show the distribution and density within the primary study. These species are listed in Table 3.

In the species accounts, we presents two types of maps. The first set of maps (on the left) show encounter rates of each species analyzed, in terms of numbers seen per km sailed (per 5-minute count, separately for portside and starboard). These data include all sightings made (positive and zero), scaled as different dot-sizes. The maps on the right are an extract of the corresponding ones on the left, showing (dots) only those sightings in which the birds were seen within the transect bands (and snapshot for flying birds). When appropriate also the model outcome is shown in these maps, as a gradient of colours. Model runs were only done when at least 25 5-minute counts were available from within the primary study area.

In Table 5 we present the estimated total numbers, for different sub-areas within the total, primary study area. First, estimates are given based on the raw data (for all survey months), as mean ± SD over all 5-minute counts for each sub-area separately (with total n = average density times surface area of sub-area). For those month/species combinations where also model predictions were made, we also provide total n estimates per sub-area, based on the modelled densities per grid cell l of 250x250 m, per sub-area.

Table 5. Seabird species that were encountered in sufficient numbers within the primary study area for analysis. The figures give, for each month, the number of 5-minute counts in which the species concerned was seen within the counting strips. Figures in bold give the month/species combinations, for which a full model analysis was done.

month	divers	gr. crest. grebe	fulmar	gannet	cormorant	eider	common scoter	little gull	black-headed gul
2	**46**	22	23	11	5	16	7	3	3
4	**60**	2	17	**43**	19	0	9	**108**	9
5	0	1	**32**	18	**85**	0	2	0	1
6	0	0	4	5	**65**	0	1	0	1
8	0	0	1	**80**	**43**	0	3	0	5
9	4	0	11	**44**	**46**	0	1	5	3
10	6	0	4	6	12	10	0	9	4
11	21	2	3	18	3	11	5	**51**	**31**
month	common gull	lesser bb gull	herring gull	greater bb gull	kittiwake	sandwich tern	commic tern	guillemot	razorbill
2	**54**	6	**31**	6	21	0	0	**198**	**29**
4	**118**	**139**	**105**	**31**	**31**	**27**	10	**47**	10
5	0	**224**	**115**	19	12	12	8	1	1
6	17	**176**	**100**	2	0	8	10	0	0
8	7	**341**	**62**	**54**	1	19	**28**	0	0
9	5	**147**	**146**	**95**	2	6	3	11	0
10	15	21	**49**	**53**	**27**	0	1	**68**	8
11	**132**	16	**92**	**104**	**111**	0	0	**277**	18

The results of the desk-study on the RIKZ aerial surveys over the study area have been incorporated in the species accounts (below) and are summarised in Appendix 3. The results from the other desk study carried out for this report, the analysis of the Meetpost Noordwijk seawatching data, is given separately in Appendix 7

Red-throated and Black-throated Divers *Gavia stellata* and *Gavia arctica*

The two most common diver species *Gavia stellata* and *Gavia arctica* in the study area were noted from September to May. No divers were seen in June and August (Maps divers 1&2; Table 6). A single Great Northern Diver Gavia immer was seen in November. Most divers could be identified to species, but some distant individuals of birds that were seen only briefly before they dived, could only be identified as "small diver" i.e. *Gavia stellata/arctica*. For this reason, and because also in earlier publications on the current study area (Camphuysen & van Dijk 1983; Baptist & Wolf 1993; Camphuysen & Leopold 1994; Platteeuw *et al.* 1994) the two species were lumped, they are also treated together, as "small divers" here. Note however, that the vast majority of small divers were Red-throated (Table 6).

Long-term trend and variation

Between surveys in successive years, divers have been noted with densities between 0 and about 2.5 per km^2 during the RIKZ aerial surveys in the study area, without a clear trend over the years. Divers were mostly seen in nearshore waters, with February 1995 as a notable exception when divers were only spotted in the offshore zone, and at a high density (but note small sample size; Appendix 3). The long series of seawatching data indicates a strong increase between the early 1970s and the mid-1980s to mid 1990s (Camphuysen & van Dijk 1983; Platteeuw *et al.* 1994).

Phenology and species composition

The absence of divers in the summer months was to be expected and in line with the earlier studies mentioned above and the recent RiKZ aerial survey data as summarised in Appendix 3. Black-throated Divers were mainly expected in April, when this species shows a small, but marked peak in numbers passing on their spring migration. However, numbers seen in April were hardly higher than in winter (Table 6).

Table 6. Total numbers of divers seen in all surveys in the primary study area.

month	G. stellata	G. arctica	% stellata	stellata or arctica	G. immer
2	161	5	97.0	23	
4	232	7	97.1	57	
5	2	1	66.7	0	
6	0	0		0	
8	0	0		0	
9	2	0	100.0	2	
10	17	0	100.0	2	
11	67	2	97.1	10	1

Flying heights

A large proportion of divers seen (during daylight!) were swimming at sea and would thus be not at risk of flying into a rotor at the time (Table 7). Most divers seen in flight also did not seem to be at (much) risk, as they flew past at altitudes below 25 m above sea level (m asl; Table 8; cf Dierschke 2002), but some, particularly in winter and spring flew at rotor heights (between 25 and 100 m). Note however, that altitudes during migration flights or at night might be considerably higher (cf. Sanders 1993).

Table 7. Total numbers of divers seen flying, respectively swimming in all surveys periods.

month	n-flying	n-swimming	% in flight
2	110	79	58
4	145	151	49
5	2	1	67
6		0	
8		0	
9	4	0	100
10	10	9	53
11	52	28	65
Totals	**323**	**268**	**55**

Table 8. Distribution of flying heights of divers in the study area, over the months as assessed during our surveys (no data on altitude recorded in September or October).

month	0-2	2-10	10-25	25-50	50-100	100-200	>200 m asl
2	8	56	21	10	3		
4	46	53	25	5	1		
5			2				
6							
8							
9	1		1	1			
10	2	6					
11	11	22	6	4			
Totals	**68**	**137**	**55**	**20**	**4**	**0**	**0**

Feeding behaviour

Apparent feeding behaviour was noted for 52 individuals, all but 2 Black-throated Divers in April being Red-throated Divers. Most feeding was seen in April (45 birds in total). Birds were noted as "apparently feeding" when they either dived or surfaced without indications that the approaching ship was disturbing them. This was often rather difficult to pin-point, as many divers flew off at considerable distances (hundreds of meters to over 1 km ahead of the ship).

Distribution patterns, numbers and densities; occurrence in NSW and Q7

Divers are known as coastal seabirds in the south-eastern North Sea and distribution patterns in February, May, October and November, largely showed a coastal distribution with most birds occurring between the coast and the -20 m (NAP) isobath. However, scattered individuals were seen throughout the study area in the months with relative high densities, from November through April (Maps divers 1&2). In April a rather astonishing distribution pattern was found, with high densities of divers continuing until the very end of the transect lines sailed, some 20 nm offshore. Although such 'offshore' distribution patterns are known from the German Bight for the entire winter through spring period (Skov *et al.* 1995), this pattern has not been noted before in any seabird survey off the Dutch coast. The salinity measurements taken during the survey also showed a remarkable pattern in that sea surface salinity throughout the study area was 18-19 pro mille, a value considerably below "normal" (over 30 in the west of the study area). It appears therefore, that the divers were responding to an unusual hydrographical feature: an unusually broad "coastal river". This should be kept in mind in any evaluation of future (T-1) situations as it would be expected that diver distribution will be back to a more normal, inshore pattern then. During the T-0 surveys, diver distribution extended into the NSW contour from November to April and into and even well beyond the Q7 contour in April.

Model predictions could be given for February and April only. They show almost complementary patterns, in that divers were mainly restricted in waters less than 20 m deep in February, while densities in April increased with water depth and were highest far offshore and just south of Q7. Here a distinct concentration of divers was found, together with Guillemots and Harbour Porpoises. This concentration was probably a response to sudden hydrographical or biological conditions, as the concentration had dispersed during the second passage of the survey (note small dots within large dots on left map, for April). It is clear however, that concentrations of divers could occur anywhere in the study area in April 2003. This situation did not last very long, as during the May survey divers had largely disappeared from the study area.

Total numbers per DONAR polygon are given in Table 9. Note that these numbers are not corrected for birds missed by the observers. The correction factor for missed birds should be 1.26 (Appendix 4).

Table 9. Estimated total numbers of divers (without corrections for birds missed by the observers) for the 11 DONAR polygons (see Figure 1). The upper panel gives total numbers based on the field measurements (average density per DONAR polygon multiplied with the polygon surface area). Modelled totals are only available for months with sufficient data (25 or more 5-minute counts with at least one bird inside the counting strip) and are based on the average (± 1 SD) densities per 250x250 m grid cell. In the graph below the numbers from the upper panel (Measured) are graphically presented.

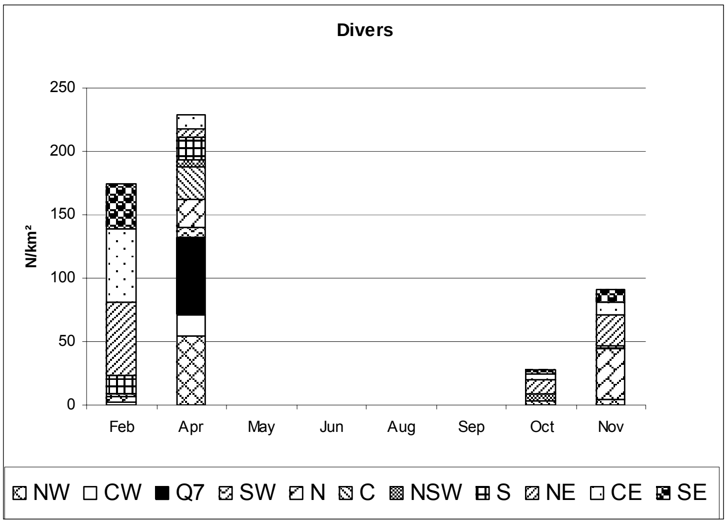
Divers

Measured

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C	2 ± 18	26 ± 91	0	0	0	0	3 ± 25	0
CE	58 ± 147	11 ± 68	0	0	0	0	4 ± 30	10 ± 52
CW	2 ± 17	17 ± 98	0	0	0	0	0	0
N	5 ± 55	22 ± 94	0	0	0	0	0	40 ± 162
NE	58 ± 115	7 ± 48	0	0	0	0	11 ± 53	24 ± 78
NSW	0	5 ± 25	0	0	0	0	6 ± 29	0
NW	0	54 ± 218	0	0	0	0	0	4 ± 32
Q7	0	61 ± 234	0	0	0	0	0	0
S	14 ± 108	18 ± 88	0	0	0	0	0	3 ± 23
SE	36 ± 122	0	0	0	0	0	4 ± 26	10 ± 75
SW	0	8 ± 60	0	0	0	0	0	0

Modelled

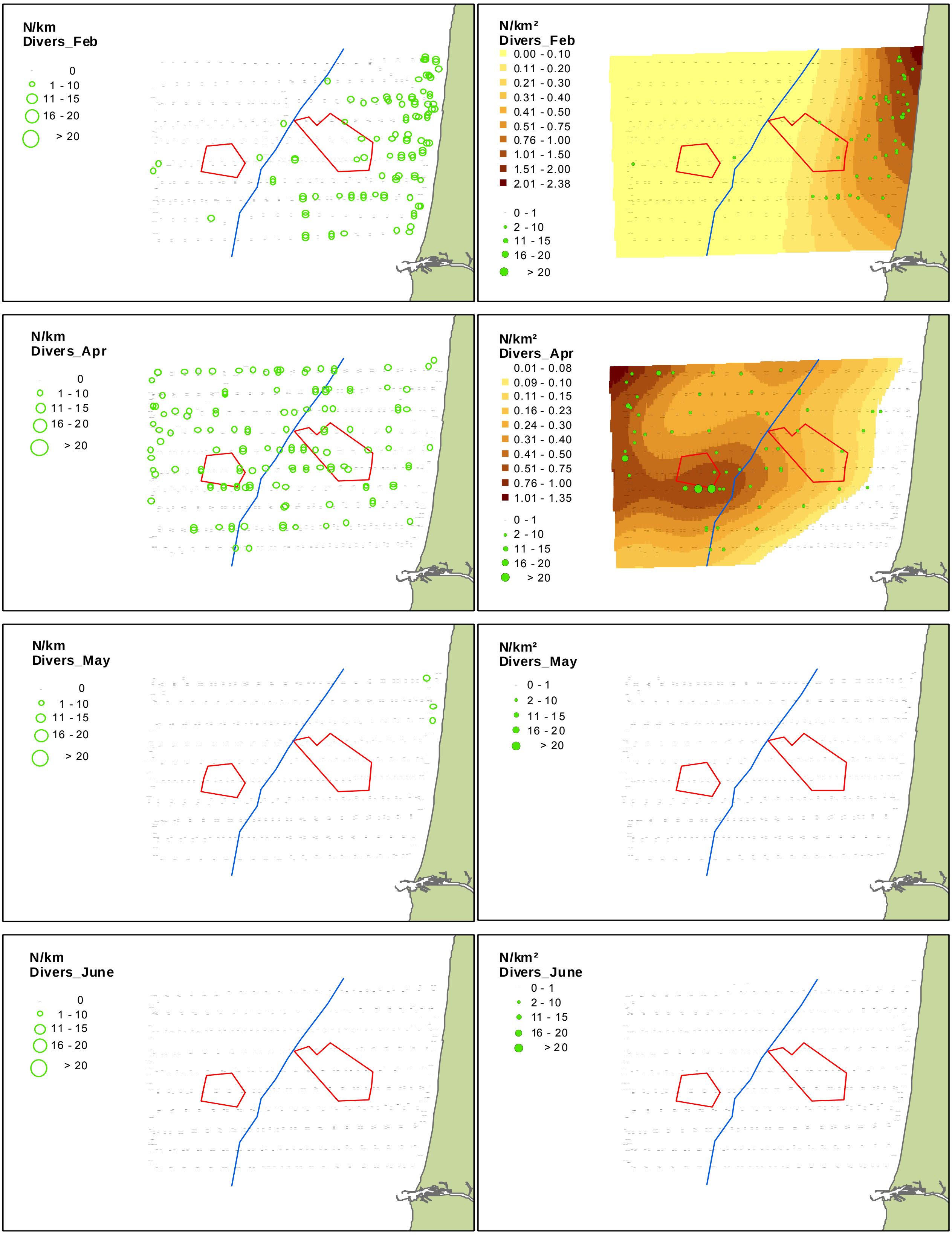
Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C	4 ± 4	34 ± 8						
CE	59 ± 23	8 ± 3						
CW	0 ± 0	26 ± 4						
N	11 ± 9	32 ± 7						
NE	56 ± 30	5 ± 2						
NSW	4 ± 2	8 ± 1						
NW	1 ± 0	52 ± 22						
Q7	0 ± 0	21 ± 3						
S	6 ± 5	18 ± 10						
SE	33 ± 11	3 ± 2						
SW	0 ± 0	28 ± 9						



BOX Calculations, Modeling and Mapping

In this report maps are provided for each species of interest, that depict the **general distritution pattern** and the distribution of **densities**. To map **distribution**, we first plotted (left panels) the numbers seen during each 5 minute count, separately for port and starboard and on the mid-positions of those respective counts, using symbols of increasing size with increasing density and the unit n/km. These maps thus include all sightings, be it near the transect line or far afield, and in the case of flying birds, inside the snapshots or passing by at other moments. For calculating **density** (right panels) only those birds that were seen within 300 m perpendicular distance (swimming birds) and within 300 m ánd within the snapshots were used and the sum of all birds of the species concerned per 5 minute count was divided by the surface area watched during that particular count (depending on vessel speed). The density maps thus make use of fewer birds and the unit is n/km². In cases where a full model could be used to map densities, the model results are included in the density maps, as shades of brown (high densities) to yellow (low densities), with a resolution (grid size) of 250x250m and also a unit of n/km². Corrections for birds missed during the observations are not included in any of these calculations.

In both the distribution and the density maps the mid-position of each 5 minute count is given as a dot (if no birds were seen) or as a larger symbol if one or more birds were seen in the distribution maps and if one or more birds were seen "in transect" in the density maps: this explains the lower number of symbols present in the the density maps (right) as compared to the distribution maps (left). In each map, the Dutch mainland to the east of the study area is indicated (grey polygon), as is the smoothed -20 m depth contour used in the modeling (blue line) and the contours of Q7 (western red polygon) and NSW (eastern red polygon).



Maps divers 1 & 2 (this page and overleaf). Total **distribution** (left panels) is mapped by calculating total numbers seen per km traveled (open circles). **Densities** (right panels; filled circles) are calculated as the sum of all birds seen "in transect" divided by the surface area watched per 5 minute count. Model results (where appropriate) are also given in the right-hand panels, as shades of brown (high densities) to yellow (low densities). A set of two maps is given for each survey separately.


N/km
Divers_Aug
0
1 - 10
11 - 15
16 - 20
> 20
N/km^2
Divers_Aug
0 - 1
2 - 10
11 - 15
16 - 20
> 20
N/km
Divers_Sep
0
1 - 10
11 - 15
16 - 20
> 20
N/km^2
Divers_Sep
0 - 1
2 - 10
11 - 15
16 - 20
> 20
N/km
Divers_Okt
0
1 - 10
11 - 15
16 - 20
> 20
N/km^2
Divers_Okt
0 - 1
2 - 10
11 - 15
16 - 20
> 20
N/km
Divers_Nov
0
1 - 10
11 - 15
16 - 20
> 20
N/km^2
Divers_Nov
0 - 1
2 - 10
11 - 15
16 - 20
> 20

Great Crested Grebe *Podiceps cristatus*

Great Crested Grebes only take to the North Sea in appreciable numbers in winter, particularly when inland, fresh water bodies freeze over (Camphuysen & Derks 1989; Camphuysen & Leopold 1994). Their distribution is restricted to very nearshore waters.

Long-term trend and variation

Seawatching data show, that numbers of Great Crested Grebes in Dutch nearshore waters are strongly related to winter temperatures and this factor is probably responsible for most of the variation between years (Camphuysen & Derks 1989). Aerial surveys do not detect grebes well and the RIKZ aerial survey data are considered to poor for grebes for a useful trend analysis. Boat surveys have done little better as Great Crested Grebes occur extremely nearshore, where most surveys have not ventured. Moreover, grebes are hard to detect and unless surveys take special care to detect them, most will probably be overlooked. As a result, not long-term trend can be given here.

Phenology

As expected on the basis of earlier surveys in the nearshore waters off Noord-Holland (Camphuysen & Leopold 1994), Great Crested Grebes were only encountered from November (10 individuals), February (87) and April (7). One individual was seen in May and another one in September and all birds but one were seen very closely near the shore (Map Great Crested Grebe). We only present a distribution map for February; other distribution patterns were very similar but with much lower total numbers. Too few counts were available to attempt modelling distributions and numbers, but there was a clear relationship with depth (or distance from the shore).

Flying heights

A total of 12 birds were seen flying past at very low altitudes (less than 2 m asl) and another 20 at altitudes between 2 and 10 m asl. Most Great Crested Grebes were noted as swimming (39). All grebes were thus seen at locations and altitudes where they would be out of harm's way, concerning rotors of planned offshore wind farms.

Feeding behaviour

Great Crested Grebes were often seen feeding when spotted. For a total of 37 birds we noted that they were diving, apparently for food.

Distribution patterns, numbers and densities; occurrence in NSW and Q7

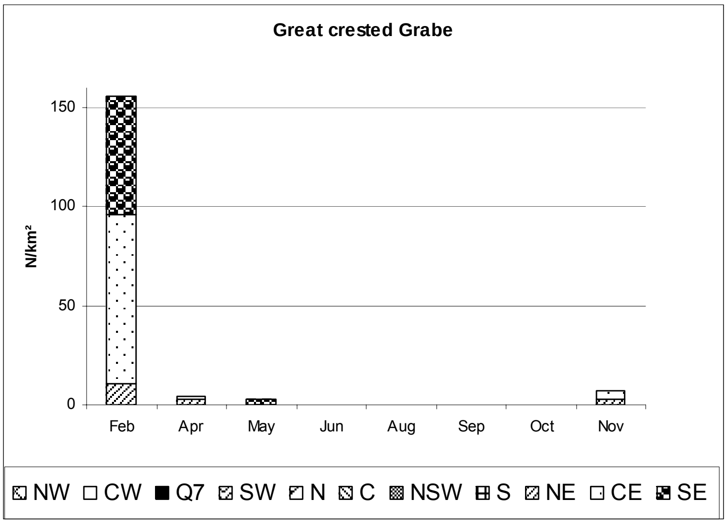
Model predictions could not be given for any month, due to low encounter rates. However, the distribution pattern was clear-cut, with over 90% of all observed Great Crested Grebes being noted at nearshore locations, with depths less than 15 m. Only some birds flying past at relatively large distances from the coastline (including the one spotted just south of the NSW contour (see Map Great Crested Grebe, left panel) were seen a little further out to sea. All these birds, as mentioned above, were seen flying close to the sea's surface. As densities greater than 0 (from birds within the transect bands) were only recorded in nearshore waters, total numbers (different from 0) could only be calculated for the DONAR polygons directly adjacent to the coast (blocks North-, Central- and South-East: Table 10). Note that these numbers are not corrected for birds missed by the observers. The correction factor for missed birds should be 2.16 (Appendix 4).

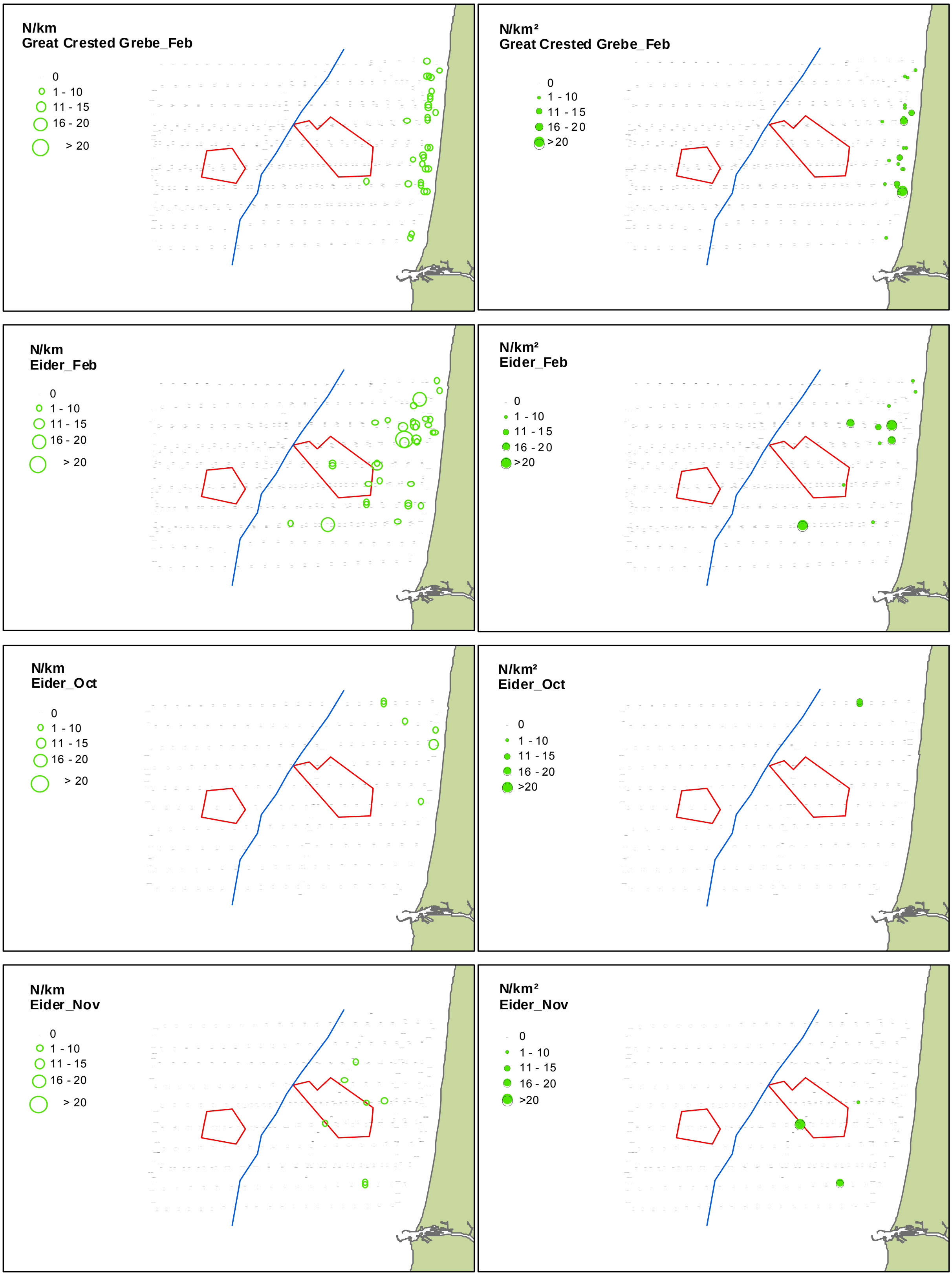
***Table 10**. Estimated total numbers of Great Crested Grebes (without corrections for birds missed by the observers) for the 11 DONAR polygons (see Figure 1). Only total numbers based on the field measurements could be generated for this species (average density per DONAR polygon multiplied with the polygon surface area), due to low encounter rates. In the graph below the numbers are graphically presented.*

Great Crested Grebe

Measured

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C	0	0	0	0	0	0	0	0
CE	85 ± 263	1 ± 16	0	0	0	0	0	4 ± 41
CW	0	0	0	0	0	0	0	0
N	0	0	0	0	0	0	0	0
NE	11 ± 37	3 ± 29	0	0	0	0	0	3 ± 20
NSW	0	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0	0
Q7	0	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0	0
SE	60 ± 362	0	3 ± 24	0	0	0	0	0
SW	0	0	0	0	0	0	0	0





Maps Great Crested Grebe and Eider. Total **distribution** (left panels) is mapped by calculating total numbers seen per km traveled (open circles). **Densities** (right panels; filled circles) are calculated as the sum of all birds seen "in transect" divided by the surface area watched per 5 minute count. Model results are not available for either species, due to low sample sizes. A set of two maps is given for each survey separately. Both Great Creasted Grebes and Eiders were only seen in significant numbers in the winter months and for this reason mapping distributions or densities over summer was not useful and the maps of these two species were plotted on the same page.

Northern Fulmar *Fulmarus glacialis*

Northern Fulmars are largely pelagic, offshore birds (Stone *et al.* 1995) that normally occur in low to zero densities in Dutch coastal waters (Camphuysen & van Dijk 1983; Baptist & Wolf 1993; Camphuysen & Leopold 1994; Platteeuw *et al.* 1994). However, the species shows erratic, mass movements throughout its range, with massive numbers sometimes occurring in nearshore waters (e.g. Dien & Ringleben 1966; Lemke & Schlenker 1968; Buckley & Jones 1982; Debout 1982; Vlugt 1986; Platteeuw *et al.* 1994). The reasons for such influxes in coastal waters will rarely be linked to the situations there; birds are more likely displaced by distant weather systems or by food shortages in distant waters where they normally occur in much higher densities. Large influxes may therefore end in so-called "wrecks" with large numbers of corpses of often emaciated birds washing up on the shore (e.g. Larsson 1960; Joensen 1961; Pashby & Cudworth 1969). There is reason to believe that during the present study, such a wreck was happening in the southern North Sea (van Franeker 2004), so numbers in the study area may have been higher than average in some surveys.

Long-term trend and variation
Fulmars have been noted in all seasons in the offshore part of the study area in the RIKZ aerial surveys, but in widely fluctuating densities (Appendix 3). Other Dutch seabirds databases show similar irregular patterns (summarised in Camphuysen & Leopold 1994) in the study area, without a clear trend over the years.

Phenology
Fulmars were seen in all months of the survey, but occurrence was erratic, with large differences between subsequent surveys. Numbers observed were generally higher in the offshore part of the study area, beyond the -20 m isobath (Table 11).

Table 11. Total numbers of Fulmars seen in all surveys in the nearshore (0-20 m deep) and offshore parts of the study area.

month	0-20 m	>20 m
2	0	76
4	3	89
5	16	111
6	2	10
8	1	10
9	7	44
10	2	22
11	1	4

Flying heights
Fulmars were either seen sitting at the sea's surface (Table 12) or flying at low altitudes (Table 13). Not a single Fulmar was seen flying over 23 m, at rotor height. A total of 28 birds were seen sitting at the surface either asleep, or preening/bathing.

Table 12. Total numbers of Fulmars seen flying, respectively swimming in all surveys periods.

month	n-flying	n-swimming	% in flight
2	33	43	43
4	51	41	55
5	99	28	78
6	11	1	92
8	10	1	91
9	34	17	67
10	23	1	96
11	3	2	60
Totals	**264**	**134**	**66**

Table 13. Distribution of flying heights of Fulmars in the study area, over the months as assessed during our surveys (no data on altitude recorded in September or October).

month	0-2	2-10	10-25	25-50	50-100	100-200	>200 m asl
2	11	9					
4	24	5					
5	25	48	2				
6	7	1					
8	2	5					
9	12	4					
10	14	6					
11		3					
Totals	**95**	**81**	**2**	**0**	**0**	**0**	**0**

Feeding behaviour

Several types of feeding behaviour were noted over the surveys. Most foraging birds were looking for, or taking natural foods, often very small planktonic particles (56 individuals). Only 35 were seen around or in the wake of fishing vessels (Table 14).

Table 14. Numbers of Fulmars showing different modes of foraging, summed over all surveys.

Actively searching	35
Scavenging at fishing vessel	16
Surface pecking	56
Surface seizing	3

Distribution patterns, numbers and densities; occurrence in NSW and Q7

The distribution maps of all sightings (left panels in Maps Fulmar) clearly indicate that Fulmars were relatively deep water, offshore birds in all months. Relatively few individuals were encountered between the coastline and the -20 m isobath. This puts Q7 within the reach of Fulmars throughout the year, and NSW only at certain moments. During the present surveys, NSW was clearly reached in April, May and September and possibly in June (but total numbers were very low in that month). Modelling was only possible in February and May and the model output shows a clear inshore-offshore gradient. In May, there seems to be a significant north-south component as well, but this is related to a cluster of birds seen within the counting strips in the southwest. This feature should probably be attributed to chance, as the general distribution pattern, as shown in the left panel, indicated a much more spread-out, offshore distribution. Total estimated numbers for all DONAR blocks are given in Table 15.

Table 15. Estimated total numbers of Northern Fulmars for the 11 DONAR polygons (see Figure 1). The upper panel gives total numbers based on the field measurements (average density per DONAR polygon multiplied with the polygon surface area). Modelled totals are only available for months with sufficient data (25 or more 5-minute counts with at least one bird inside the counting strip) and are based on the average (± 1 SD) densities per 250x250 m grid cell. In the graph below the numbers from the upper panel (Measured) are graphically presented.

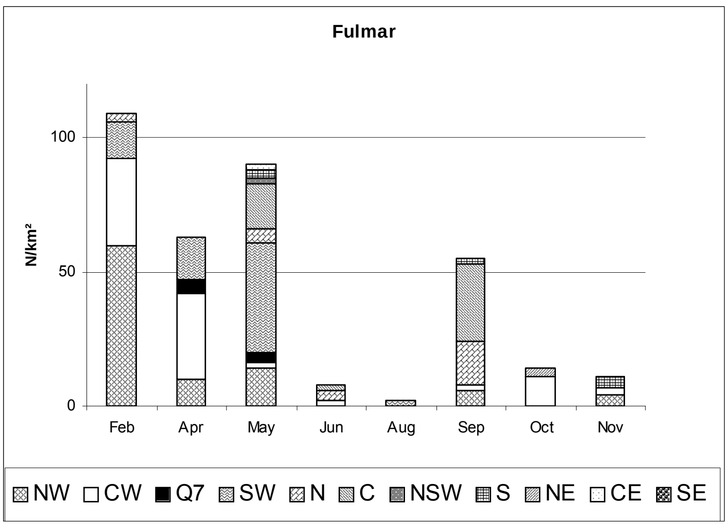
Fulmar

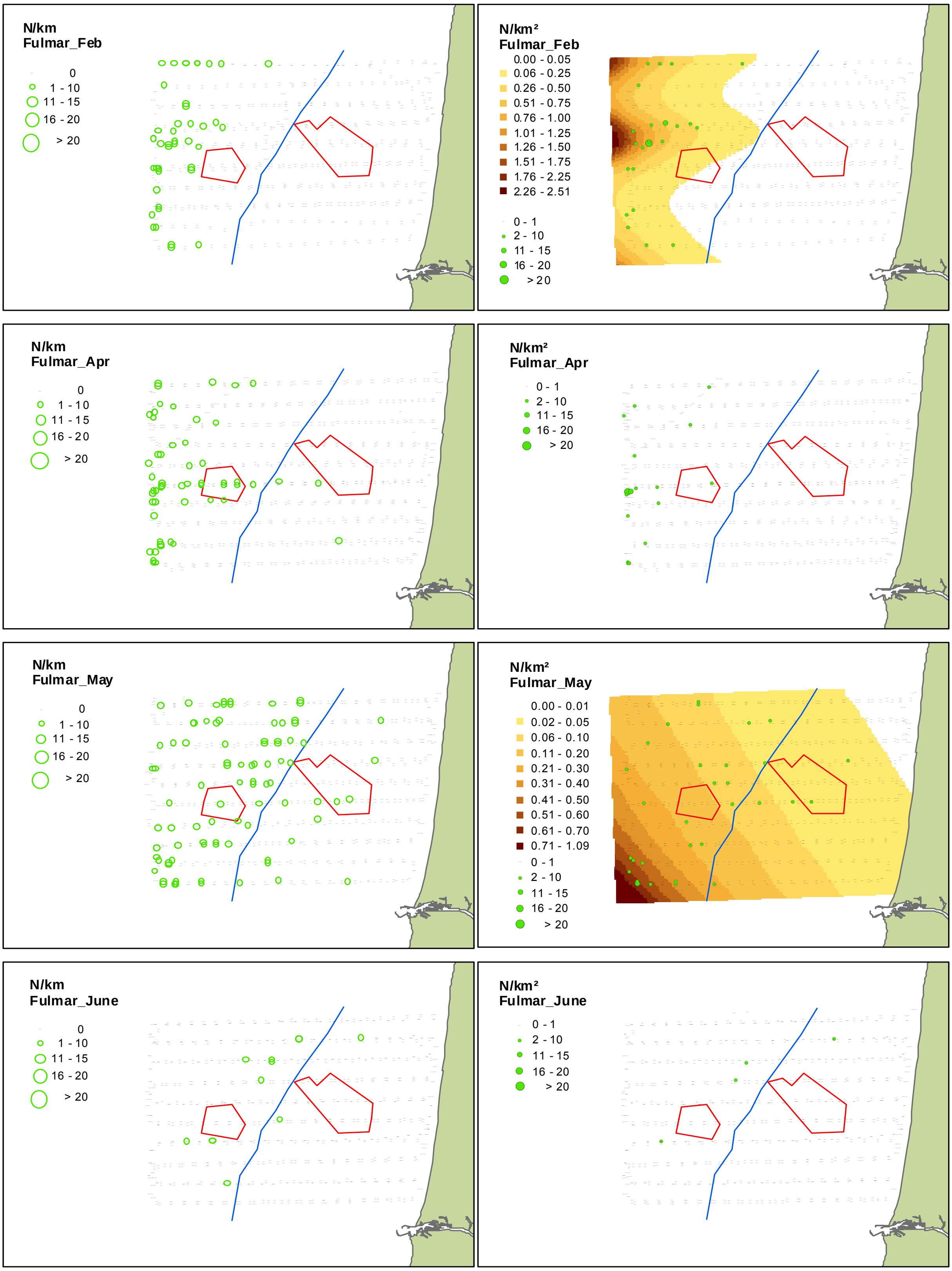
Measured

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C	0	0	17 ± 66	2 ± 17	0	29 ± 268	0	0
CE	0	0	2 ± 20	0	0	0	0	0
CW	32 ± 131	32 ± 130	2 ± 15	2 ± 14	0	2 ± 15	11 ± 36	3 ± 18
N	3 ± 29	0	5 ± 36	4 ± 32	0	16 ± 109	0	0
NE	0	0	0	0	0	0	3 ± 21	0
NSW	0	0	2 ± 12	0	0	0	0	0
NW	60 ± 218	10 ± 71	14 ± 69	0	0	6 ± 42	0	4 ± 31
Q7	0	5 ± 34	4 ± 19	0	0	0	0	0
S	0	0	3 ± 22	0	0	2 ± 22	0	4 ± 28
SE	0	0	0	0	0	0	0	0
SW	14 ± 48	16 ± 78	41 ± 140	0	2 ± 18	0	0	0

Modelled

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C	3 ± 3		6 ± 2					
CE	0 ± 0		2 ± 1					
CW	26 ± 23		13 ± 3					
N	3 ± 2		4 ± 2					
NE	0 ± 0		1 ± 0					
NSW	0 ± 0		1 ± 0					
NW	56 ± 49		15 ± 6					
Q7	4 ± 4		6 ± 1					
S	1 ± 1		11 ± 5					
SE	0 ± 0		3 ± 1					
SW	13 ± 12		32 ± 14					





Maps Northern Fulmar 1 & 2 (this page and overleaf). Total **distribution** (left panels) is mapped by calculating total numbers seen per km traveled (open circles). **Densities** (right panels; filled circles) are calculated as the sum of all birds seen "in transect" divided by the surface area watched per 5 minute count. Model results (where appropriate) are also given in the right-hand panels, as shades of brown (high densities) to yellow (low densities). A set of two maps is given for each survey separately.


N/km
Fulmar_Aug
0
1 - 10
11 - 15
16 - 20
> 20
N/km²
Fulmar_Aug
0 - 1
2 - 10
11 - 15
16 - 20
> 20
N/km
Fulmar_Sep
0
1 - 10
11 - 15
16 - 20
> 20
N/km²
Fulmar_Sep
0 - 1
2 - 10
11 - 15
16 - 20
> 20
N/km
Fulmar_Okt
0
1 - 10
11 - 15
16 - 20
> 20
N/km²
Fulmar_Okt
0 - 1
2 - 10
11 - 15
16 - 20
> 20
N/km
Fulmar_Nov
0
1 - 10
11 - 15
16 - 20
> 20
N/km²
Fulmar_Nov
0 - 1
2 - 10
11 - 15
16 - 20
> 20

Northern Gannet *Morus bassanus*

Northern Gannets are mostly pelagic, offshore birds, but they readily enter coastal Dutch waters if conditions area favourable (Camphuysen & van Dijk 1983; Leopold & Platteeuw 1987; Baptist & Wolf 1993; Camphuysen & Leopold 1994; Platteeuw *et al.* 1994). Mass influxes have been noted in Dutch coastal waters in autumn, probably triggered by good feeding opportunities (calm seas, with high densities of herring close to the surface; Leopold & Platteeuw 1987).

Long-term trend and variation
The RIKZ aerial surveys in the study area do not show a trend in the occurrence of Gannets. Peaks in densities are all related to small sample sizes, and therefore not reliable (Appendix 3).

Phenology
Gannets were seen in all months of the survey, but occurrence differed greatly, and sometimes unexpectedly, between surveys. Surprisingly, densities were low in October and November, while in other years peak numbers had been seen at this time of year. Densities were also low in the breeding season (May and June) when most Gannets live relatively close to the breeding colonies in the north-western North Sea. Surprisingly large numbers were seen during the August survey, with a large and spread-out flock of several hundreds of Gannets was seen circling, looking down into the water (but with birds very rarely actually diving) in nearshore waters in the northwest of the study area (Maps Gannet). In other months, densities were generally higher in the offshore part of the study area, beyond the -20 m isobath (Table 16).

Table 16. Total numbers of Northern Gannets seen in all surveys in the nearshore (0-20 m deep) and offshore parts of the study area.

month	0-20 m	>20 m
2	8	26
4	23	233
5	13	76
6	11	20
8	378	238
9	108	253
10	12	55
11	27	76

Flying heights
About three quarters of all Gannets seen were flying past, the others were either swimming or plunge-diving (Table 17). Flying heights varied considerably, with about 1 in 8 birds reaching future rotor heights (Table 18). Birds diving down from the sky to catch a fish (plunge diving) did so from altitudes between a few meters asl and altitudes up to several tens of meters asl. Data collected at Meetpost Noordwijk by radar and visual observations (Bureau Waardenburg / Alterra) have shown that, on occasions, Gannets will join high-circling gulls reaching altitudes in excess of 100 m asl (Martin Poot, Bureau Waardenburg *pers. comm.*).

Table 17. Total numbers of Gannets seen flying, respectively swimming in all surveys periods.

month	n-flying	n-swimming or plunge-diving	% in flight
2	26	8	76
4	103	153	40
5	65	24	73
6	26	5	84
8	455	161	74
9	306	55	85
10	57	10	85
11	69	34	67
Totals	**1107**	**450**	**71**

Table 18. Distribution of flying heights of Gannets in the study area, over the months as assessed during our surveys (no data on altitude recorded in September or October).

month	0-2	2-10	10-25	25-50	50-100	100-200	>200 m asl
2	4	10	7	1			
4	15	15	18	10	5		
5	1	7	14	4			
6	7	9	6	2			
8	23	118	182	41	6		
9	25	60	89	23	6		
10	11	18	13	5			
11	4	27	14	3			
Totals	**90**	**264**	**343**	**89**	**17**	**0**	**0**

Feeding behaviour

Several different types of feeding behaviour were noted over the surveys. Most foraging birds were looking for feeding opportunities (flying with bill pointing down, which is clearly visible in the large and large-billed species), or plunge-diving for natural foods or for fishery waste behind fishing vessels operating in the area. Birds that were flying around, searching for food (bill pointing down) did so at higher altitudes (mostly over 10 m high) than birds that were not actively searching for prey (flying about either with or without a straight course: mostly under 10 m high; Table 19a). Many Gannets seen on the water were preening or bathing or even asleep, often in the wake of trawlers. Such birds had probably been feeding just before, and were now showing post-feeding behaviour (Table 19b).

Table 19a. Distribution of flying heights of Gannets that were searching for prey (bill pointing down), compared to Gannets flying with their bill pointing forward (non-searching). Data are combined for all survey months, except for September and October when no data on flying heights were recorded.

altitude	n-searching	n non-searching
0-2	6	82
2-10	50	209
10-25	212	126
25-50	45	39
50-100	7	10
>100	0	1

Table 19b. Numbers of Gannets engaged in different types of (post)foraging behaviour, summed over all surveys.

Actively searching	532
Deep plunging	115
Shallow plunging	8
Surface seizing	1
Scavenging at fishing vessel	50
Preening or bathing	62
Resting or apparently asleep	39

Distribution patterns, numbers and densities; occurrence in NSW and Q7

The distribution maps of all sightings (left panels in Maps Gannet) indicate that Gannets were mostly seen over the deeper parts of the survey area, with a clear NW to SE gradient in densities (most clearly seen in the modelling output for September). In August this pattern was disturbed by a large concentration of birds circling in block North-East and another concentration in the adjoining block North. However these concentrations were no permanent feature as they were only seen on one of the two passages made during the survey (note smaller density circles within large ones, in the nearshore concentration on the August left panel). The underlying NW to SE density gradient still shines through the more temporary pattern, when all sightings are seen together for August (left panel for that month).

Both windfarms, Q7 more so than NSW are within the realm of Gannets, in all months. The near-absence of Gannets in October and November should probably seen as a year effect, as higher densities have been noted in the area in previous years. Total estimated numbers for all DONAR blocks are given in Table 20.

Table 20. Estimated total number of Northern Gannets for the 11 DONAR polygons (see Figure 1). The upper panel gives total numbers based on the field measurements (average density per DONAR polygon multiplied with the polygon surface area). Modelled totals are only available for months with sufficient data (25 or more 5-minute counts with at least one bird inside the counting strip) and are based on the average (± 1 SD) densities per 250x250 m grid cell. In the graph below the numbers from the upper panel (Measured) are graphically presented.

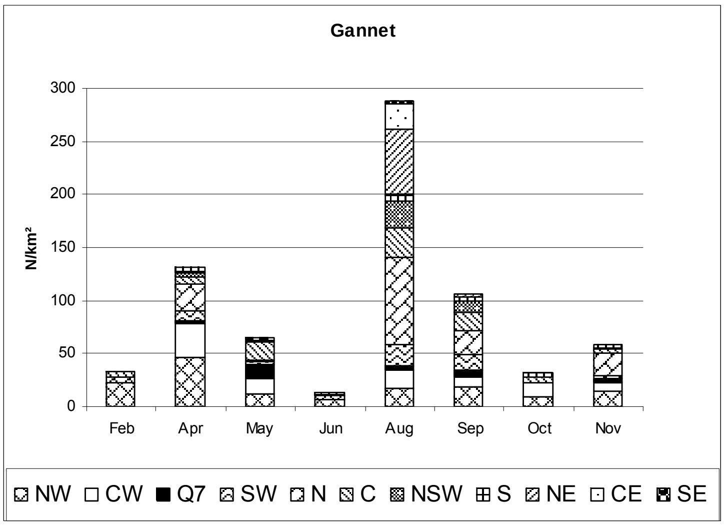
Gannet

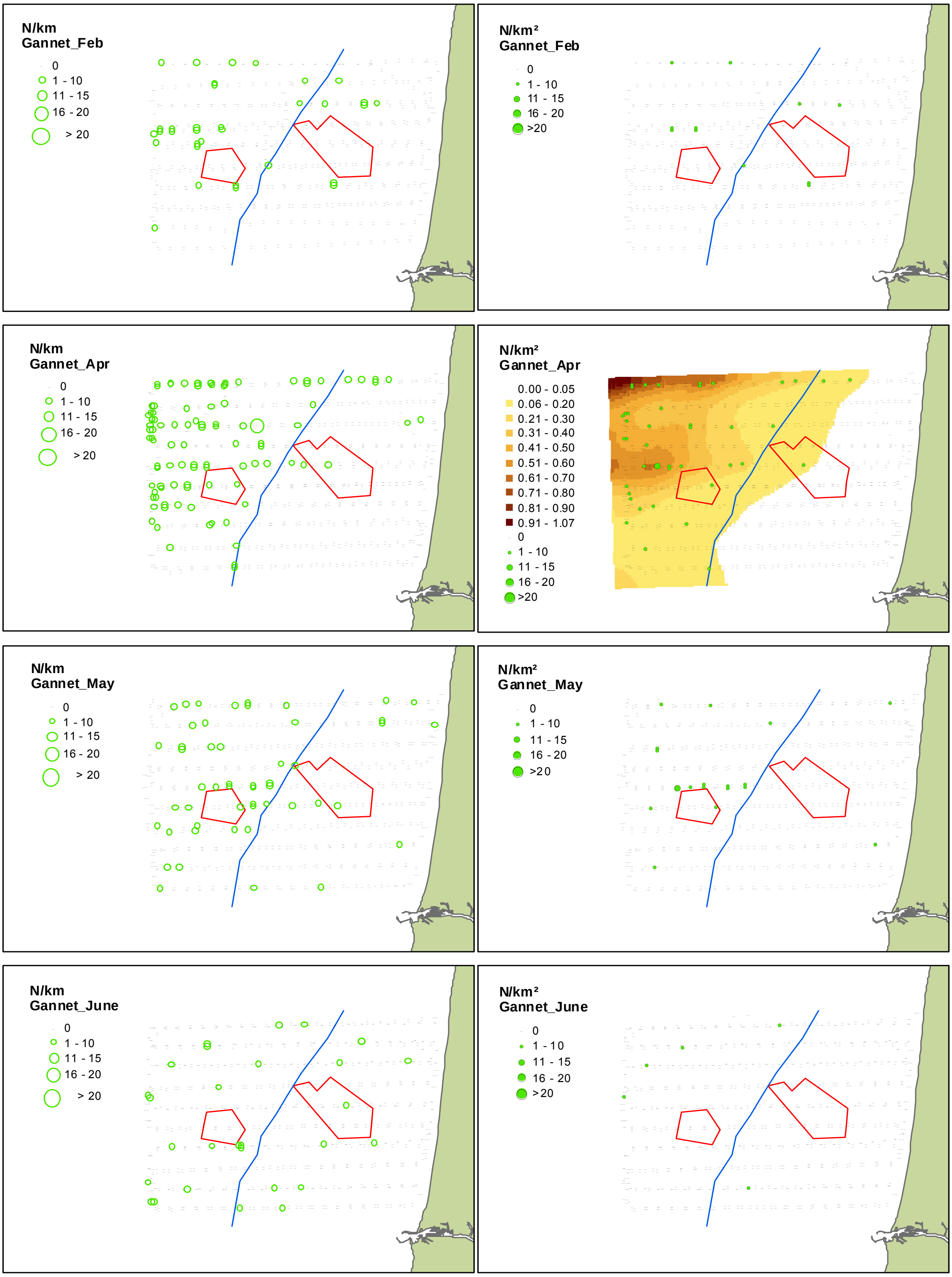
Measured

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C	5 ± 27	6 ± 42	17 ± 83	0	28 ± 110	17 ± 59	6 ± 48	5 ± 28
CE	0	0	0	0	25 ± 153	0	0	0
CW	0	31 ± 107	15 ± 99	0	18 ± 53	10 ± 35	13 ± 58	9 ± 30
N	5 ± 38	26 ± 143	2 ± 25	5 ± 52	82 ± 392	23 ± 98	0	21 ± 85
NE	0	0	2 ± 14	0	61 ± 375	2 ± 19	0	0
NSW	0	4 ± 24	0	0	25 ± 73	11 ± 36	0	0
NW	23 ± 89	47 ± 154	12 ± 83	6 ± 38	17 ± 86	18 ± 72	9 ± 53	14 ± 61
Q7	0	3 ± 17	13 ± 41	0	4 ± 18	6 ± 22	0	3 ± 16
S	0	6 ± 58	0	2 ± 21	6 ± 33	4 ± 29	4 ± 28	3 ± 23
SE	0	0	2 ± 20	0	2 ± 20	0	0	0
SW	0	9 ± 53	2 ± 21	0	20 ± 60	15 ± 58	0	3 ± 21

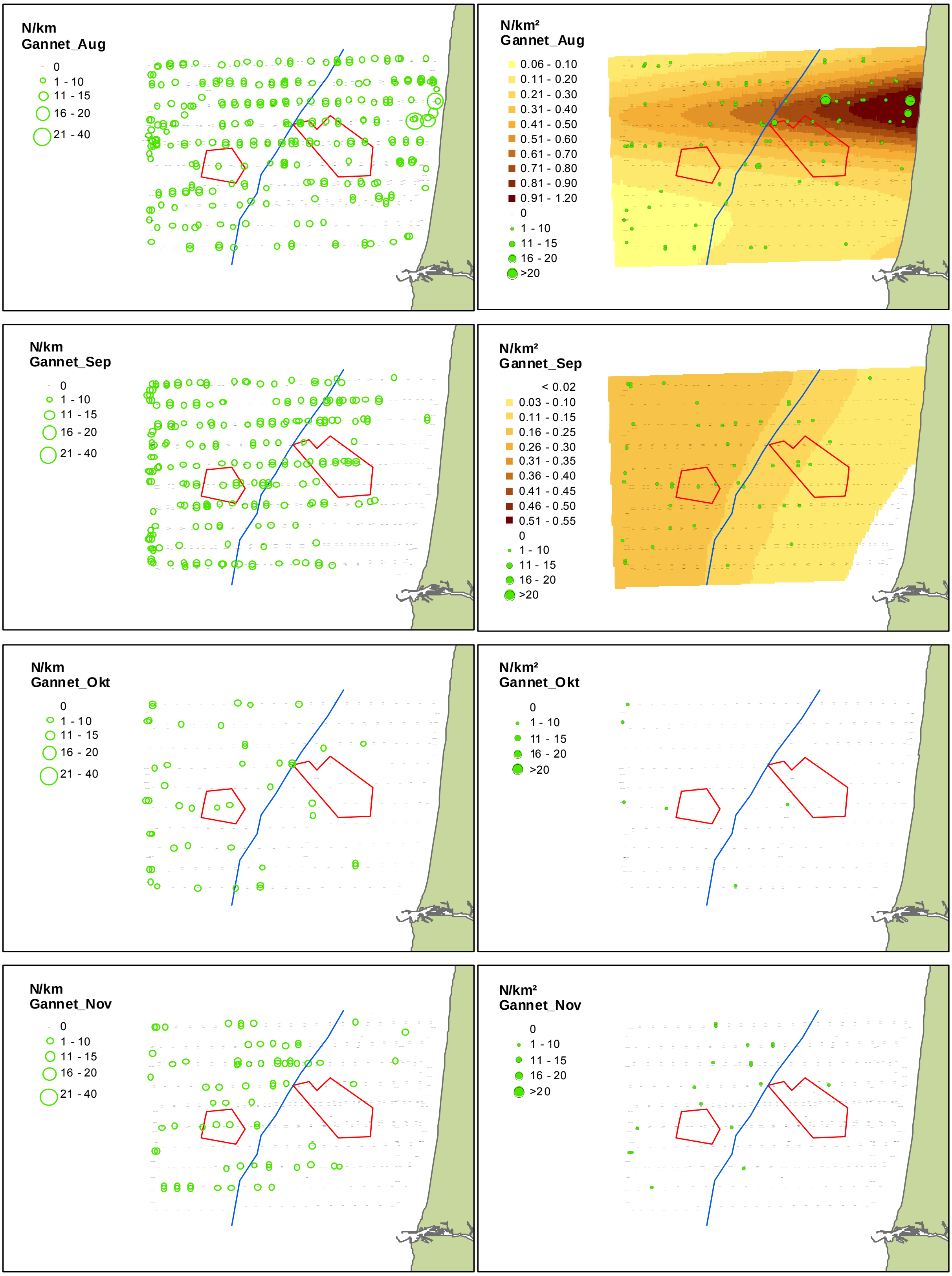
Modelled

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C		10 ± 7			25 ± 12	11 ± 2		
CE		1 ± 1			47 ± 24	4 ± 1		
CW		20 ± 8			10 ± 4	9 ± 0		
N		19 ± 11			65 ± 24	17 ± 3		
NE		1 ± 1			43 ± 15	4 ± 1		
NSW		2 ± 1			15 ± 5	3 ± 1		
NW		57 ± 15			44 ± 15	23 ± 2		
Q7		9 ± 4			8 ± 4	7 ± 0		
S		2 ± 2			11 ± 1	9 ± 3		
SE		0 ± 0			14 ± 2	2 ± 1		
SW		10 ± 4			7 ± 1	14 ± 1		





Maps Northern Fulmar 1 & 2 (this page and overleaf). Total **distribution** (left panels) is mapped by calculating total numbers seen per km traveled (open circles). **Densities** (right panels; filled circles) are calculated as the sum of all birds seen "in transect" divided by the surface area watched per 5 minute count. Model results (where appropriate) are also given in the right-hand panels, as shades of brown (high densities) to yellow (low densities). A set of two maps is given for each survey separately.


N/km
Gannet_Aug
0
1 - 10
11 - 15
16 - 20
21 - 40
N/km²
Gannet_Aug
0.06 - 0.10
0.11 - 0.20
0.21 - 0.30
0.31 - 0.40
0.41 - 0.50
0.51 - 0.60
0.61 - 0.70
0.71 - 0.80
0.81 - 0.90
0.91 - 1.20
0
1 - 10
11 - 15
16 - 20
>20
N/km
Gannet_Sep
0
1 - 10
11 - 15
16 - 20
21 - 40
N/km²
Gannet_Sep
< 0.02
0.03 - 0.10
0.11 - 0.15
0.16 - 0.25
0.26 - 0.30
0.31 - 0.35
0.36 - 0.40
0.41 - 0.45
0.46 - 0.50
0.51 - 0.55
0
1 - 10
11 - 15
16 - 20
>20
N/km
Gannet_Okt
0
1 - 10
11 - 15
16 - 20
21 - 40
N/km²
Gannet_Okt
0
1 - 10
11 - 15
16 - 20
>20
N/km
Gannet_Nov
0
1 - 10
11 - 15
16 - 20
21 - 40
N/km²
Gannet_Nov
0
1 - 10
11 - 15
16 - 20
>20

Great Cormorant *Phalacrocorax carbo*

Great Cormorants have increased so greatly in numbers in recent years in Dutch coastal waters that earlier publications on their numbers and distribution here, only begin to describe the present situation. Two breeding colonies now host the birds that use the nearshore waters off Noord-Holland for foraging: Zwanenwater (Callantsoog) with nearly 1000 breeding pairs at the time of the survey and Hoefijzermeer, (Castricum) with over 200 birds. Cormorants have a plumage that is not suitable for a long stay in or on the water, as it is wettable and forces the birds to go to dry ground as soon as it finishes feeding. Thus, all birds seen on the water, may be regarded as actively feeding. The Great Cormorants have learnt to use offshore gas platforms as temporary roosting sites, and these are used by tens of birds at a time, possibly also at night as we noted some flocks of birds returning from an unknown offshore location, to the Zwanenwater colony at sunrise during the June survey. This behavioural adaptation has greatly expanded the foraging range of the species in the area.

Long-term trend and variation

Great Cormorants have taken residence as a breeding bird in several two along the Noord-Holland mainland coast near the study area: at Zwanenwater (colony founded in 1989; around 1000 pairs at the time of this study) and near Castricum (colony founded in 2000, around 300 pairs at the time of this study). As a result, the species has "invaded" the Noord-Holland nearshore waters, including the present study area from about 1990. A marked increase in numbers was noted by seawatchers as early as during the mid-1980s (Platteeuw *et al.* 1994); this upward trend was later corroborated by boat surveys (Camphuysen and Leopold 1994) and aerial surveys (Appendix 3) alike. Numbers may continue to rise in the years to come and we would not be surprised if the next new colony would be an offshore one, for instance on one of the offshore platforms in or near the study area or even on a wind turbine, if the (base of the) construction allows nest-building. The writing is on the wall: 53 Great Cormorants were seen roosting at the newly placed "meetpaal Nearshore Windpark" off Egmond aan Zee on 28 June 2004 (C.J. Camphuysen), with numerous individuals foraging in close association with that new roosting opportunity.

Phenology

Great Cormorants were present in the study area throughout the year, which is also a new feature of this species occurrence in Dutch coastal waters (compare to e.g. Camphuysen & van Dijk 1983 and to Platteeuw *et al.* 1994). Birds were most numerous in the summer months, and then a gap in the distribution was visible that separated northern Zwanenwater birds from birds associated with the more southern Castricum colony. Although Great Cormorants were seen in all months of the survey, their abundance at sea differed considerably over the year. Large resting flocks of up to about 100 birds were seen on some offshore platforms. We could not (yet) detect nests on any of these platforms, but that seems only a matter of time. In any months, the majority of birds seen was confined to nearshore, shallow waters (Table 21).

Table 21. Total numbers of Great Cormorants seen in all surveys in the nearshore (0-20 m deep) and offshore parts of the study area.

month	0-20 m	>20 m
2	19	1
4	147	3
5	651	15
6	476	20
8	288	4
9	271	13
10	86	0
11	63	12

Flying heights

During any survey, about half of all Great Cormorants seen were commuting between feeding sites at sea and the shore or temporary roosting sites on platforms. The other half was swimming, and therefore actively feeding (Table 22). Flying heights varied considerably, with many commuting birds flying low, especially when flying into the wind, but others flying and circling at high altitudes (Table 23).

Table 22. Total numbers of Great Cormorants seen flying, respectively swimming in all surveys periods.

month	n-flying	n-swimming or resting on platforms	% in flight
2	11	9	55
4	76	74	51
5	355	311	53
6	276	220	56
8	161	131	55
9	140	144	49
10	46	40	53
11	41	34	55
Totals	**1106**	**963**	53

Table 23. Distribution of flying heights of Great Cormorants in the study area, over the months as assessed during our surveys (no data on altitude recorded in September or October).

month	0-2	2-10	10-25	25-50	50-100	100-200	>200 m asl
2	1	3	2	4			
4	14	20	6	2	3		
5	104	112	68	8	4		1
6	53	97	63	17		2	
8	59	74	17	6	1		
9	45	42	8	4	6		
10	9	8	18	9			
11	10	6	19	1	3		
Totals	**295**	**362**	**201**	**51**	**17**	**2**	**1**

Feeding behaviour

Several different types of feeding behaviour were noted over the surveys, making the Great Cormorant one of the most versatile foragers of all seabirds in the area. Many were seen feeding solitary and some of these surfaced with a flatfish in their bills (about 10-20 cm long fishes). In June, one flock of about 90 birds was seen feeding socially in a tight group in nearshore (turbid) waters, probably on pelagic fish (cf van Eerden & Voslamber 1995). Others, up to several dozens at a time, joined flocks of gulls feeding in the wakes of fishing trawlers to feed on the discards and/or escaping fish from the nets. Some birds joined the active parts of the large flocks of gulls apparently feeding on large schools of small pelagic fish. On very calm summer days, when the coastal front was relatively well noticeable, some birds flew directly to that front and started diving there. In summer, most birds from the Zwanenwater colony flew to the waters around the Razende Bol and fed there, solitary or in small groups, in the shallows around that sandbank. Finally, some birds were associated with the offshore platforms in the area and by doing so, went out to sea much further than most of their conspecifics. They used the platforms to rest, and as an offshore starting point for feeding. It should also be noted that many birds from the coastal colonies also go inland to feed, adding yet another way of feeding to the list.

Distribution patterns, numbers and densities; occurrence in NSW and Q7
The distribution maps of all sightings (left panels in Maps Great Cormorant), as well as the modelling results for the summer months when sufficiently large sample sizes were available (right panels), clearly show that Great Cormorants were inshore feeding birds. An offshore extension of this nearshore distribution pattern is visible in some months, particularly in September. This is related to the locations of several offshore gas platforms, used by the birds for resting. Numbers in the winter months were clearly lower than in the breeding season, but the species did not leave the area in winter.

Future windfarm Q7 is situated beyond the current range of the Great Cormorants, but NSW is within reach of these birds. Densities in and around NSW are "artificially high" and linked to the locations of several offshore platforms close by. Cormorants will probably try to roost on the bases of wind turbines as well, once these have been placed in the area, and this might change the distribution pattern, such that these birds may soon invade the Q7 area as well. Total estimated numbers for all DONAR blocks are given in Table 24. Note that these numbers are not corrected for birds missed by the observers. The correction factor for missed birds should be 1.16, except for the June-figures, where it should be 1.30 (Appendix 4).

Table 24. Estimated total numbers of Great Cormorants (without corrections for birds missed by the observers) for the 11 DONAR polygons (see Figure 1). The upper panel gives total numbers based on the field measurements (average density per DONAR polygon multiplied with the polygon surface area). Modelled totals are only available for months with sufficient data (25 or more 5-minute counts with at least one bird inside the counting strip) and are based on the average (± 1 SD) densities per 250x250 m grid cell. In the graph below the numbers from the upper panel (Measured) are graphically presented.

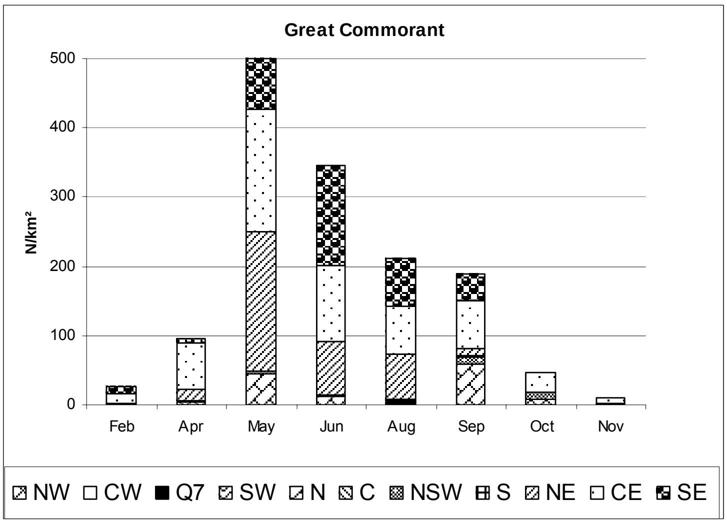
Great Cormorant

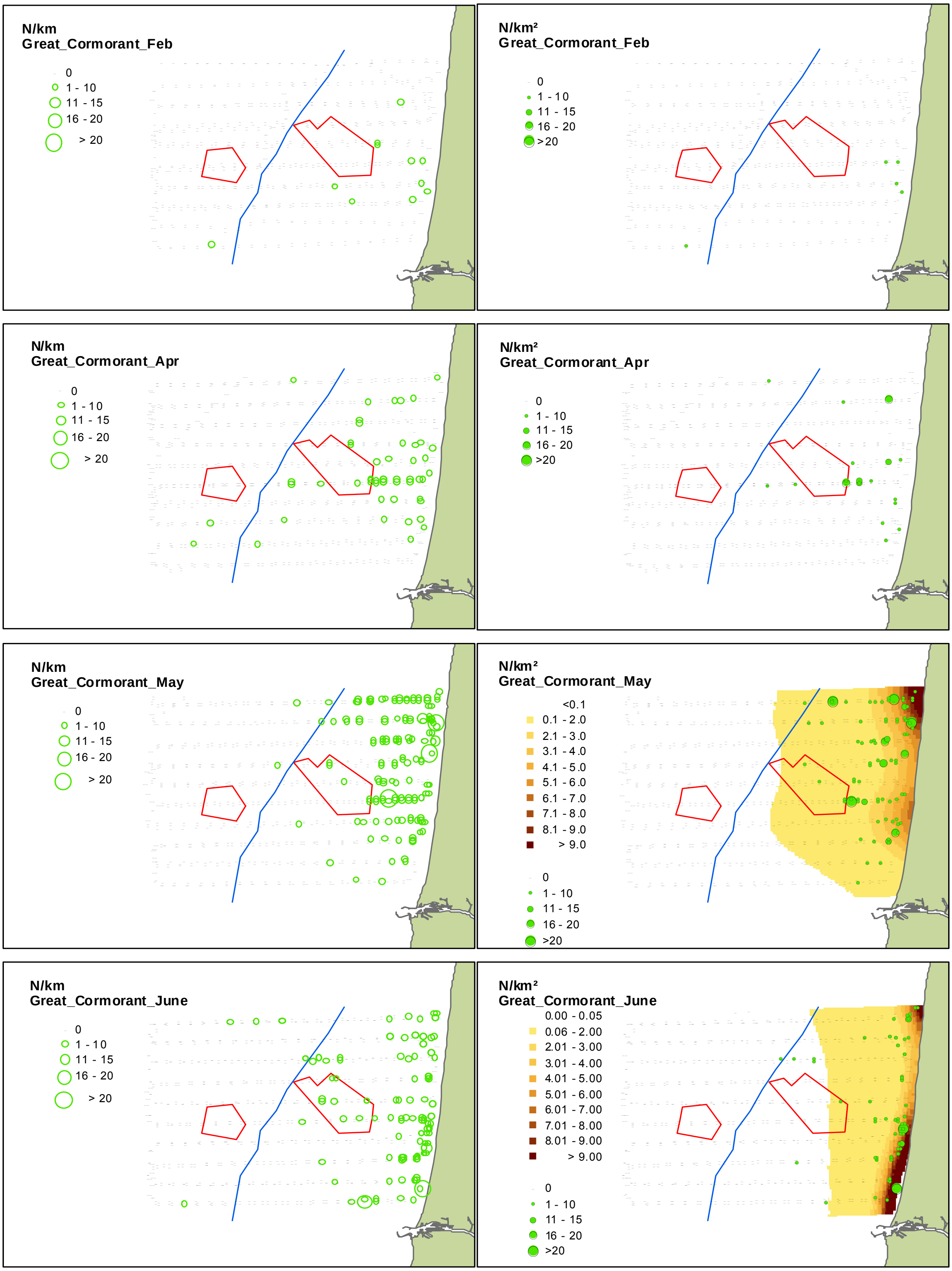
Measured

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C	0	3 ± 24	0	0	2 ± 18	0	0	0
CE	13 ± 88	66 ± 250	177 ± 370	111 ± 270	68 ± 223	69 ± 162	29 ± 80	8 ± 59
CW	0	0	0	0	0	0	0	0
N	0	4 ± 34	44 ± 302	13 ± 75	0	59 ± 240	9 ± 48	0
NE	0	16 ± 131	202 ± 603	76 ± 159	66 ± 215	10 ± 49	0	0
NSW	0	0	4 ± 17	0	0	11 ± 45	9 ± 24	0
NW	0	0	0	0	0	0	0	0
Q7	0	0	0	0	4 ± 26	0	0	0
S	0	0	0	2 ± 21	2 ± 18	2 ± 21	0	0
SE	10 ± 76	6 ± 32	72 ± 226	143 ± 727	70 ± 211	38 ± 169	0	0
SW	3 ± 21	0	0	0	0	0	0	3 ± 20

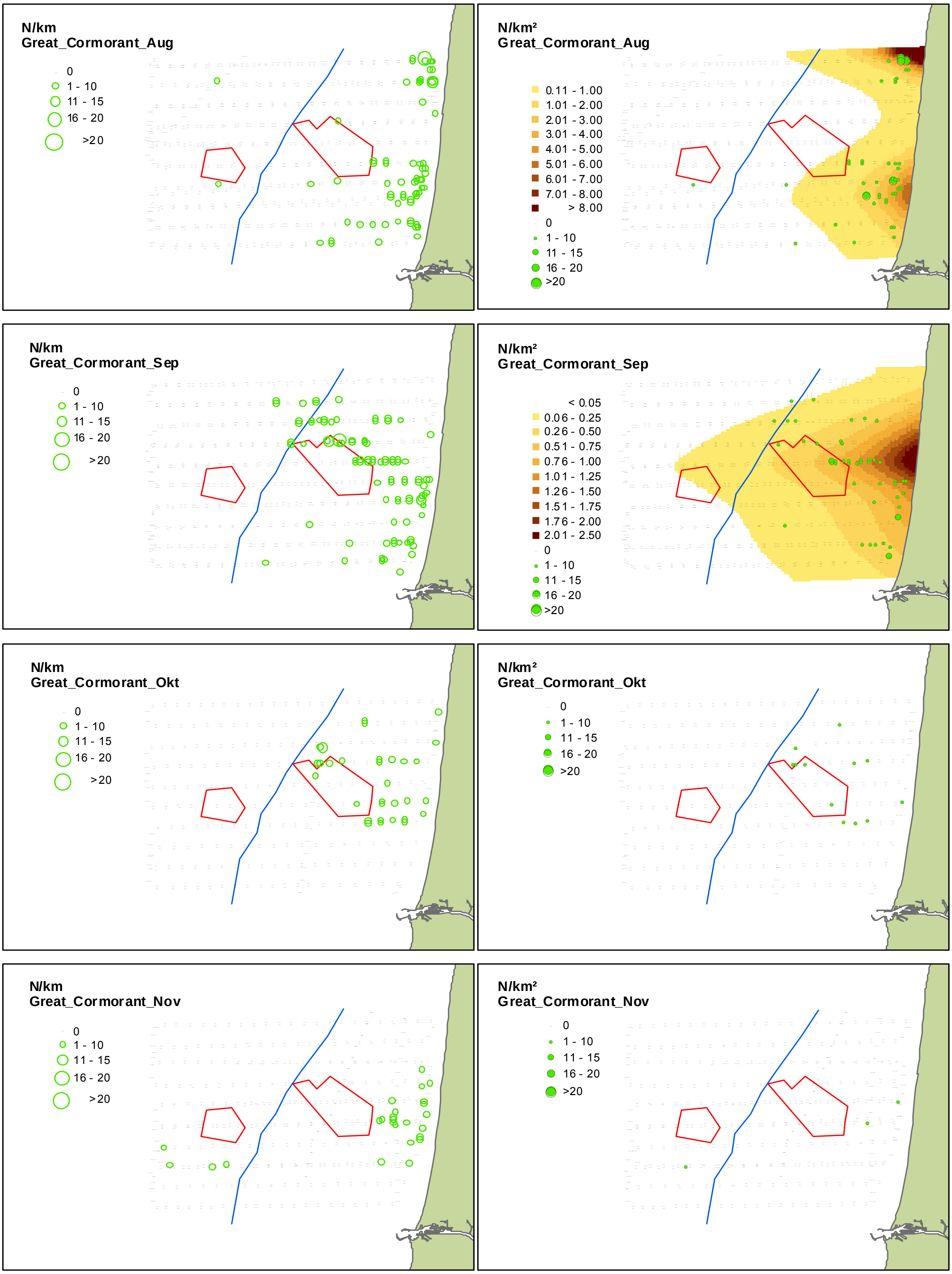
Modelled

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C			7 ± 7	0 ± 0	2 ± 3	11 ± 5		
CE			188 ± 122	93 ± 130	61 ± 80	86 ± 42		
CW			0 ± 0	0 ± 0	0 ± 0	1 ± 1		
N			30 ± 29	4 ± 5	7 ± 17	13 ± 17		
NE			214 ± 157	83 ± 99	97 ± 184	21 ± 16		
NSW			8 ± 4	1 ± 0	1 ± 1	11 ± 3		
NW			1 ± 1	0 ± 0	0 ± 0	2 ± 2		
Q7			0 ± 0	0 ± 0	0 ± 0	2 ± 1		
S			4 ± 6	0 ± 0	3 ± 4	6 ± 4		
SE			67 ± 76	172 ± 308	72 ± 83	26 ± 14		
SW			0 ± 0	0 ± 0	0 ± 0	1 ± 1		





Maps Great Cormorant 1 & 2 (this page and overleaf). Total **distribution** (left panels) is mapped by calculating total numbers seen per km traveled (open circles). **Densities** (right panels; filled circles) are calculated as the sum of all birds seen "in transect" divided by the surface area watched per 5 minute count. Model results (where appropriate) are also given in the right-hand panels, as shades of brown (high densities) to yellow (low densities). A set of two maps is given for each survey separately.


N/km
Great_Cormorant_Aug
0
1 - 10
11 - 15
16 - 20
>20
N/km²
Great_Cormorant_Aug
0.11 - 1.00
1.01 - 2.00
2.01 - 3.00
3.01 - 4.00
4.01 - 5.00
5.01 - 6.00
6.01 - 7.00
7.01 - 8.00
> 8.00
0
1 - 10
11 - 15
16 - 20
>20
N/km
Great_Cormorant_Sep
0
1 - 10
11 - 15
16 - 20
>20
N/km²
Great_Cormorant_Sep
< 0.05
0.06 - 0.25
0.26 - 0.50
0.51 - 0.75
0.76 - 1.00
1.01 - 1.25
1.26 - 1.50
1.51 - 1.75
1.76 - 2.00
2.01 - 2.50
0
1 - 10
11 - 15
16 - 20
>20
N/km
Great_Cormorant_Okt
0
1 - 10
11 - 15
16 - 20
>20
N/km²
Great_Cormorant_Okt
0
1 - 10
11 - 15
16 - 20
>20
N/km
Great_Cormorant_Nov
0
1 - 10
11 - 15
16 - 20
>20
N/km²
Great_Cormorant_Nov
0
1 - 10
11 - 15
16 - 20
>20

Common Eider *Somateria mollissima*

Common Eiders used to reside in the Wadden Sea, but have taken to North Sea coastal waters recently, driven off by food shortages (Camphuysen & Leopold 1994; Camphuysen *et al.* 2002; Berrevoets & Arts 2003; de Jong *et al.* 2003). However, during the winter survey in 2004 the food situation in the Wadden Sea has changed for the better again (Bruno Ens, pers. comm.) and numbers of Eiders in the North Sea were low.

Long-term trend and variation

Eiders show an "all or nothing" pattern in the coastal waters off the Dutch mainland coast. Until recently, Eiders wintered mainly in the Wadden Sea. Driven by food shortages in this preferred habitat, tens of thousands of Eiders turned to the North Sea coastal waters, including those off Noord-Holland. The distribution and relative quality of food resources probably determines where Eiders will winter, making the coastal waters off Noord-Holland a preferred site in some years only. With the relatively poor quality of Wadden Sea feeding grounds, the importance of Noord-Holland has increased, a trend also picked up by the RIKZ aerial surveys (Baptist & Wolf 1993). The data for the (small) study area show the expected erratic occurrence, with flocks present in some years and absent in most (Appendix 3). However, major flocks have wintered close to the study area in 1997, 2001 and 2002 (January counts; Berrevoets & Arts 2003). This is hardly visible in the counts in the study area, but birds from such large flocks (27,000-40,000 birds) may have flown through the study site in large numbers on other days than used for the aerial surveys.

Phenology

As expected on the basis of earlier surveys in Dutch coastal North Sea waters, most Eiders were encountered in mid-winter. In February 761 Eiders were noted, while in other months less than 100 birds were seen per survey.

Flying heights

Most birds seen in flight passed by at very low (52 birds at less than 2 m asl) to low altitudes (147 birds at heights betweeen 2 and 10 m asl). Few (33 in total) reached altitudes between 10 and 25 m and very few (3 birds) got up to possible rotor-collision altitudes (between 25 and 50 m asl).

Feeding behaviour

Common Eiders were either seen in flight (n=335 in total), or swimming in groups on the water (n=614). In February, there was a cluster of groups of swimming birds in the Northwest of the study area (totalling nearly 500 birds) and many of these were seen diving.

Distribution patterns, numbers and densities; occurrence in NSW and Q7

Even in February the total number of sightings with birds in the counting strips were low (eiders were seen in relatively few, rather large groups and often flying at distances beyond 300 m). There was a clear relationship with depth (or distance from the shore) and all Eiders were seen between the coast and the -20 m isobath (see

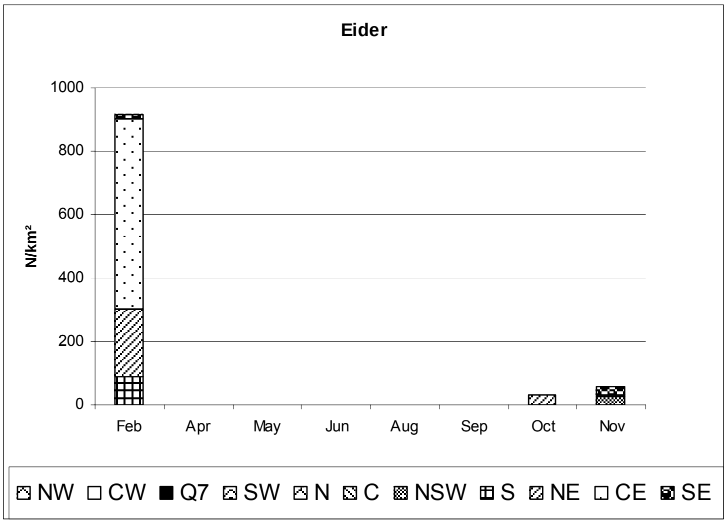
Maps Eiders, which are plotted with the map for Great Crested Grebe). In winter, the NSW contour was within range for the Eiders, but the situation in February 2004 was not comparable with some earlier years, when up to 100,000 Eiders were counted off the coast of Noord-Holland (data Dutch Seabird Group). Estimates of total numbers could not be generated from the modelling routine used for other species, due to low sample sizes (counts with densities different from 0): see Table 25).

Table 25. Estimated total numbers of Common Eiders for the 11 DONAR polygons (see Figure 1). Only total numbers based on the field measurements could be generated for this species (average density per DONAR polygon multiplied with the polygon surface area), due to low encounter rates. In the graph below the numbers are graphically presented.

Eider

Measured

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C	0	0	0	0	0	0	3 ± 25	0
CE	598 ± 3163	0	0	0	0	0	4 ± 30	10 ± 52
CW	0	0	0	0	0	0	0	0
N	0	0	0	0	0	0	0	40 ± 162
NE	215 ± 1179	0	0	0	0	0	11 ± 53	24 ± 78
NSW	0	0	0	0	0	0	6 ± 29	0
NW	0	0	0	0	0	0	0	4 ± 32
Q7	0	0	0	0	0	0	0	0
S	88 ± 678	0	0	0	0	0	0	3 ± 23
SE	13 ± 94	0	0	0	0	0	4 ± 26	10 ± 75
SW	0	0	0	0	0	0	0	0



Common Scoter *Melanitta nigra*

Common Scoters often use the same nearshore North Sea areas as do the Eiders in the Netherlands. Common Scoters use the Wadden Sea to a much lesser extent and have been found mainly over Spisula (bivalve shellfish) banks in the North Sea (Leopold *et al.* 1995; Leopold 1996; Berrevoets & Arts 2003). Common Scoters appear to have several preferred sites in the country and they switch between alternative sites between, and sometimes within years. During the current winter survey in February 2004 most birds resided off the Wadden Sea islands and off the Brouwersdam, Zeeland and numbers encountered during any of the T-0 surveys discussed here were very low. It is thus important to note that, although the surveys were probably successful in that we will have found most if not all scoters residing in the area at the time, total numbers were have low and have been up to 100,000 in other years. It will thus be difficult to draw any conclusions from the present data for seaduck occurrence, other than that they were basically absent at the time of the T-0 surveys.

Long-term trend and variation

Scoters, like Eiders, show an erratic presence off the Noord-Holland coast, including the study area (Appendix 3). Very large numbers were never encountered in the study area (Appendix 3), but thousands of Common Scoters wintered nearby in (January) 1996, 1997 and 2001 (Berrevoets & Arts 2003) and extremely large groups (up to some 100,000 birds) in some earlier years. There is no clear trend in the data, but the study area may be visited by very large numbers of seaduck in the future, as it is situated in one of the most important scoter wintering sites in Europe.

Phenology

As expected on the basis of seawatching results and earlier surveys in Dutch coastal North Sea waters, Common Scoters were seen in all survey months (Table 26) and most were seen in nearshore, shallow waters. Most Common Scoters encountered were seen flying up or down the coast and the sample size for all birds seen (left panels in Maps Common Scoter) were much higher than numbers within the counting strips, that could be used for density estimations (right panels in Maps Common Scoter).

Table 26. Total numbers of Common Scoters seen in all surveys in the nearshore (0-20 m deep) and offshore parts of the study area.

month	0-20 m	>20 m
2	551	63
4	1077	37
5	78	0
6	196	0
8	63	4
9	436	106
10	165	3
11	362	24

Flying heights
During all surveys, most Common Scoters were seen in flight (Table 27), using altitudes that were generally low (Table 28). Scoters only rarely reached rotor heights (cf Krüger & Garthe 2001), during our daytime watches. Note however, that like for divers, it is known that Scoters migrate overland, often at considerable altitudes (e.g. Pedersen 1988).

Table 27. Total numbers of Common Scoters seen flying, respectively swimming in all surveys periods.

month	n-flying	n-swimming	% in flight
2	512	102	83
4	1,062	52	95
5	76	2	97
6	196	0	100
8	67	0	100
9	542	0	100
10	163	5	97
11	364	22	94
Totals	**2982**	**183**	94

Table 28. Distribution of flying heights of Common Scoters in the study area, over the months as assessed during our surveys (no data on altitude recorded in September or October).

month	0-2	2-10	10-25	25-50	50-100	100-200	>200 m asl
2	47	263	104				
4	409	495	40	1			
5	1	52					
6	39	147					
8	33	29	5				
9	107	99	56	12			
10	8	55	4	4			
11	72	166	10				
Totals	**716**	**1306**	**219**	**17**	**0**	**0**	**0**

Feeding behaviour
During all surveys, the vast majority of Common Scoters was seen just flying by (Table 27), so few were potentially feeding. Only in February were some small groups seen swimming with groups of Common Eiders in the North-East of the study area, where these ducks were potentially feeding.

Distribution patterns, numbers and densities; occurrence in NSW and Q7
The distributions of all sightings (left panels in Maps Common Scoter) show mainly locations were birds were seen flying up and down the coast (see Table 27). With few birds noted from within the counting strips, modelling distribution or densities was not feasible. The right-hand panels thus show extractions of relatively small proportions flying at the times of the snapshots or of birds swimming within 300 m of the ship's trackline.

On the basis of these results, little can be said about the possible impact of the future windparks Q7 and NSW on scoters. The birds had chosen a different location during this winter, although the largest local *Spisula* stock was probably available off the

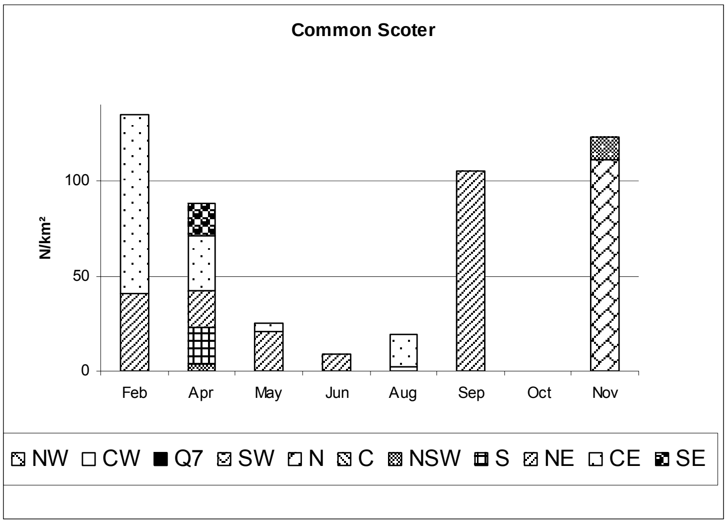
Noord-Holland coast (Craeymeersch & Perdon 2004). Q7 seems to be at the edge of the range of scoters residing in the area, but how the situation would be with a large (tens of thousands) group of birds wintering in the general area, remains unknown. Certainly NSW must be regarded as being situated within the normal migration route of scoters, even though most will probably pass it by on its landward side, at least during daytime. However, it has been noted from observations of migrating Common Scoters along the Dutch mainland coast, that large numbers must fly along a straight line from Walcheren or from the Hook of Holland to the Razende Bol, west of Den Helder (Platteeuw 1990) and by doing so they could easily pass through Q7 as well. If, when, and in what numbers such passages occur at any of these sites remains to be established. Total estimated numbers for all DONAR blocks are given in Table 29.

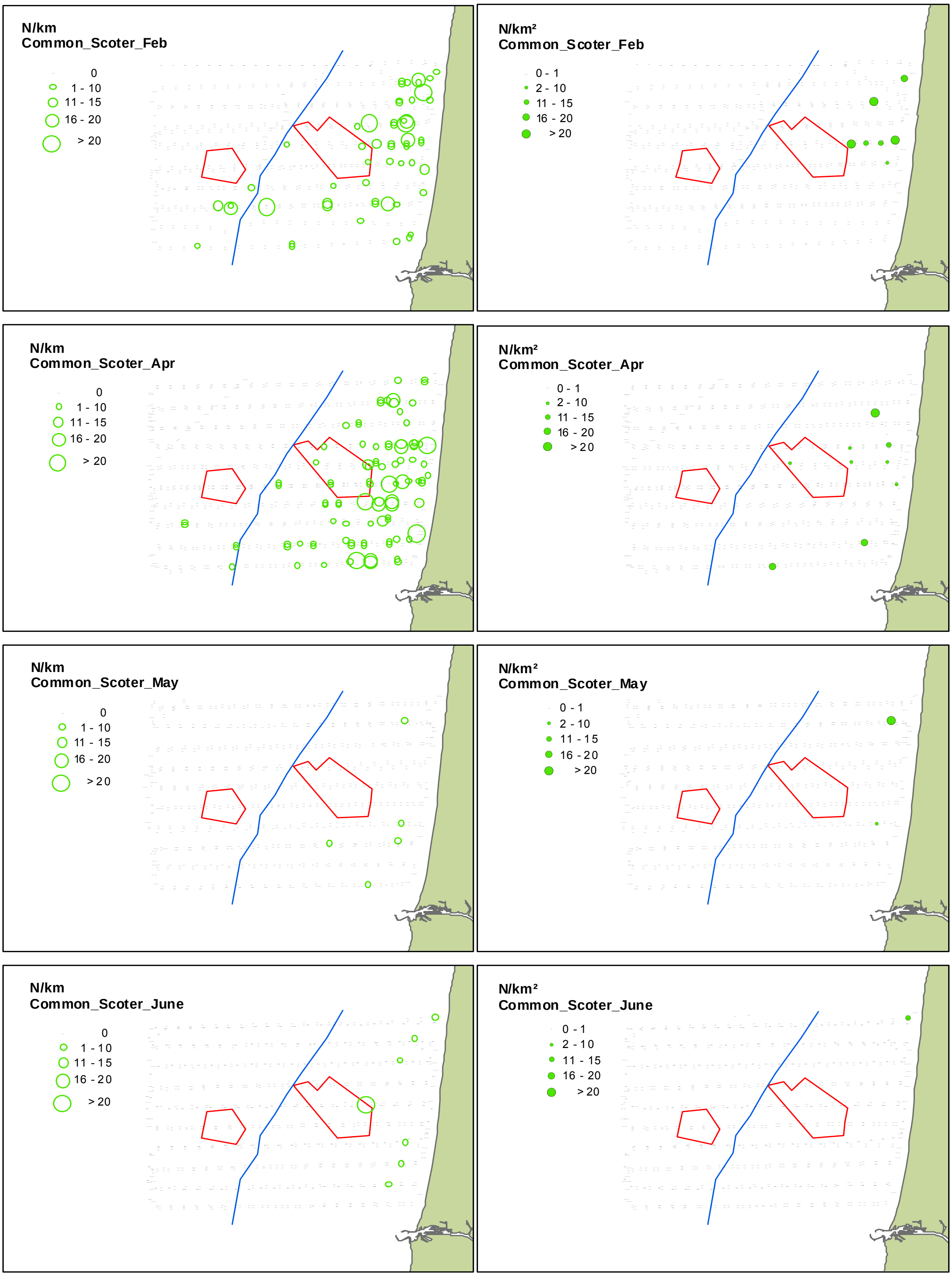
Table 29. Estimated total numbers of Common Scoters for the 11 DONAR polygons (see Figure 1). Only total numbers based on the field measurements could be generated for this species (average density per DONAR polygon multiplied with the polygon surface area), due to low encounter rates. In the graph below the numbers are graphically presented.

Common Scoter

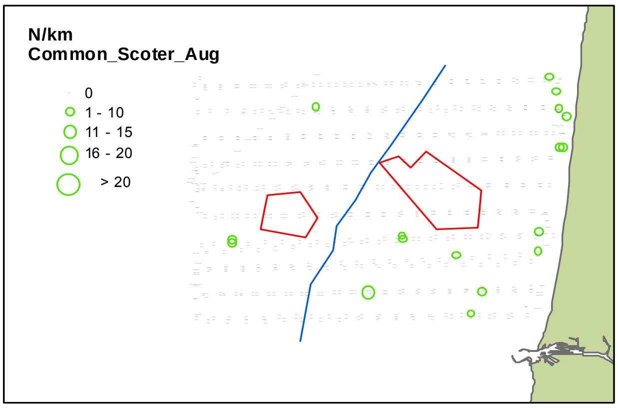
Measured

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C	0	0	0	0	0	0	0	0
CE	94 ± 500	29 ± 156	4 ± 41	0	17 ± 118	0	0	0
CW	0	0	0	0	2 ± 13	0	0	0
N	0	0	0	0	0	0	0	111 ± 710
NE	41 ± 229	19 ± 161	21 ± 180	9 ± 75	0	105 ± 851	0	0
NSW	0	4 ± 24	0	0	0	0	0	12 ± 73
NW	0	0	0	0	0	0	0	0
Q7	0	0	0	0	0	0	0	0
S	0	19 ± 182	0	0	0	0	0	0
SE	0	17 ± 168	0	0	0	0	0	9 ± 65
SW	0	0	0	0	0	0	0	0





Maps Common Scoter 1 & 2 (this page and overleaf). Total **distribution** (left panels) is mapped by calculating total numbers seen per km traveled (open circles). **Densities** (right panels; filled circles) are calculated as the sum of all birds seen "in transect" divided by the surface area watched per 5 minute count. Modeling densities was not possible for this species, due to low sample sizes (i.e. numbers of counts with birds "in transect". A set of two maps is given for each survey separately.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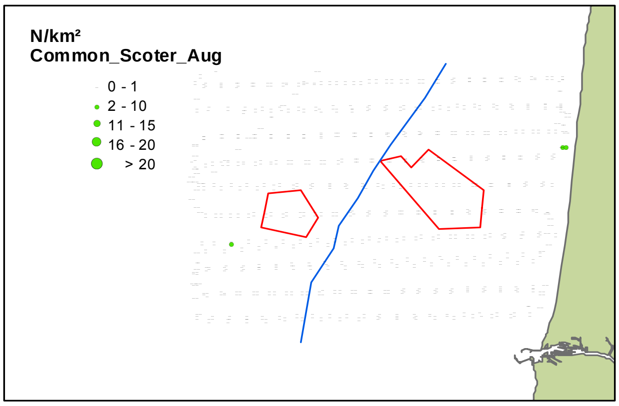
0
1 - 10
11 - 15
16 - 20
> 20


N/km²
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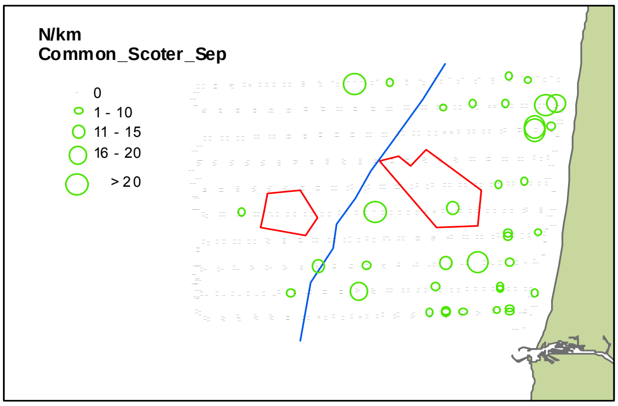
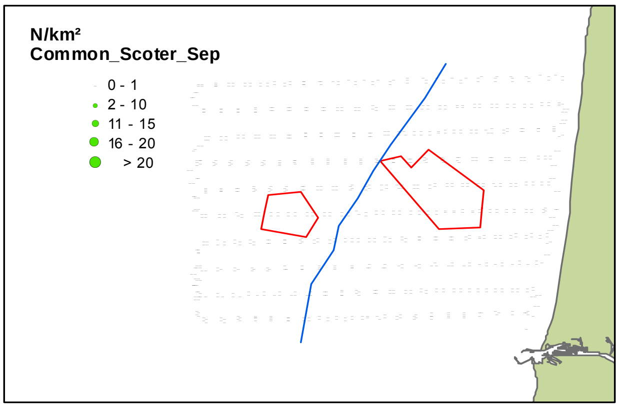
2 - 10
11 - 15
16 - 20
> 20


N/km
Common_Scoter_Sep
0
1 - 10
11 - 15
16 - 20
> 20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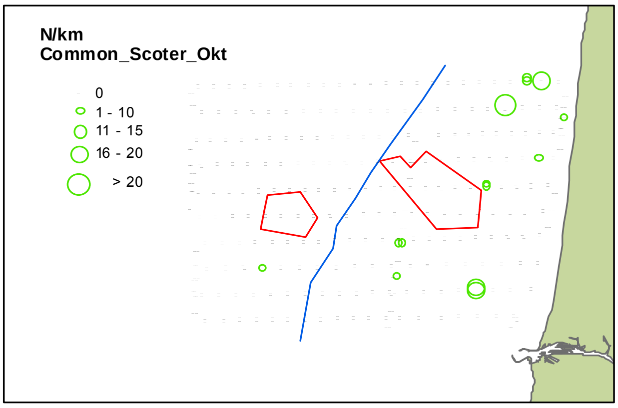
2 - 10
11 - 15
16 - 20
> 20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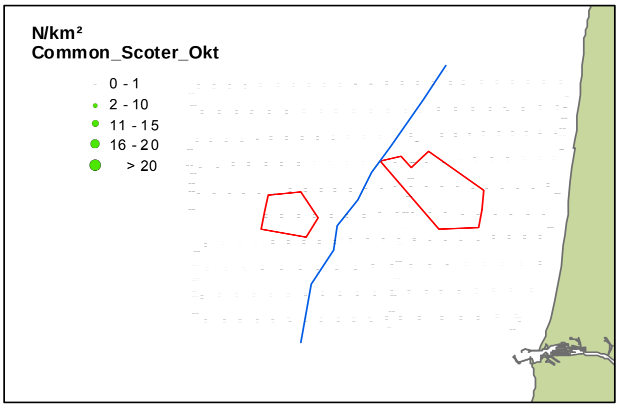
1 - 10
11 - 15
16 - 20
> 20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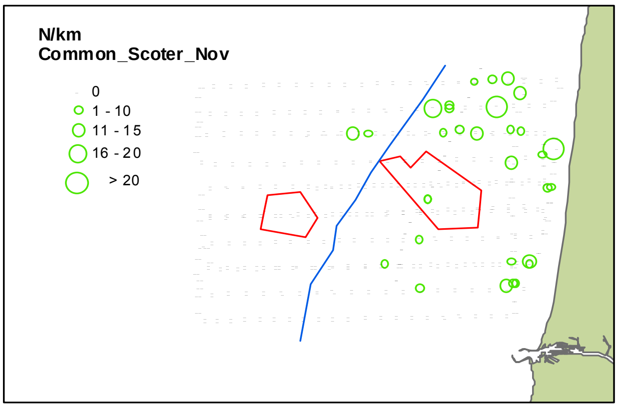
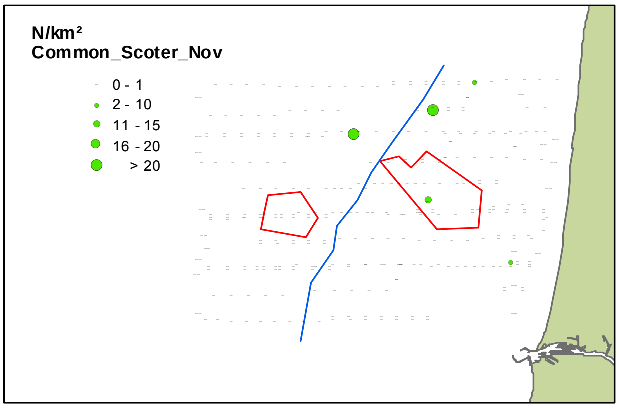
2 - 10
11 - 15
16 - 20
> 20


N/km
Common_Scoter_Nov
0
1 - 10
11 - 15
16 - 20
> 20


N/km²
Common_Scoter_Nov
0 - 1
2 - 10
11 - 15
16 - 20
> 20

Little Gull, Black-headed Gull and Common Gull *Larus minutus, L. ridibundus* and *L. canus*

The three smaller *Larus*-gulls: Little, Black-headed and Common Gull are usually seen as coastal species that show their highest densities in nearshore waters (Baptist & Wolf 1993; Camphuysen & Leopold 1994) on the Dutch sector of the North Sea. Being relatively weak competitors as compared to the larger *Larus* species, they tend to rely less on fishing fleets than e.g. Herring Gulls. However, particularly Common Gulls may show up in large numbers behind trawlers in coastal waters (Camphuysen *et al.* 1993; 1995). Black-headed Gulls follow trawlers in large numbers when within the Wadden Sea (Berghahn & Rösner 1992), but seem less inclined to do so in the North Sea. Little Gulls hardly follow trawlers in the North Sea. All three species are migratory and may turn up anywhere in the North Sea.

Long-term trend and variation

Little Gulls show a narrow peak in their passage on migration, that may or may not coincide with the aerial surveys. Estimated densities in the nearshore part of the study area in spring varied more than ten-fold (Appendix 3), but if this truly mimics numbers using the area remains unclear. Numbers were generally low in the offshore zone, with Feb/Mar 1992 as a notable exception (Appendix 3). Black-headed Gulls and Common Gulls show considerable differences in occurrence in the study area between surveys in successive years, but the overall trend seems a slight decline for both species (Appendix 6). The variation between years is not surprising, given the very brief presence of the RIKZ plane over the study area and the erratic nature of gull distributions.

Phenology

Little Gulls showed high densities on both the autumn (November survey) and spring migration periods (April survey). In November, the Little Gulls showed a "normal" distribution pattern, with most birds being observed in nearshore waters (Table 30), but during the April survey the distribution was much more spread-out, with high densities continuing all the way out to the westernmost part of the study area, and probably beyond (Table 30; Maps Little Gull). Black-headed Gulls were seen in all surveys, but were only moderately common in November, in nearshore waters (Maps Black-headed Gulls). Common Gulls were relatively common over the whole winter (November through April) and their distribution continued much further offshore than that of the Black-headed Gull (Maps Common Gulls).

Table 30. Total numbers of Little, Black-headed and Common Gulls seen in all surveys in the nearshore (0-20 m deep) and offshore parts of the study area.

	Little Gull		Black-headed Gull		Common Gull	
month	**0-20 m**	**>20 m**	**0-20 m**	**>20 m**	**0-20 m**	**>20 m**
2	13	4	14	11	328	154
4	600	1365	54	5	1186	186
5	0	0	3	2	13	1
6	0	0	19	1	392	0
8	0	0	28	22	28	3
9	28	29	4	2	15	10
10	38	38	46	9	54	5
11	225	225	441	13	3641	78

Flying heights

Gulls switch frequently between flying (often searching for prey) to "swimming" which includes all behaviour that involves touching the water. All three species taken together show altitudes in flight that were generally rather low. However, 7 Little Gulls were spotted at altitudes between 50 and 100 m asl in April and 7 more at altitudes over 100 m in that same month, while one Little Gulls was seen flying between 50 and 100 m asl during the May survey. In June, 5 Black-headed Gulls were seen at this altitude, but in August 3 Black-headed Gulls were spotted at an altitude estimated to be over 200 m asl (Table 31). Over the months, a total of 26 Common Gulls were seen between 50 and 100 m asl and one each was seen at 100-200 m in February and April.

Table 31. Distribution of flying heights of Little, Black-headed and Common Gulls taken together, in the study area, over the months as assessed during our surveys (no data on altitude recorded in September or October).

month	0-2	2-10	10-25	25-50	50-100	100-200	>200 m asl
2	5	66	126	53	11	1	
4	49	274	129	35	20	8	
5	1	5	1				
6	5	13	10	7	9		
8	2	22	5	16			3
9	8	3	1				
10	25	43	38	2	1		
11	57	429	352	26	1		
Totals	**152**	**855**	**662**	**139**	**42**	**9**	**3**

Feeding behaviour

It may be postulated that the vast majority of gulls at sea was engaged in some sort of foraging behaviour, the only exceptions being birds on "true" migration. It is often difficult to separate these from gulls just flying about, looking for opportunities to feed. A striking feature of Little Gull behaviour in April was, that many formed large groups (up to several hundreds) over lines of foam on the water's surface. These birds frequently switched between active searching (flying low above the water with head down) to surface dipping, taking tiny, invisible (for us) prey, to resting on the water in tight flocks. During the April we skimmed the water surface with a kitchen sieve from a zodiac, to get a sample of potential prey for these Little Gulls. The most abundant potential prey turned out to be fish larvae, later identified as *Ammodytes marinus*, of some 3 cm body length.

Distribution patterns, numbers and densities; occurrence in NSW and Q7

The distribution maps of all sightings for Little and Black-headed Gulls show predominantly nearshore distribution patterns, with April being a noticeable exception for Little Gull (as outlined above). Common Gulls (see Maps Common Gull) showed a much more spread-out distribution, particularly in the winter months. In summer, Common Gulls resided closer inshore.

Little Gulls were thus abundantly present in both the NSW and the Q7 prospects in April, but this may have been a rather unusual, or at least a short-lasting situation. On the other hand, many Little Gulls were feeding at the time and the waters off Noord-Holland may serve as a stop-over site for these birds, during their spring migration. Similar mass-presence of Little Gulls in this area has been noted once before in spring (in April 1996; Keyl & Leopold 1997) and this phenomenon clearly needs more attention. Most Black-headed Gulls do not venture so far out to sea that they reach the future windfarms, only some birds on migration to and from the UK obviously will. Common Gull distribution on the other hand, reaches out to beyond even Q7 and these gulls may be expected to occur in both future windfarms. Total estimated numbers for the three species in all DONAR blocks are given in Tables 32, 33 and 34.

Table 32. Estimated total numbers of Little Gulls for the 11 DONAR polygons (see Figure 1). The upper panel gives total numbers based on the field measurements (average density per DONAR polygon multiplied with the polygon surface area). Modelled totals are only available for months with sufficient data (25 or more 5-minute counts with at least one bird inside the counting strip) and are based on the average (± 1 SD) densities per 250x250 m grid cell. In the graph below the numbers from the upper panel (Measured) are graphically presented.

Little Gull

Measured

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C	0	22 ± 126	0	0	0	0	0	36 ± 128
CE	0	126 ± 419	0	0	0	17 ± 123	7 ± 39	54 ± 180
CW	0	183 ± 863	0	0	0	0	6 ± 37	0
N	0	76 ± 347	0	0	0	0	0	37 ± 168
NE	2 ± 19	123 ± 459	0	0	0	0	24 ± 88	13 ± 43
NSW	0	4 ± 16	0	0	0	0	6 ± 29	10 ± 31
NW	0	539 ± 2866	0	0	0	2 ± 24	0	0
Q7	0	15 ± 48	0	0	0	0	0	0
S	0	72 ± 376	0	0	0	2 ± 21	0	37 ± 99
SE	7 ± 54	69 ± 254	0	0	0	0	5 ± 28	30 ± 94
SW	5 ± 38	76 ± 268	0	0	0	7 ± 62	0	10 ± 64

Modelled

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C		41 ± 14						27 ± 13
CE		102 ± 28						38 ± 7
CW		124 ± 30						1 ± 1
N		121 ± 70						25 ± 15
NE		95 ± 29						22 ± 2
NSW		17 ± 5						14 ± 3
NW		499 ± 215						2 ± 2
Q7		32 ± 11						4 ± 2
S		62 ± 20						54 ± 13
SE		123 ± 23						37 ± 11
SW		118 ± 85						10 ± 7

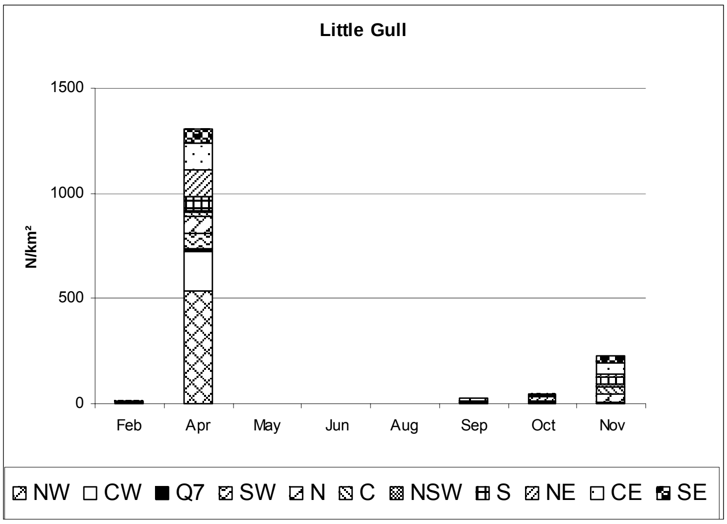


Table 33. Estimated total numbers of Black-headed Gulls for the 11 DONAR polygons (see Figure 1). The upper panel gives total numbers based on the field measurements (average density per DONAR polygon multiplied with the polygon surface area). Modelled totals are only available for months with sufficient data (25 or more 5-minute counts with at least one bird inside the counting strip) and are based on the average (± 1 SD) densities per 250x250 m grid cell. In the graph below the numbers from the upper panel (Measured) are graphically presented.

Black-headed Gull

Measured

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C	0	0	0	0	0	4 ± 26	0	0
CE	0	8 ± 53	2 ± 20	2 ± 17	9 ± 62	0	6 ± 48	134 ± 571
CW	0	2 ± 15	0	0	0	0	0	0
N	0	0	0	0	0	2 ± 25	52 ± 413	16 ± 89
NE	0	5 ± 43	0	0	2 ± 15	0	0	39 ± 116
NSW	0	0	0	0	0	0	0	0
NW	0	5 ± 46	0	0	0	0	15 ± 134	0
Q7	0	0	0	0	0	0	0	0
S	0	0	0	0	2 ± 18	0	8 ± 55	9 ± 56
SE	31 ± 191	12 ± 87	0	0	0	0	0	15 ± 68
SW	0	0	0	0	13 ± 128	0	0	0

Modelled

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C								2 ± 2
CE								117 ± 100
CW								0 ± 0
N								8 ± 13
NE								48 ± 45
NSW								5 ± 3
NW								0 ± 0
Q7								0 ± 0
S								4 ± 4
SE								23 ± 5
SW								0 ± 0

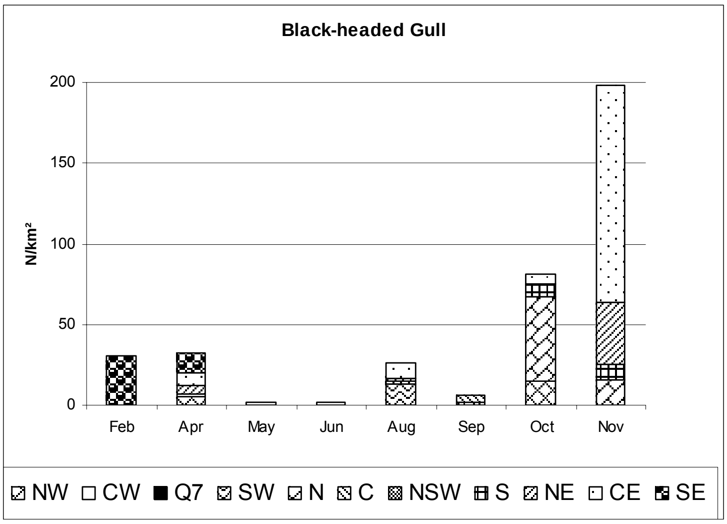


Table 34. Estimated total numbers of Common Gulls for the 11 DONAR polygons (see Figure 1). The upper panel gives total numbers based on the field measurements (average density per DONAR polygon multiplied with the polygon surface area). Modelled totals are only available for months with sufficient data (25 or more 5-minute counts with at least one bird inside the counting strip) and are based on the average (± 1 SD) densities per 250x250 m grid cell. In the graph below the numbers from the upper panel (Measured) are graphically presented.

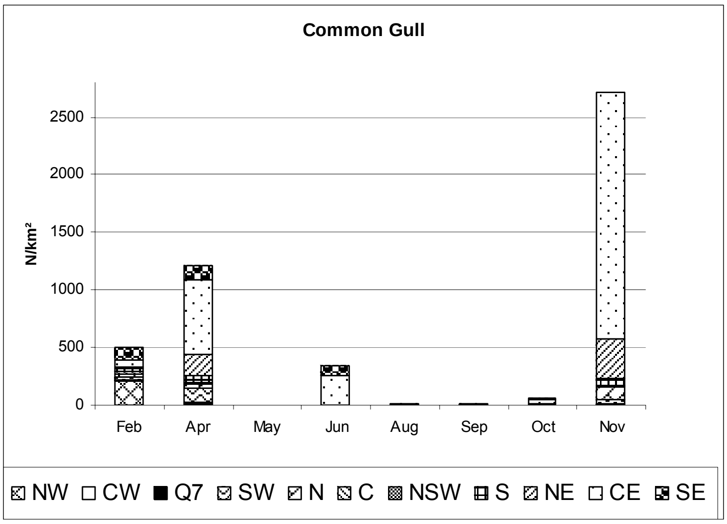
Common Gull

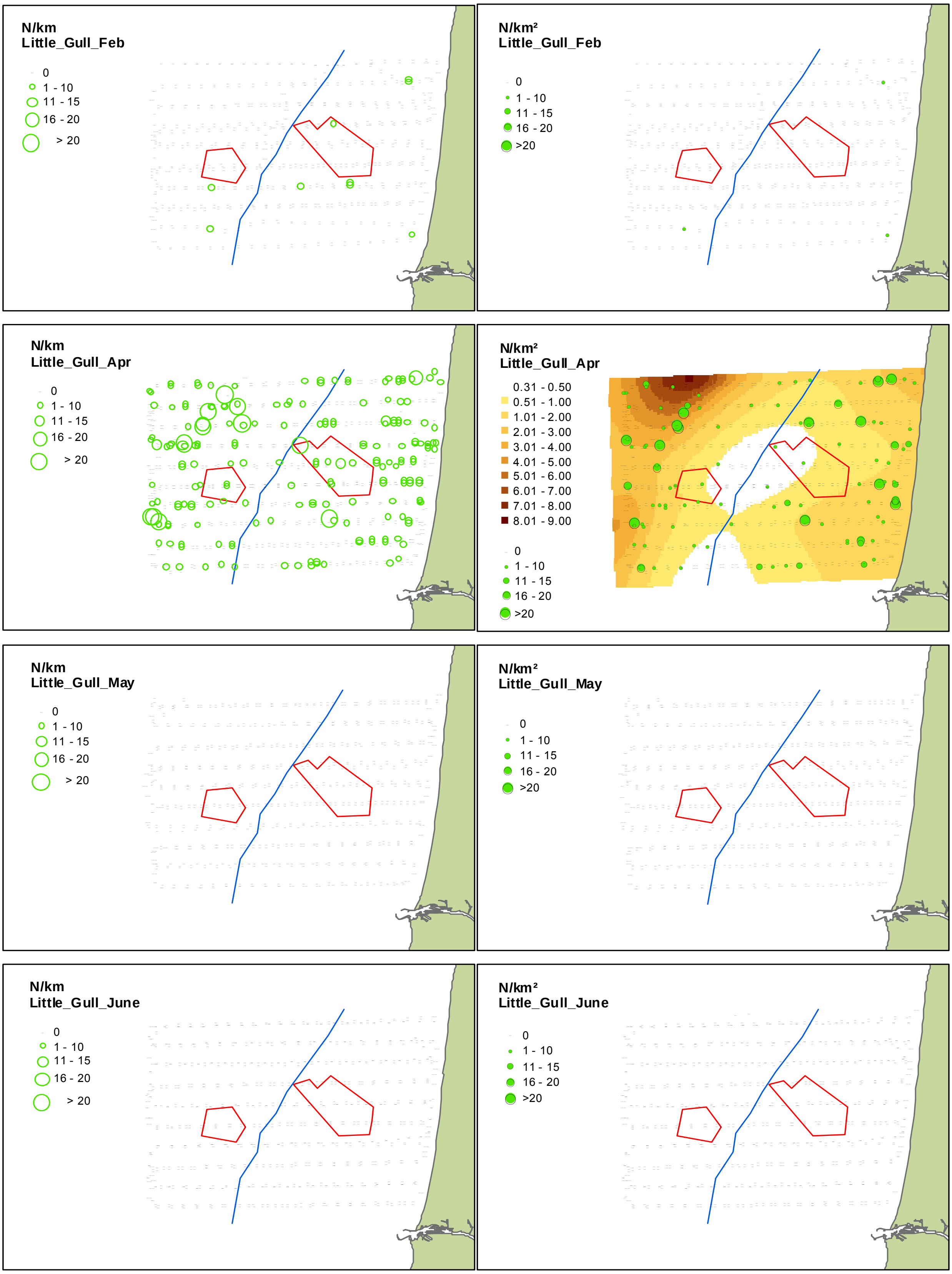
Measured

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C	33 ± 163	5 ± 38	0	0	4 ± 26	0	7 ± 36	5 ± 31
CE	59 ± 235	649 ± 3189	0	255 ± 1619	5 ± 50	4 ± 30	29 ± 80	2130 ± 8762
CW	5 ± 27	8 ± 49	0	0	0	2 ± 13	0	0
N	18 ± 78	39 ± 277	0	0	0	5 ± 50	0	112 ± 448
NE	21 ± 94	182 ± 1062	0	4 ± 22	2 ± 15	0	7 ± 35	344 ± 1224
NSW	0	7 ± 22	0	0	0	2 ± 12	0	4 ± 17
NW	204 ± 1348	16 ± 69	0	0	0	0	0	7 ± 43
Q7	5 ± 20	2 ± 13	0	0	0	0	0	3 ± 16
S	16 ± 101	63 ± 355	0	2 ± 20	0	0	0	63 ± 131
SE	111 ± 387	120 ± 662	0	83 ± 627	7 ± 37	0	13 ± 47	312 ± 591
SW	33 ± 144	122 ± 524	0	0	0	0	3 ± 23	42 ± 170

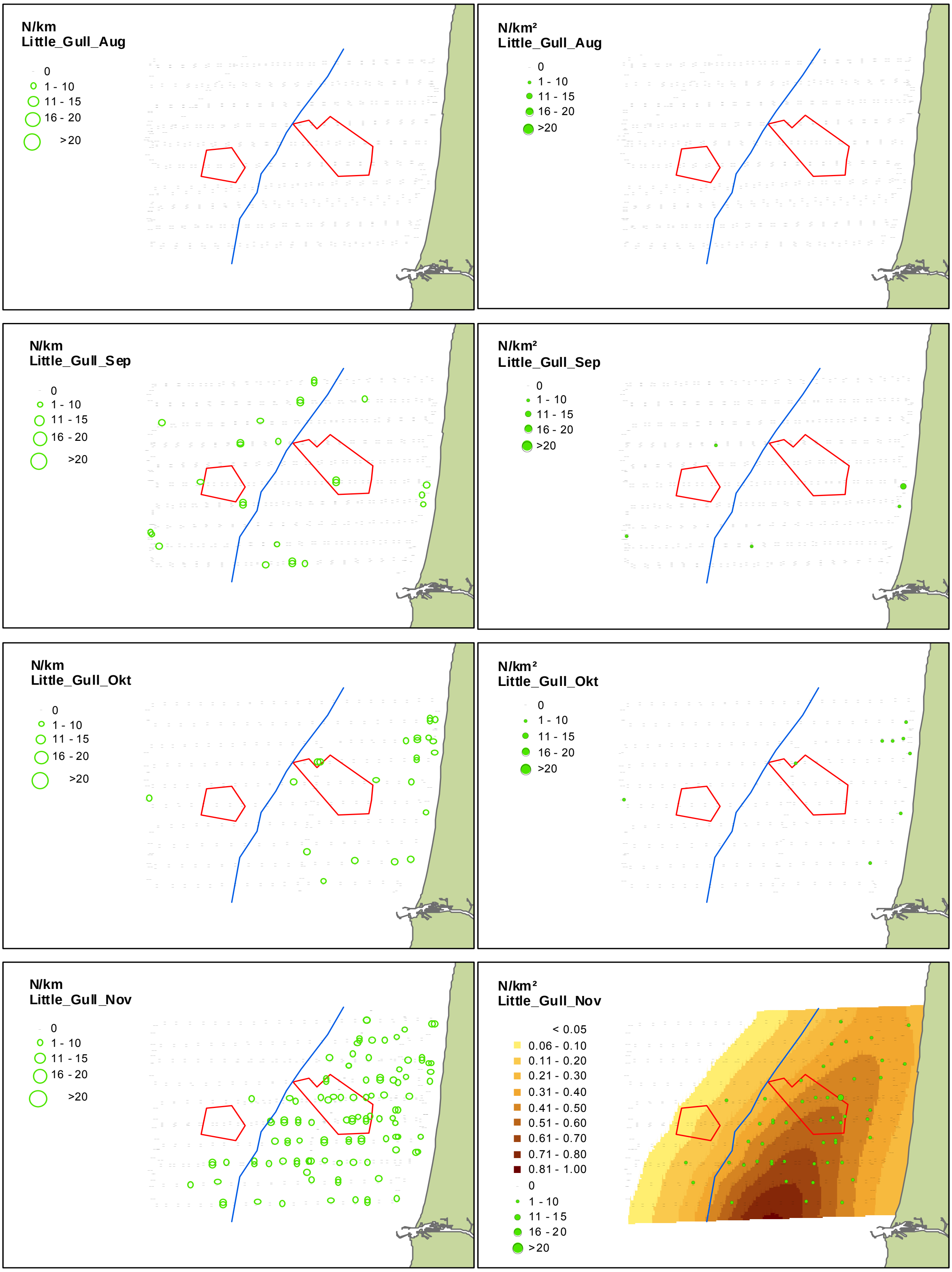
Modelled

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C	37 ± 20	69 ± 46						53 ± 45
CE	64 ± 24	449 ± 275						1729 ± 1081
CW	24 ± 8	16 ± 3						13 ± 7
N	45 ± 24	64 ± 30						69 ± 137
NE	20 ± 13	124 ± 54						405 ± 319
NSW	15 ± 4	37 ± 19						81 ± 57
NW	50 ± 40	28 ± 4						20 ± 10
Q7	25 ± 9	17 ± 4						11 ± 7
S	31 ± 10	60 ± 48						75 ± 90
SE	102 ± 81	321 ± 236						411 ± 67
SW	43 ± 14	17 ± 10						6 ± 1





Maps Little Gull 1 & 2 (this page and overleaf). Total **distribution** (left panels) is mapped by calculating total numbers seen per km traveled (open circles). **Densities** (right panels; filled circles) are calculated as the sum of all birds seen "in transect" divided by the surface area watched per 5 minute count. Model results (where appropriate) are also given in the right-hand panels, as shades of brown (high densities) to yellow (low densities). A set of two maps is given for each survey separately.


N/km
Little_Gull_Aug
0
1 - 10
11 - 15
16 - 20
>20
N/km²
Little_Gull_Aug
0
1 - 10
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>20
N/km
Little_Gull_Sep
0
1 - 10
11 - 15
16 - 20
>20
N/km²
Little_Gull_Sep
0
1 - 10
11 - 15
16 - 20
>20
N/km
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0
1 - 10
11 - 15
16 - 20
>20
N/km²
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0
1 - 10
11 - 15
16 - 20
>20
N/km
Little_Gull_Nov
0
1 - 10
11 - 15
16 - 20
>20
N/km²
Little_Gull_Nov
< 0.05
0.06 - 0.10
0.11 - 0.20
0.21 - 0.30
0.31 - 0.40
0.41 - 0.50
0.51 - 0.60
0.61 - 0.70
0.71 - 0.80
0.81 - 1.00
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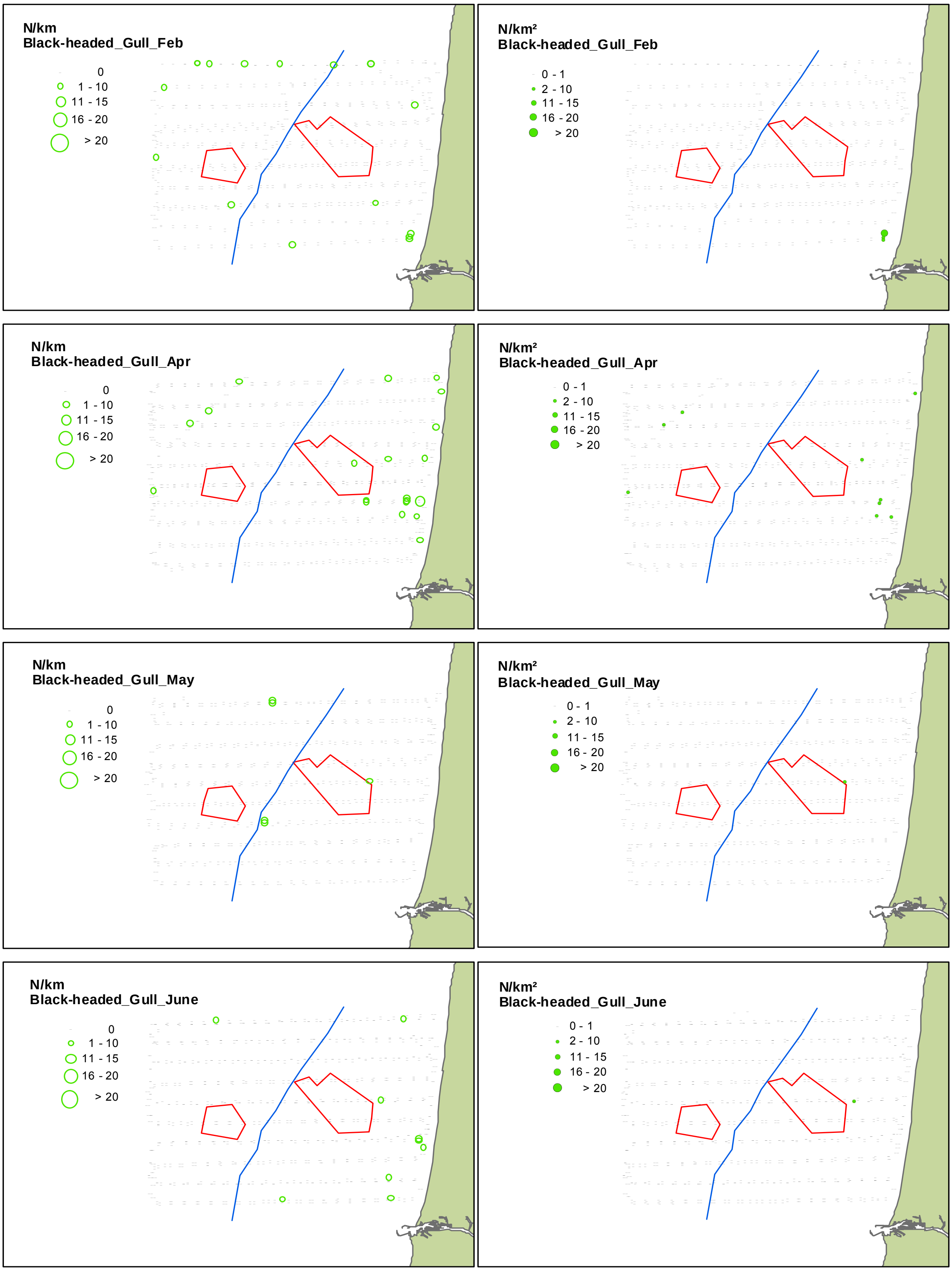
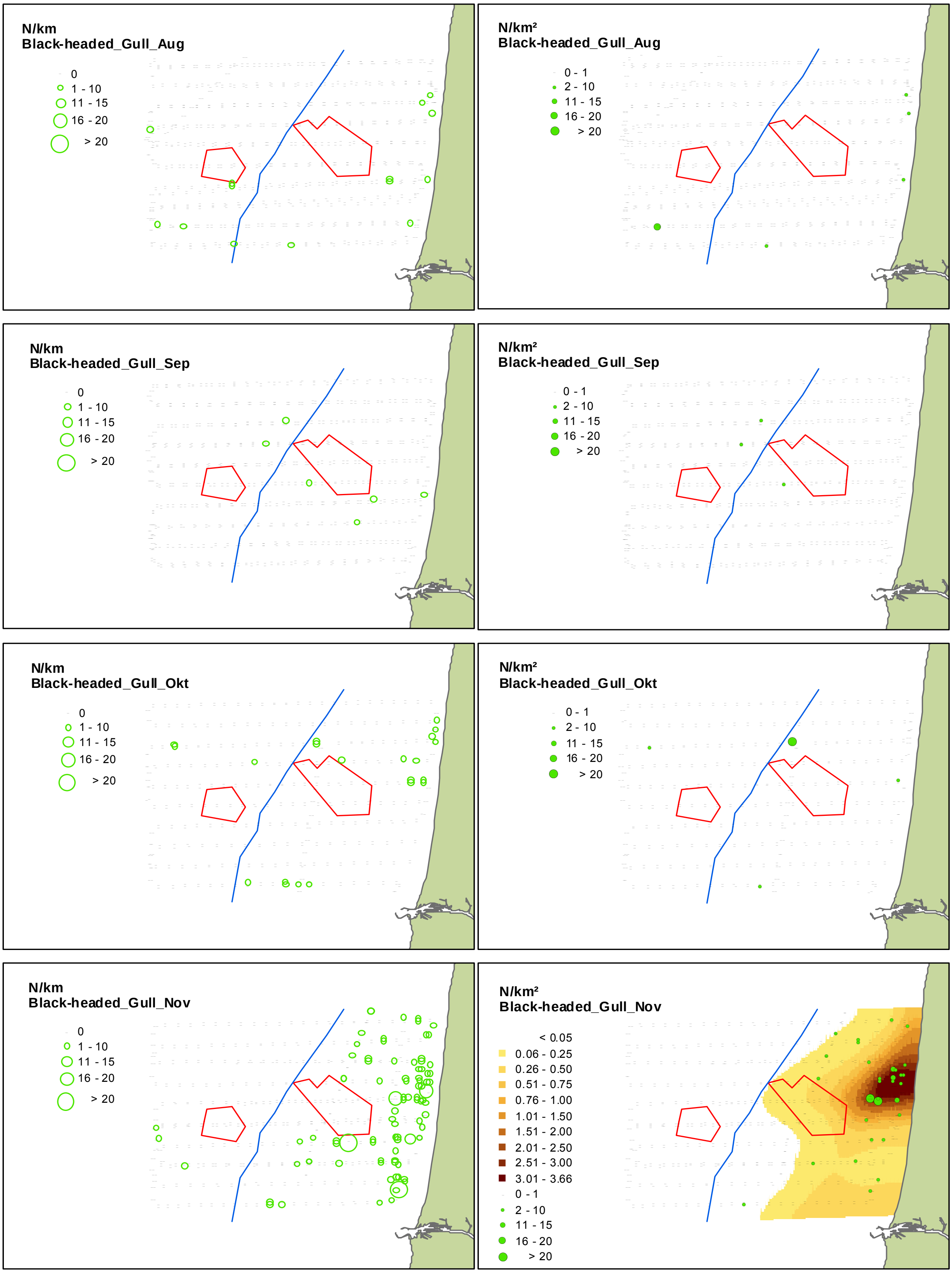
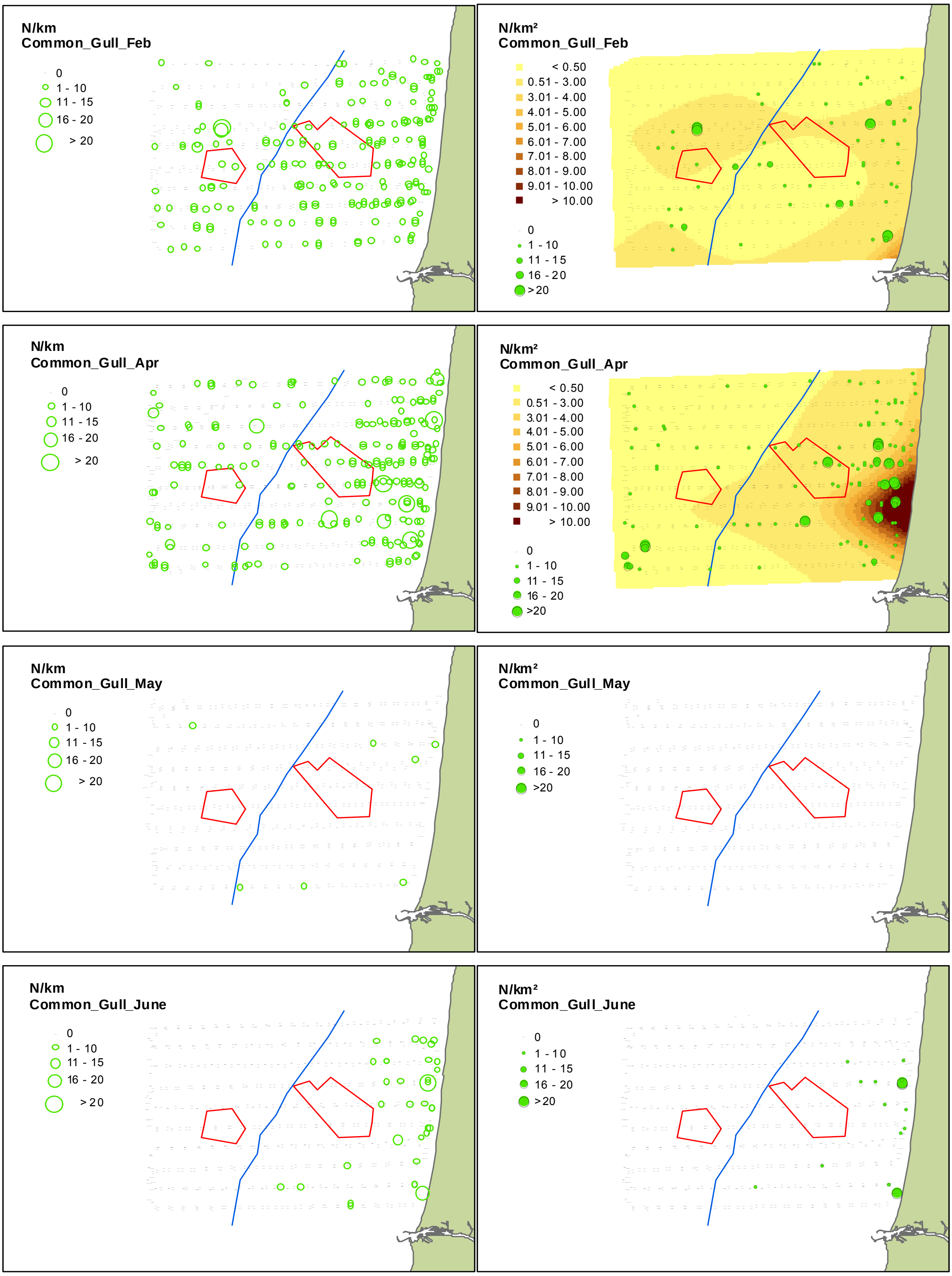
11 - 15
16 - 20
>20



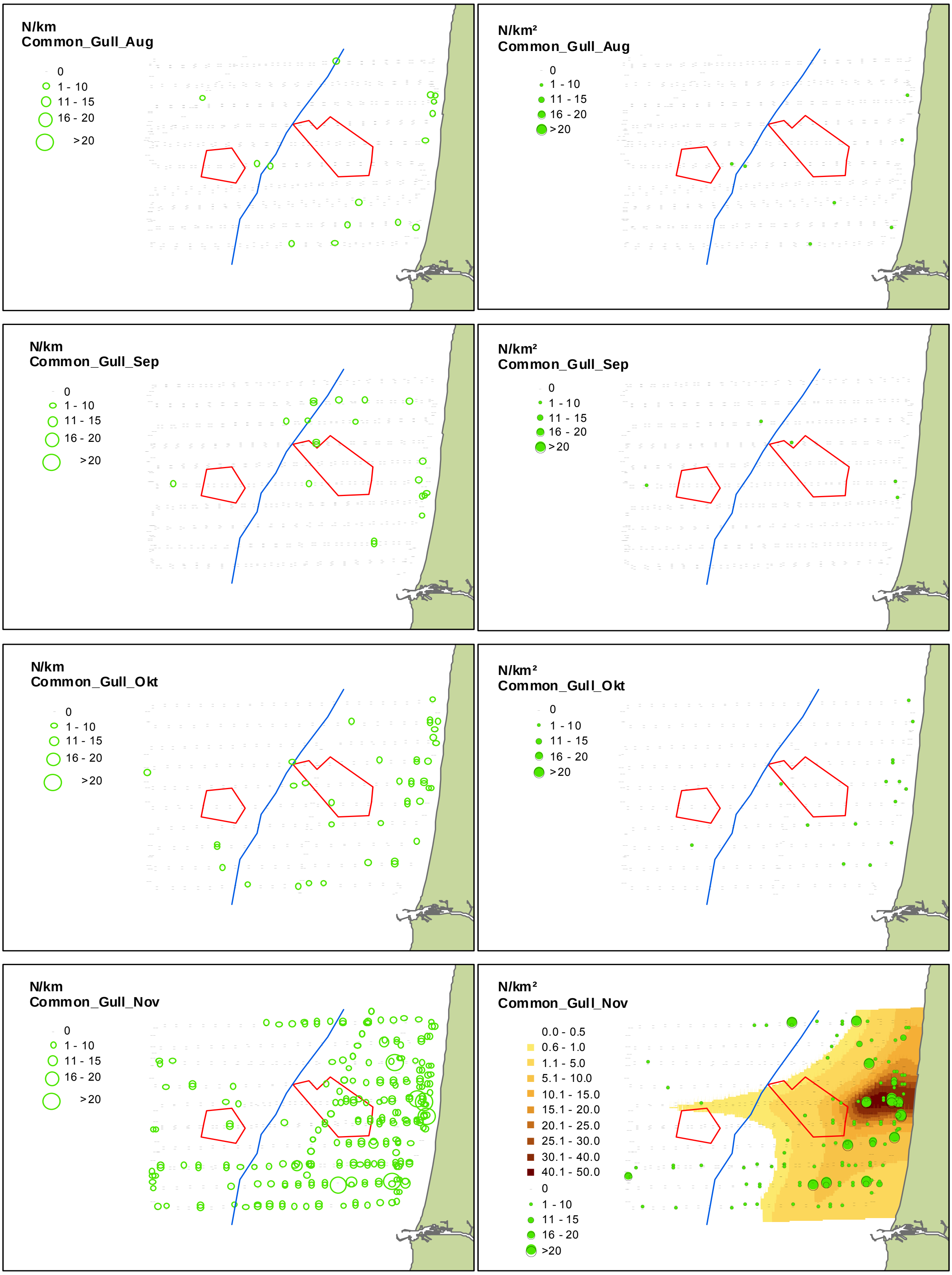
Maps Black-headed Gull 1 & 2 (this page and overleaf). Total **distribution** (left panels) is mapped by calculating total numbers seen per km traveled (open circles). **Densities** (right panels; filled circles) are calculated as the sum of all birds seen "in transect" divided by the surface area watched per 5 minute count. Model results (where appropriate) are also given in the right-hand panels, as shades of brown (high densities) to yellow (low densities). A set of two maps is given for each survey separately.



N/km
Black-headed_Gull_Aug
0
1 - 10
11 - 15
16 - 20
> 20
N/km²
Black-headed_Gull_Aug
0 - 1
2 - 10
11 - 15
16 - 20
> 20
N/km
Black-headed_Gull_Sep
0
1 - 10
11 - 15
16 - 20
> 20
N/km²
Black-headed_Gull_Sep
0 - 1
2 - 10
11 - 15
16 - 20
> 20
N/km
Black-headed_Gull_Okt
0
1 - 10
11 - 15
16 - 20
> 20
N/km²
Black-headed_Gull_Okt
0 - 1
2 - 10
11 - 15
16 - 20
> 20
N/km
Black-headed_Gull_Nov
0
1 - 10
11 - 15
16 - 20
> 20
N/km²
Black-headed_Gull_Nov
< 0.05
0.06 - 0.25
0.26 - 0.50
0.51 - 0.75
0.76 - 1.00
1.01 - 1.50
1.51 - 2.00
2.01 - 2.50
2.51 - 3.00
3.01 - 3.66
0 - 1
2 - 10
11 - 15
16 - 20
> 20



Maps Common Gull 1 & 2 (this page and overleaf). Total **distribution** (left panels) is mapped by calculating total numbers seen per km traveled (open circles). **Densities** (right panels; filled circles) are calculated as the sum of all birds seen "in transect" divided by the surface area watched per 5 minute count. Model results (where appropriate) are also given in the right-hand panels, as shades of brown (high densities) to yellow (low densities). A set of two maps is given for each survey separately.


N/km
Common_Gull_Aug
0
1 - 10
11 - 15
16 - 20
>20
N/km²
Common_Gull_Aug
0
1 - 10
11 - 15
16 - 20
>20
N/km
Common_Gull_Sep
0
1 - 10
11 - 15
16 - 20
>20
N/km²
Common_Gull_Sep
0
1 - 10
11 - 15
16 - 20
>20
N/km
Common_Gull_Okt
0
1 - 10
11 - 15
16 - 20
>20
N/km²
Common_Gull_Okt
0
1 - 10
11 - 15
16 - 20
>20
N/km
Common_Gull_Nov
0
1 - 10
11 - 15
16 - 20
>20
N/km²
Common_Gull_Nov
0.0 - 0.5
0.6 - 1.0
1.1 - 5.0
5.1 - 10.0
10.1 - 15.0
15.1 - 20.0
20.1 - 25.0
25.1 - 30.0
30.1 - 40.0
40.1 - 50.0
0
1 - 10
11 - 15
16 - 20
>20

Lesser Black-backed, Herring, and Greater Black-backed Gull *Larus fuscus, L. argentatus* and *L. marinus*

The three larger *Larus*-gulls: Lesser Black-backed, Herring, and Greater Black-backed Gull are all ship-followers that constantly watch nearby and distant fishing vessels, as well as other gulls flying towards fishing vessels, for opportunities to feed. Besides, they also have many means to forage naturally, without the aid of man. "Natural, multi-species feeding frenzies" often of many hundreds or even thousands of gulls, may be seen anywhere in the coastal zone, but probably particularly in summer, over calm seas with schools of small fish at the surface. Large gulls not engaged in such feeding groups spend much time flying around, seeming haphazardly, but always on the lookout for feeding opportunities. As the largest flocks of gulls in the coastal zone, besides the natural feeding frenzies, invariably are found behind trawlers, and because trawlers are nearly always present in the area, human fishing activities greatly affect the distribution patterns of the large gulls. On short time scales (hours or even days), the distribution of fishing ships is rather predictable for the gulls and trawlers can be seen over large distances on days with average to good visibility. On days with good to excellent visibility, a high-flying gull in the study area can probably see any trawler in that area or at least it can see other gulls suddenly changing from flying in "searching mode" to flying in a definite direction, to a distant trawler.

Long-term trend and variation

Like in the smaller gulls, the aerial survey data for the three species of large *Larus* gulls in the study area show considerable variation (Appendix 3). Herring Gulls may have been declining slightly, at the expense of Lesser Black-backed Gulls, but the data do not allow a firm conclusion.

Phenology

Except during the February survey, when both fishing vessels (Maps fishing vessel) and large gulls were remarkably rare, both fishing and large gulls were abundant in the study area. Lesser Black-backed Gulls were more or less replaced by Greater Black-backed Gulls in winter, as the smaller species is mainly a summer visitor to the North Sea, while Greater Black-backed Gulls are mainly winter visitors to the study area (Maps Lesser & Greater Black-backed Gull). Herring Gulls on the other hand, are abundantly present in The Netherlands throughout the year; only during wing moult (August) do they leave the more offshore parts of the North Sea and, with reduced flight capabilities, retreat into the Wadden Sea and inland locations (Camphuysen & Leopold 1994; Leopold *et al.* 2004). This pattern is also clearly visible in the present results: during the August survey they were the most coastal of the large gulls (Maps Herring Gull). This coastal distribution remained more or less until at least November (Table 35). Only in September were relatively large numbers of Herring Gulls seen beyond the -20 m depth contour, in two diffuse clusters (Maps Herring Gulls). Radar counts of active fishing vessels were not carried out during the two 2002-surveys (September and October; hence these are missing from Figure 5 that maps the distribution of fishing vessels per month), but the standard notes on behaviour, flying directions and associations of birds with a.o. fishing vessels showed that in September, 95% of the Herring Gulls over >20 m deep waters were in any way associated with fishing vessels at the time of observation.

Table 35. Total numbers of Lesser Black-backed, Herring and Greater Black-backed Gulls seen in all surveys in the nearshore (0-20 m deep) and offshore parts of the study area.

	Lesser Black-backed Gull		Herring Gull		Greater Black-backed Gull	
month	**0-20 m**	**>20 m**	**0-20 m**	**>20 m**	**0-20 m**	**>20 m**
2	12	30	133	196	12	48
4	983	9126	2909	815	53	310
5	3089	3860	1796	685	52	94
6	3709	1081	2180	254	2	7
8	3991	3119	239	8	152	132
9	608	1144	1701	435	551	2675
10	59	22	493	15	194	123
11	73	26	10957	27	2220	65

Flying heights
The large gulls were among the most numerous and highest flying birds in the study area, in all survey months. Significant proportions of all species were noted to fly at rotor altitudes (25-100+ meters asl; Table 36). High-flying gulls were engaged in at least three types of behaviour: circling (circling gulls of all three species can go up to estimated altitudes of over 200 m asl); directional seaward (mainly in the mornings) and landward flights (return flights towards the evening), often in line formations; cruising and looking for feeding opportunities (e.g. distant trawlers, other gulls engaged in feeding; but also individual prey, such as single fish or swimming crabs).

Table 36. Distribution of flying heights of , Black-headed and Common Gulls taken together, in the study area, over the months as assessed during our surveys (no data on altitude recorded in September or October).

month	**0-2**	**2-10**	**10-25**	**25-50**	**50-100**	**100-200**	**>200 m asl**
2	4	20	43	59	29	1	
4	61	147	404	303	193	243	37
5	105	844	798	334	28	12	
6	72	298	1015	408	87	24	1
8	37	245	673	193	250	227	1
9	47	147	245	84	17	6	
10	34	95	175	64	4	3	
11	182	227	234	81	6		
Totals	**542**	**2023**	**3587**	**1526**	**614**	**516**	**39**

Feeding behaviour
Like in the smaller gulls, also the vast majority of large gulls at sea were probably engaged in some sort of foraging behaviour, the only possible exceptions being birds on “true” migration. Natural feeding on large schools of small pelagic fish was most prominent in the summer months. A remarkable feeding mode was on swimming crabs *Liocarcinus* spp. This behaviour was shown by all large gull species, (including one Yellow-legged Gull *Larus cachinnans*, but mostly by Lesser Black-backed Gulls in August (Table 37). This behaviour was mostly shown by gulls flying singly, at altitudes between a few metres and about 40 m asl. A gull would then suddenly stop flying, scrutinize an object at or just under the water’s surface and dive almost

vertically down to grab and swallow it. Large gulls are known to take swimming crabs and this prey can be very important as food for chicks on the Wadden islands (Germany; Garthe *et al.* 1999), but apparently the gulls use it for self-feeding as well, during a longer period than just the chick phase. However, most food was probably obtained behind fishing trawlers, in any month (compare right hand columns of Table 37). Trawlers were visited in large numbers in all months and on the one occasion that trawlers were nearly absent (February) also Gull numbers were extremely low in the study area (see also Table 35).

Table 37. Total numbers of Lesser Black-backed Gulls, Herring Gulls, Yellow-legged Gulls and Greater Black-backed Gulls noted to catch a swimming crab (left) and notes as being associated with fishing vessel (right), per survey.

	Large Gulls taking swimming crabs				**Large gulls associated with trawlers**		
month	**LBB**	**Herring**	**YLG**	**GBB**	**LBB**	**Herring**	**GBB**
2					24	155	32
4					9208	3312	343
5					6067	2051	100
6	2	5			419	251	2
8	132	14		8	4876	34	258
9	45	26	1	3	1151	1281	2665
10		1			191	3016	636
11					68	10035	1942

Distribution patterns, numbers and densities; occurrence in NSW and Q7

The distribution maps the three common large gull species show some interesting features, especially when viewed in comparison and together with the maps of fishing vessel distribution. In February, the only fishing activity of some importance took place to the northwest of Q7 and here some Greater Black-backed Gulls and Herring Gulls had gathered. Lesser Black-backed Gulls were nearly absent in mid-winter but some were seen around these trawlers as well. In April we noted an inshore fishing fleet of euro cutters and shrimpers with large numbers of associated Herring and Lesser Black-backed Gulls (Herring Gulls dominating) and a large offshore fleet, of 16 large beam trawlers was fishing in a tight pack in the south-western corner of the study area in the first half of the week. This attracted large numbers of gulls, but here the Lesser Black-Backed Gulls were numerically the dominant species. Note similarity in model-outcomes for the two black-backed species, while in Herring Gulls, the nearshore component is of overriding importance! There was little fishing in the central part of the study area in April and these parts also had low gull densities. In May fishing concentrated on nearhore waters, with an extension into the centre of the study area. Both Lesser Black-backed and Herring Gulls were numerous in the central part, while Herring Gulls did so nearshore and model predictions follow this neatly. June shows a rather similar picture, but Herring Gulls no longer ventured far offshore, while Lesser Black-backed Gulls became relatively more numerous in nearshore waters. In August, Lesser Black-backed Gulls were more or less very numerous anywhere. The model picked up a north-south component, but peak numbers were present all over the coastal zone and in the southwest. Greater Black-backed Gulls were back in appreciable numbers and showed a similar distribution pattern, while Herring Gulls had made a retreat into coastal waters. In September many Herring Gulls remained inshore but some also joined large flocks of both Lesser and Greater Black-backed Gulls feeding around a fleet of trawlers just to the northwest of the NSW contour. By October most Lesser Black-backed Gulls had left the study area and both Herring and Greater Black-backed Gulls had their peak numbers in nearshore waters (but note low densities of Greater Black-backed Gulls in October). A similar picture was obtained during the November survey, with very large numbers of gulls feeding around a fleet of inshore operating fishing vessels, due east of NSW.

It is clear that large gulls can be very abundant anywhere in Dutch coastal waters, including at any site where turbines might be placed. Gulls also frequently fly at rotor-altitudes, but will probably tend to settle down at sea (or on land) at night, although nightly activity around (illuminated!) fishing vessels has been noted (Garthe & Hüppop 1993). The distribution is governed to a large extent by the presence and activity of fishing vessels. Gulls commute between different vessels, trying to keep up with those hauling nets and discarding waste, and will also commute between the shore and distant fleets (e.g. to the west of a future windfarm in which case the shortest flight path may cross such a wind park). As wind park locations will be closed to fishery, these areas will loose much of their present attraction for gulls. Total estimated numbers for the three species in all DONAR blocks are given in Tables 38, 39 and 40.

Table 38. Estimated total numbers of Lesser Black-backed Gulls for the 11 DONAR polygons (see Figure 1). The upper panel gives total numbers based on the field measurements (average density per DONAR polygon multiplied with the polygon surface area). Modelled totals are only available for months with sufficient data (25 or more 5-minute counts with at least one bird inside the counting strip) and are based on the average (± 1 SD) densities per 250x250 m grid cell. In the graph below the numbers from the upper panel (Measured) are graphically presented.

Lesser Black-backed Gull

Measured

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C	0	154 ± 1223	3441 ± 15749	671 ± 3221	50 ± 120	548 ± 4782	10 ± 73	0
CE	2 ± 19	399 ± 1539	511 ± 2048	535 ± 2221	469 ± 710	75 ± 260	36 ± 127	42 ± 178
CW	0	1101 ± 4885	26 ± 74	2 ± 14	472 ± 2266	102 ± 724	0	0
N	5 ± 50	178 ± 1640	610 ± 2924	54 ± 127	413 ± 2040	1483 ± 9407	22 ± 113	3 ± 29
NE	0	25 ± 150	47 ± 146	24 ± 64	439 ± 851	68 ± 173	0	5 ± 24
NSW	0	34 ± 180	211 ± 1023	35 ± 82	21 ± 51	28 ± 59	6 ± 21	0
NW	70 ± 579	965 ± 7188	103 ± 630	37 ± 150	29 ± 101	4 ± 33	0	7 ± 44
Q7	0	285 ± 2017	437 ± 1864	181 ± 993	1113 ± 4457	2 ± 13	0	0
S	0	107 ± 840	291 ± 1249	317 ± 1933	352 ± 969	100 ± 231	14 ± 51	0
SE	6 ± 34	28 ± 122	178 ± 344	390 ± 2208	639 ± 1033	222 ± 1186	13 ± 44	3 ± 23
SW	0	5285 ± 19784	397 ± 1698	97 ± 600	358 ± 2213	107 ± 636	30 ± 164	57 ± 453

Modelled

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C		151 ± 68	2009 ± 1002	321 ± 171	419 ± 52	426 ± 498		
CE		33 ± 15	466 ± 199	540 ± 184	475 ± 59	129 ± 84		
CW		1039 ± 427	187 ± 111	76 ± 40	239 ± 24	26 ± 20		
N		132 ± 100	1024 ± 626	216 ± 202	436 ± 53	1170 ± 1049		
NE		11 ± 3	144 ± 75	99 ± 94	219 ± 21	135 ± 82		
NSW		21 ± 4	523 ± 205	131 ± 29	156 ± 15	86 ± 106		
NW		1215 ± 580	247 ± 404	129 ± 203	416 ± 52	214 ± 311		
Q7		281 ± 118	756 ± 285	169 ± 58	202 ± 19	137 ± 58		
S		544 ± 397	413 ± 306	175 ± 62	660 ± 66	98 ± 77		
SE		147 ± 85	87 ± 52	319 ± 116	640 ± 65	101 ± 46		
SW		4187 ± 3530	430 ± 345	171 ± 82	556 ± 54	198 ± 147		

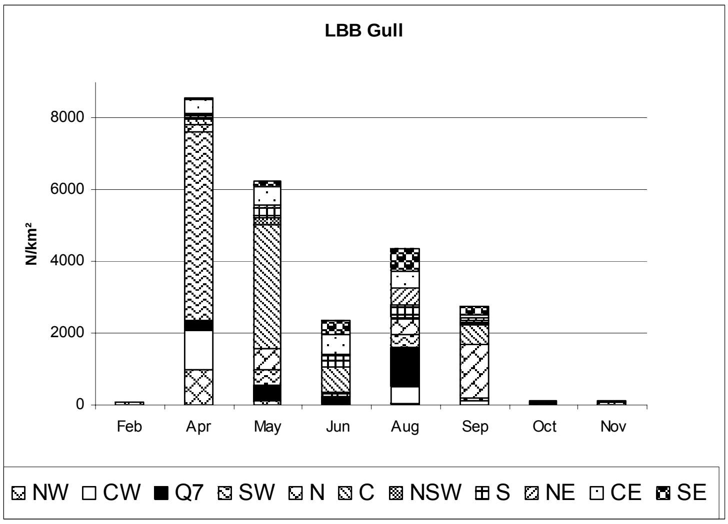


Table 39. Estimated total numbers of Herring Gulls for the 11 DONAR polygons (see Figure 1). The upper panel gives total numbers based on the field measurements (average density per DONAR polygon multiplied with the polygon surface area). Modelled totals are only available for months with sufficient data (25 or more 5-minute counts with at least one bird inside the counting strip) and are based on the average (± 1 SD) densities per 250x250 m grid cell. In the graph below the numbers from the upper panel (Measured) are graphically presented.

Herring Gull

Measured

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C	0	22 ± 142	946 ± 4662	264 ± 1451	0	88 ± 729	4 ± 26	2 ± 21
CE	30 ± 125	1326 ± 5365	820 ± 3647	761 ± 3710	52 ± 126	361 ± 1519	671 ± 3328	6071 ± 21973
CW	2 ± 12	52 ± 223	0	0	0	29 ± 196	3 ± 18	0
N	19 ± 129	39 ± 259	49 ± 137	16 ± 62	2 ± 25	662 ± 3997	22 ± 113	26 ± 131
NE	6 ± 29	719 ± 4930	82 ± 279	40 ± 78	54 ± 127	167 ± 279	83 ± 201	1919 ± 7817
NSW	0	4 ± 17	77 ± 410	12 ± 34	0	21 ± 49	0	2 ± 15
NW	396 ± 2921	125 ± 1193	4 ± 33	0	0	0	4 ± 32	0
Q7	0	31 ± 224	40 ± 159	2 ± 12	0	2 ± 12	0	0
S	16 ± 82	107 ± 788	175 ± 755	68 ± 303	6 ± 41	30 ± 95	33 ± 84	34 ± 143
SE	23 ± 79	155 ± 597	68 ± 162	232 ± 1533	142 ± 323	278 ± 913	180 ± 483	783 ± 4433
SW	3 ± 24	472 ± 1850	32 ± 264	0	0	56 ± 434	10 ± 40	25 ± 160

Modelled

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C	29 ± 57	218 ± 54	614 ± 233	91 ± 91	1 ± 1	139 ± 51	16 ± 10	43 ± 59
CE	30 ± 31	653 ± 131	656 ± 303	632 ± 602	44 ± 36	311 ± 159	617 ± 749	5691 ± 4642
CW	28 ± 38	45 ± 7	11 ± 10	13 ± 12	0 ± 0	24 ± 10	4 ± 1	2 ± 1
N	41 ± 53	426 ± 132	201 ± 217	98 ± 103	4 ± 4	384 ± 74	17 ± 10	142 ± 415
NE	9 ± 8	480 ± 99	98 ± 77	117 ± 178	47 ± 38	224 ± 66	74 ± 76	1417 ± 1475
NSW	6 ± 5	127 ± 18	226 ± 52	48 ± 22	1 ± 1	57 ± 15	11 ± 9	164 ± 163
NW	137 ± 228	146 ± 40	15 ± 40	49 ± 85	0 ± 0	101 ± 72	7 ± 3	3 ± 2
Q7	38 ± 52	58 ± 7	136 ± 88	33 ± 26	0 ± 0	53 ± 13	4 ± 1	2 ± 2
S	3 ± 1	247 ± 71	186 ± 117	17 ± 9	4 ± 5	52 ± 17	7 ± 7	72 ± 96
SE	14 ± 11	554 ± 137	107 ± 106	288 ± 312	161 ± 192	238 ± 174	215 ± 208	876 ± 390
SW	22 ± 17	85 ± 25	83 ± 105	11 ± 5	0 ± 0	40 ± 21	2 ± 1	0 ± 0

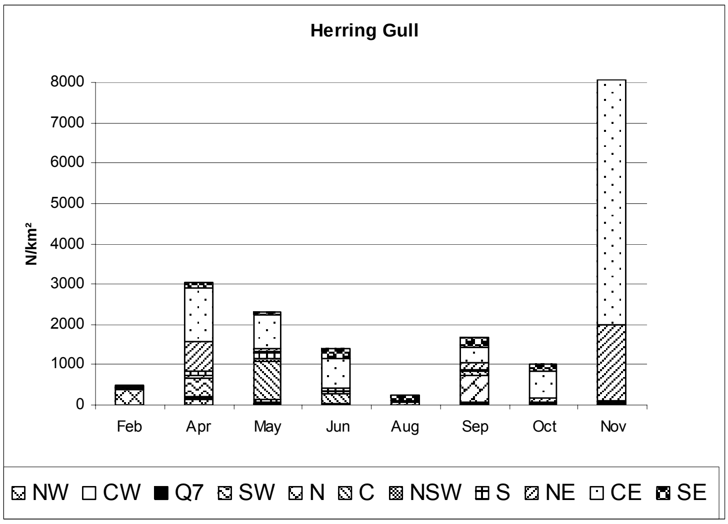


Table 40. Estimated total numbers of Greater Black-backed Gulls for the 11 DONAR polygons (see Figure 1). The upper panel gives total numbers based on the field measurements (average density per DONAR polygon multiplied with the polygon surface area). Modelled totals are only available for months with sufficient data (25 or more 5-minute counts with at least one bird inside the counting strip) and are based on the average (± 1 SD) densities per 250x250 m grid cell. In the graph below the numbers from the upper panel (Measured) are graphically presented.

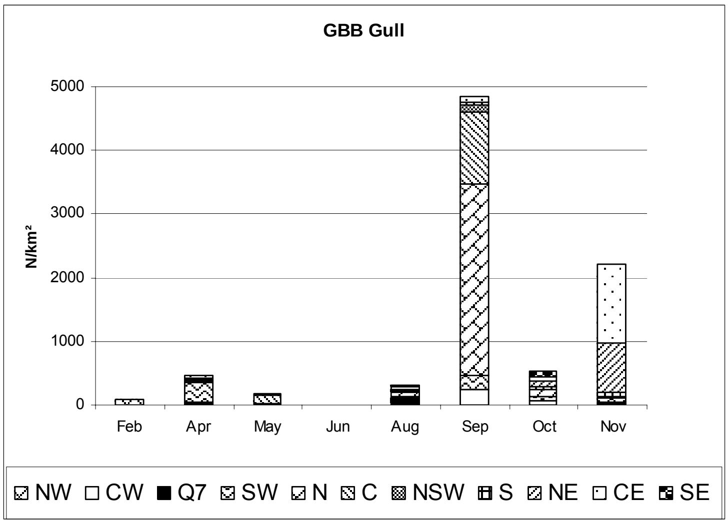
Greater Black-Backed Gull

Measured

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C	0	17 ± 153	122 ± 832	0	0	1138 ± 9552	6 ± 34	6 ± 34
CE	0	40 ± 243	17 ± 68	0	56 ± 186	77 ± 265	57 ± 219	1238 ± 5085
CW	0	6 ± 30	2 ± 14	0	8 ± 39	247 ± 1356	52 ± 293	0
N	5 ± 36	25 ± 280	0	2 ± 21	70 ± 464	3004 ± 16231	112 ± 390	54 ± 160
NE	0	25 ± 150	0	0	15 ± 43	8 ± 33	97 ± 307	771 ± 2509
NSW	0	0	4 ± 24	0	6 ± 27	109 ± 418	0	11 ± 49
NW	86 ± 678	29 ± 200	4 ± 30	2 ± 19	6 ± 42	0	4 ± 33	14 ± 61
Q7	5 ± 32	0	2 ± 14	0	93 ± 377	2 ± 12	0	3 ± 17
S	0	11 ± 107	8 ± 50	0	10 ± 50	40 ± 120	35 ± 101	79 ± 395
SE	0	0	6 ± 47	0	14 ± 48	14 ± 49	95 ± 258	414 ± 1997
SW	3 ± 22	317 ± 1409	14 ± 122	0	29 ± 252	214 ± 1649	69 ± 164	38 ± 186

Modelled

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C		20 ± 7			29 ± 2	914 ± 830	48 ± 5	43 ± 31
CE		5 ± 2			34 ± 2	48 ± 39	75 ± 6	1073 ± 688
CW		55 ± 19			17 ± 1	80 ± 55	20 ± 1	6 ± 4
N		9 ± 5			38 ± 2	2452 ± 1534	72 ± 9	140 ± 206
NE		1 ± 0			19 ± 1	106 ± 55	48 ± 3	625 ± 355
NSW		3 ± 1			12 ± 1	155 ± 166	21 ± 1	90 ± 54
NW		45 ± 22			36 ± 2	439 ± 507	49 ± 5	21 ± 8
Q7		23 ± 7			14 ± 1	370 ± 155	19 ± 1	6 ± 4
S		51 ± 27			38 ± 2	93 ± 106	57 ± 6	87 ± 96
SE		13 ± 6			37 ± 2	6 ± 4	72 ± 6	437 ± 273
SW		182 ± 94			32 ± 1	213 ± 167	36 ± 4	4 ± 2



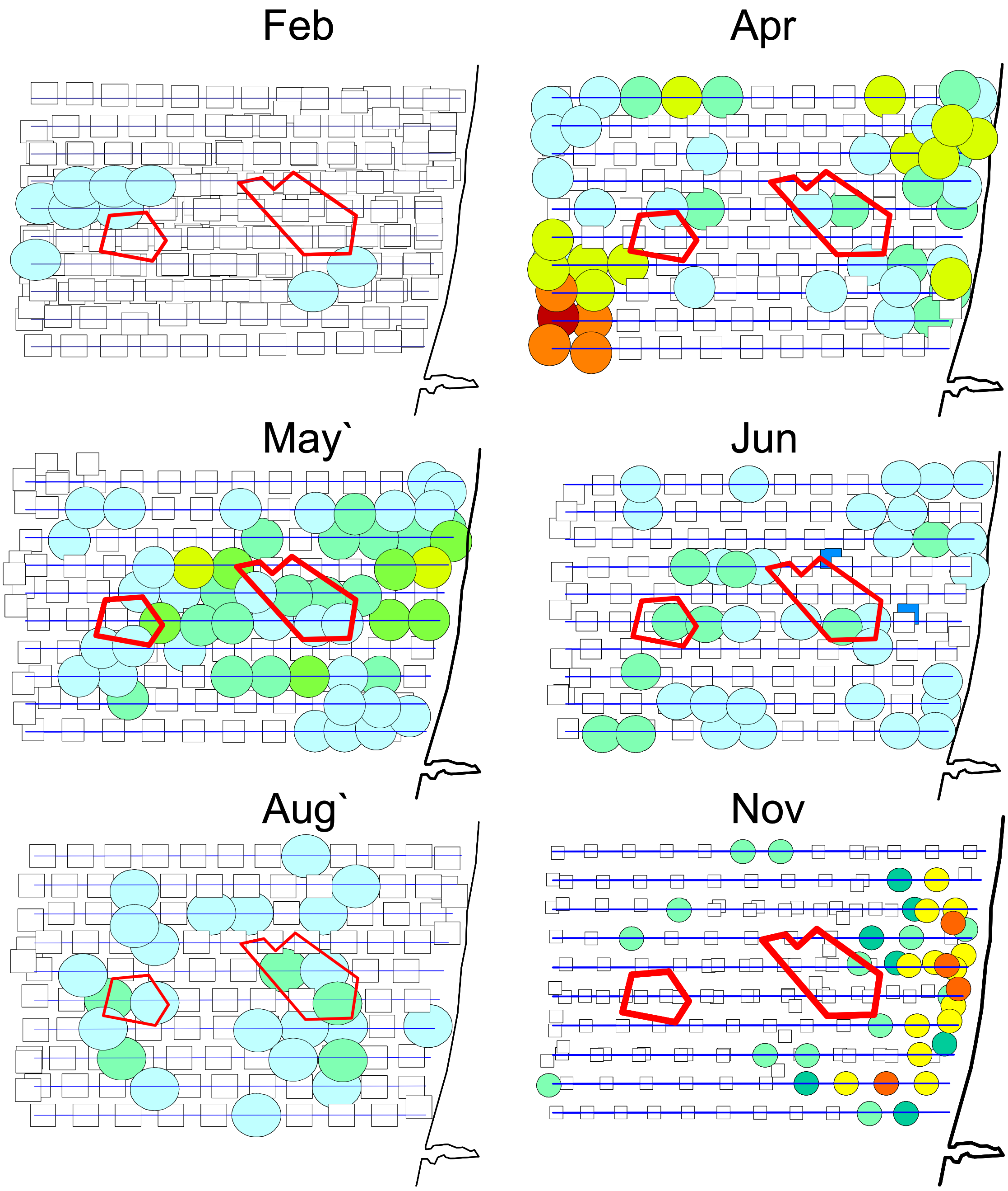
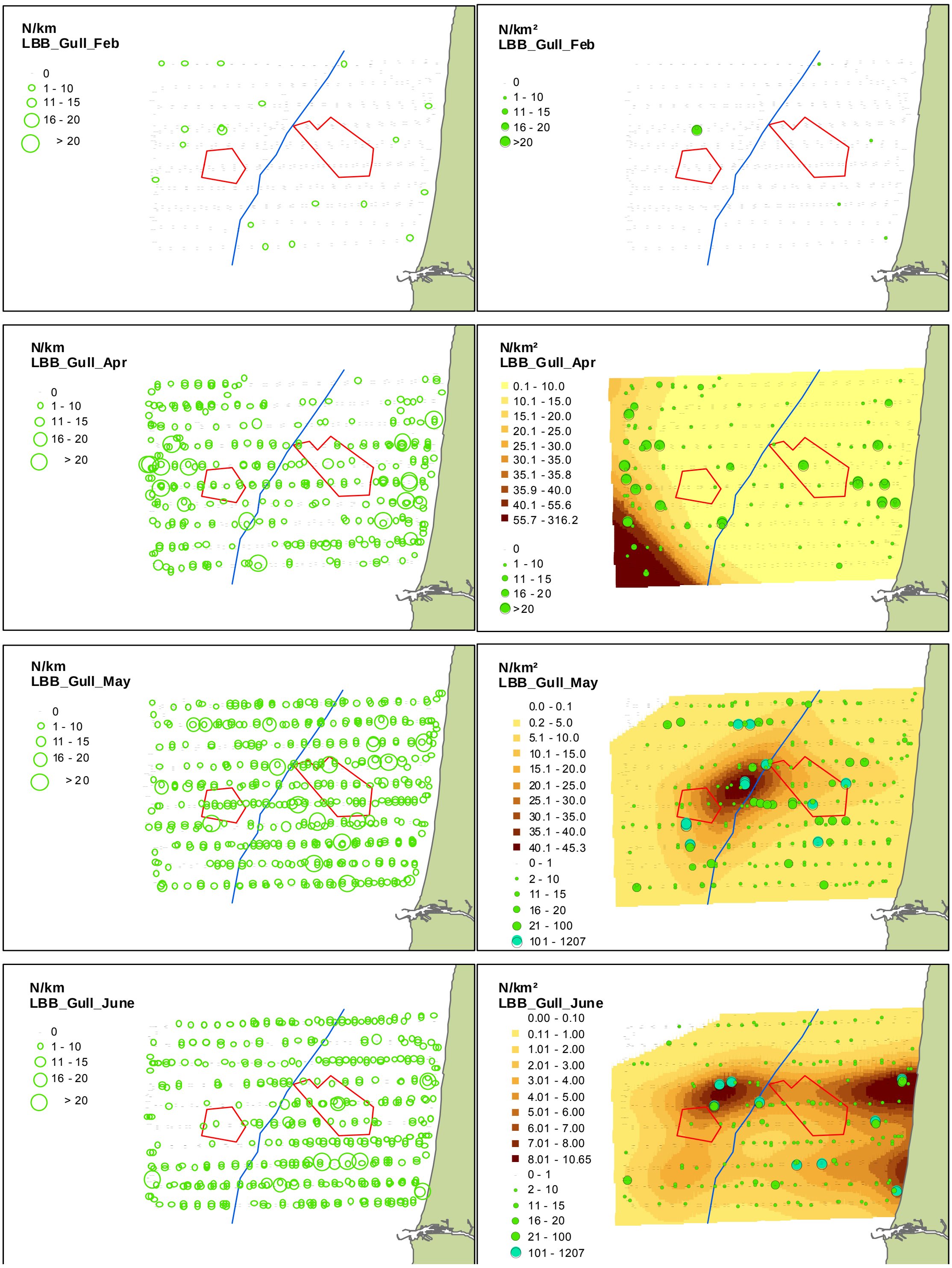
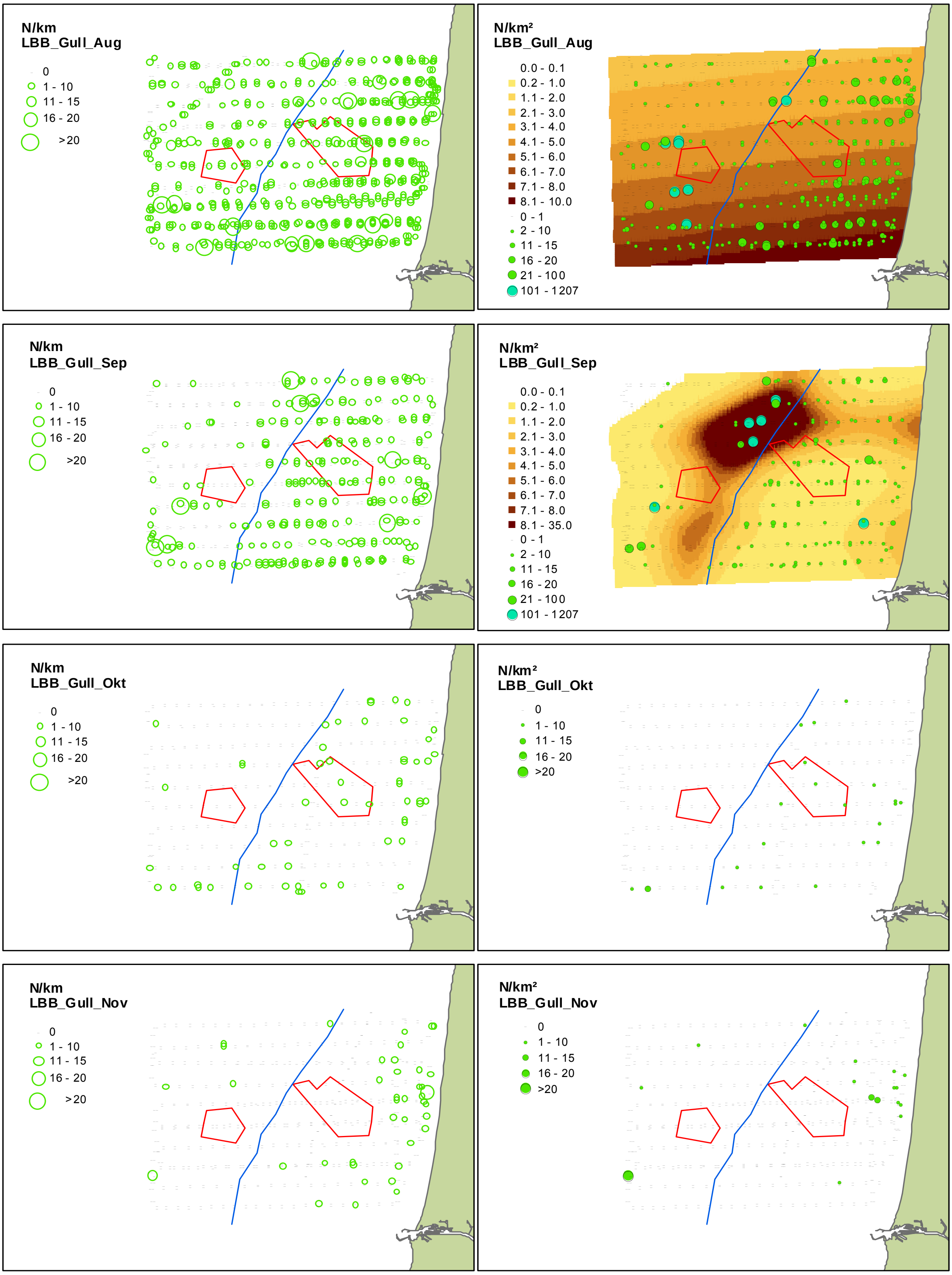


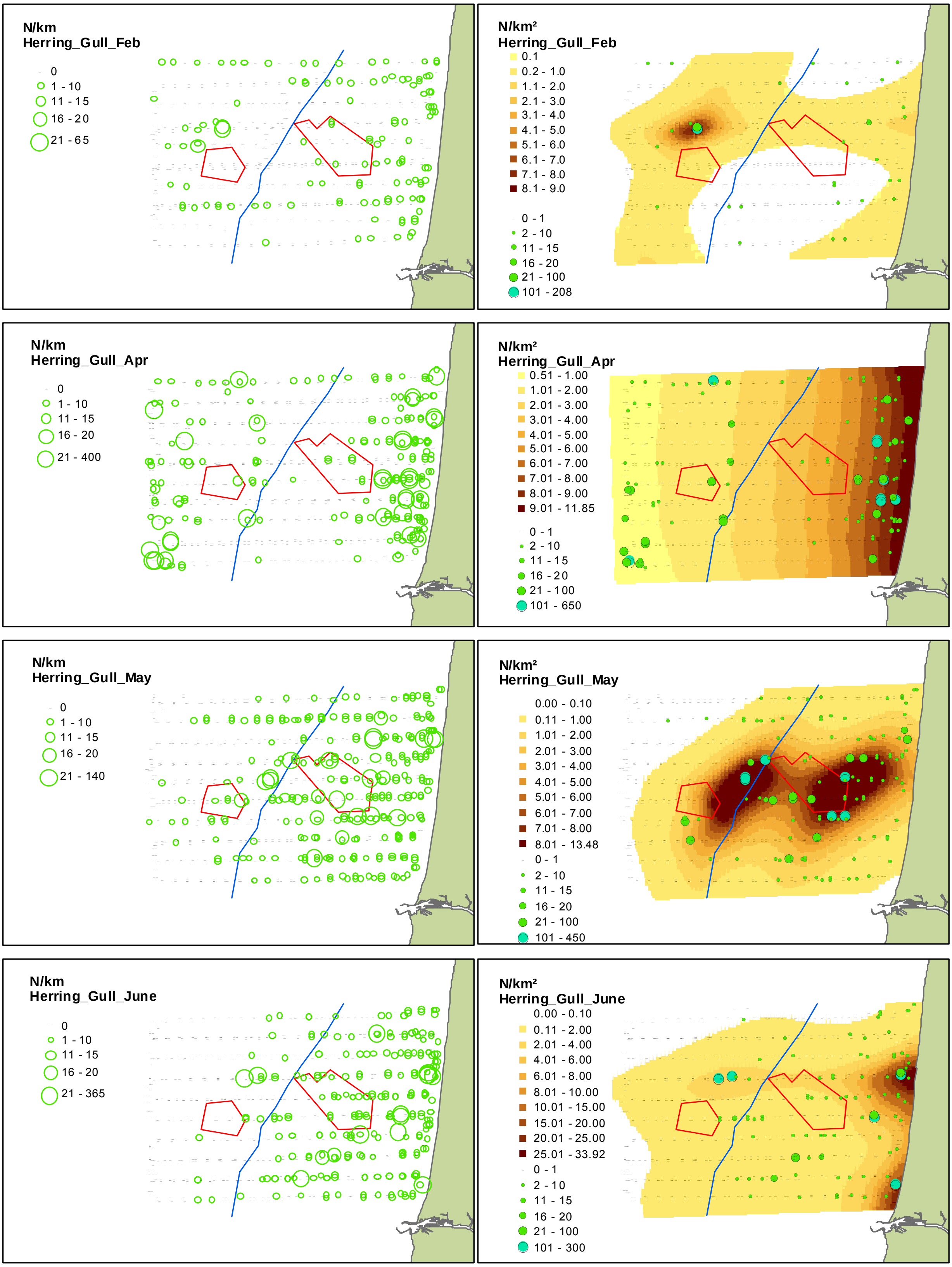
Figure 6:
# of active boats
within 2 nm; no data
for Oct, Nov (2002)



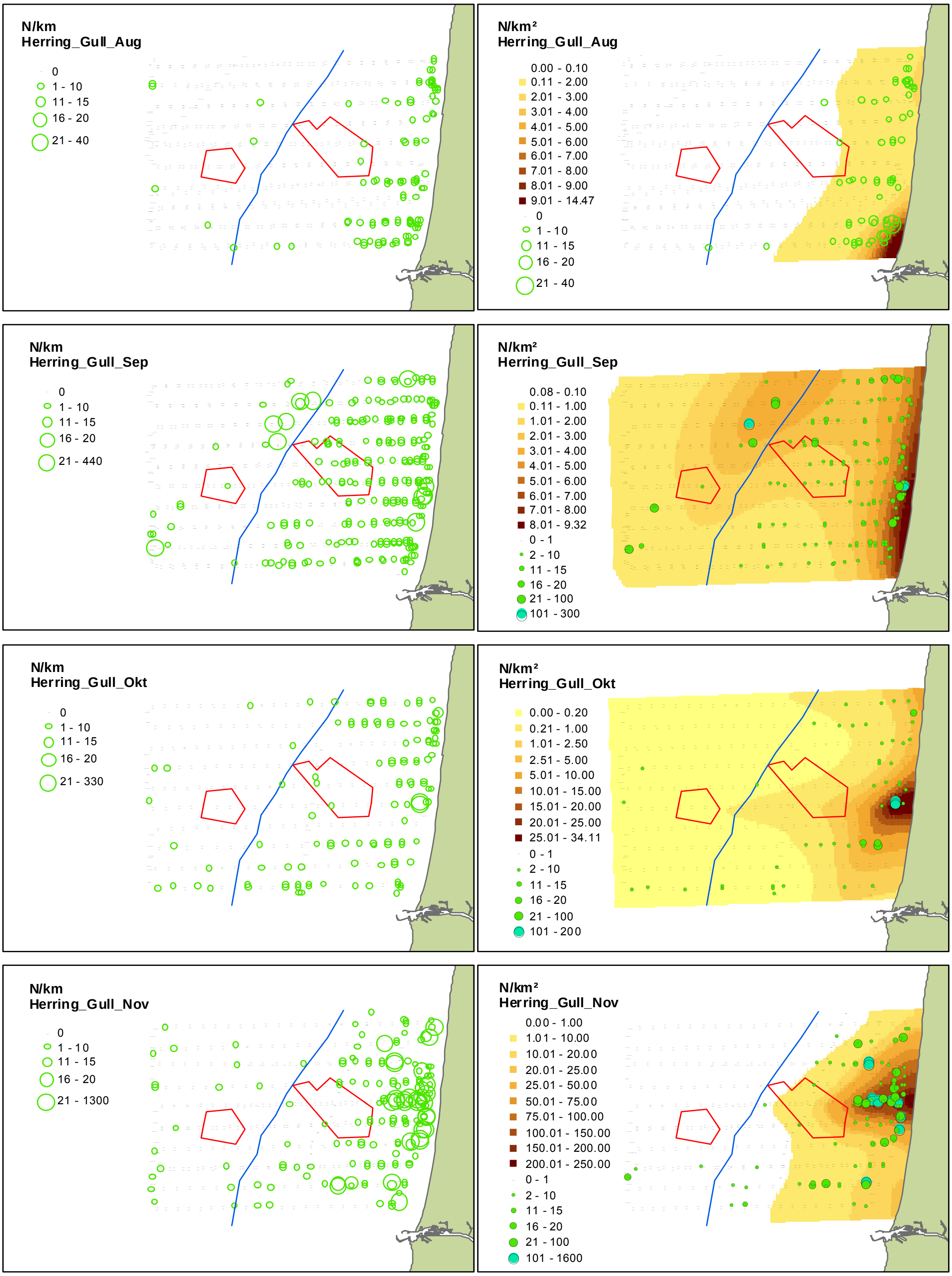
Maps Lesser Black-backed Gull 1 & 2 (this page and overleaf). Total **distribution** (left panels) is mapped by calculating total numbers seen per km traveled (open circles). **Densities** (right panels; filled circles) are calculated as the sum of all birds seen “in transect” divided by the surface area watched per 5 minute count. Model results (where appropriate) are also given in the right-hand panels, as shades of brown (high densities) to yellow (low densities). A set of two maps is given for each survey separately. Note that datapoints with extremely high densities have been depicted



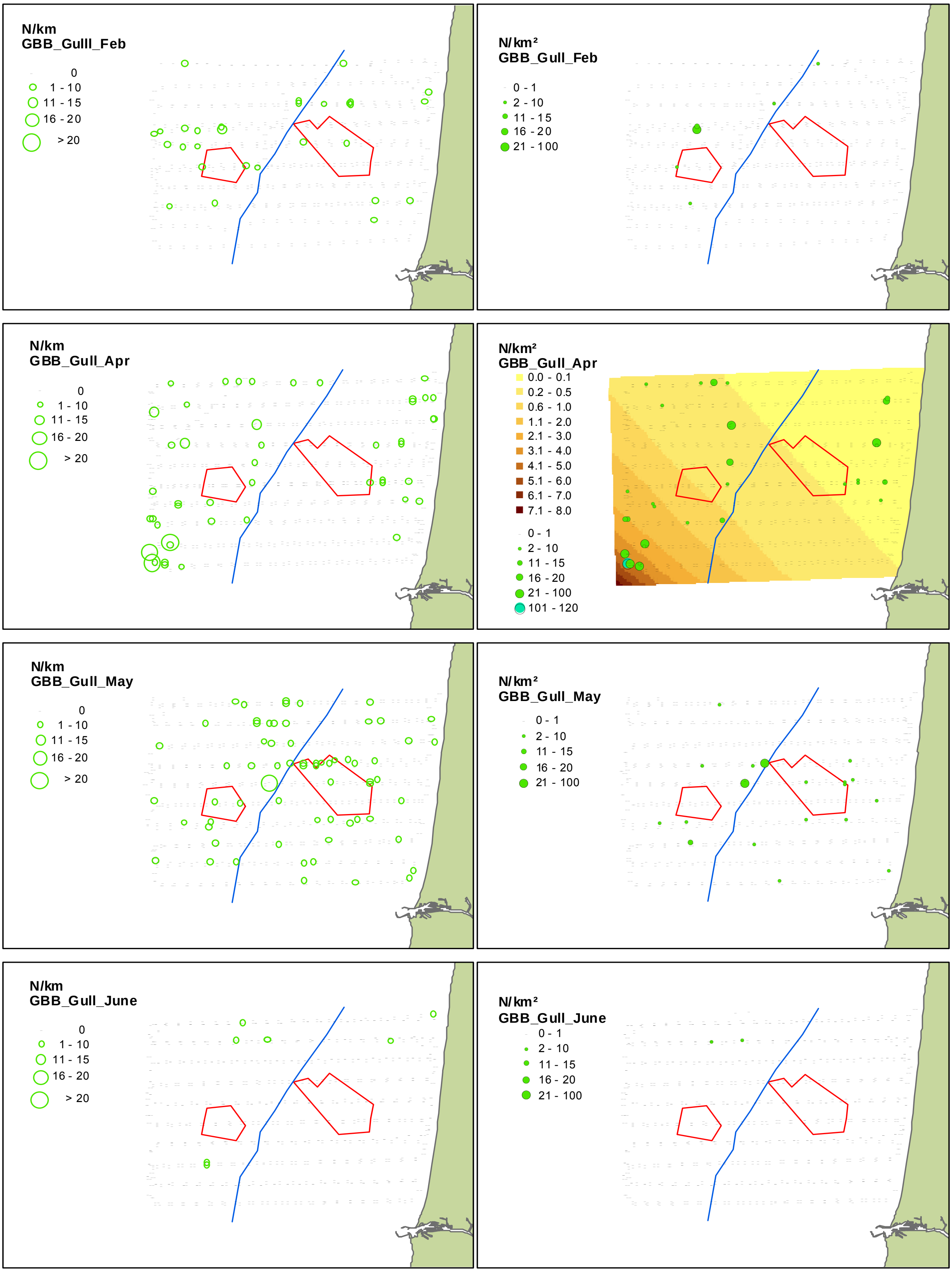
N/km
LBB_Gull_Aug
0
1 - 10
11 - 15
16 - 20
>20
N/km²
LBB_Gull_Aug
0.0 - 0.1
0.2 - 1.0
1.1 - 2.0
2.1 - 3.0
3.1 - 4.0
4.1 - 5.0
5.1 - 6.0
6.1 - 7.0
7.1 - 8.0
8.1 - 10.0
0 - 1
2 - 10
11 - 15
16 - 20
21 - 100
101 - 1207
N/km
LBB_Gull_Sep
0
1 - 10
11 - 15
16 - 20
>20
N/km²
LBB_Gull_Sep
0.0 - 0.1
0.2 - 1.0
1.1 - 2.0
2.1 - 3.0
3.1 - 4.0
4.1 - 5.0
5.1 - 6.0
6.1 - 7.0
7.1 - 8.0
8.1 - 35.0
0 - 1
2 - 10
11 - 15
16 - 20
21 - 100
101 - 1207
N/km
LBB_Gull_Okt
0
1 - 10
11 - 15
16 - 20
>20
N/km²
LBB_Gull_Okt
0
1 - 10
11 - 15
16 - 20
>20
N/km
LBB_Gull_Nov
0
1 - 10
11 - 15
16 - 20
>20
N/km²
LBB_Gull_Nov
0
1 - 10
11 - 15
16 - 20
>20



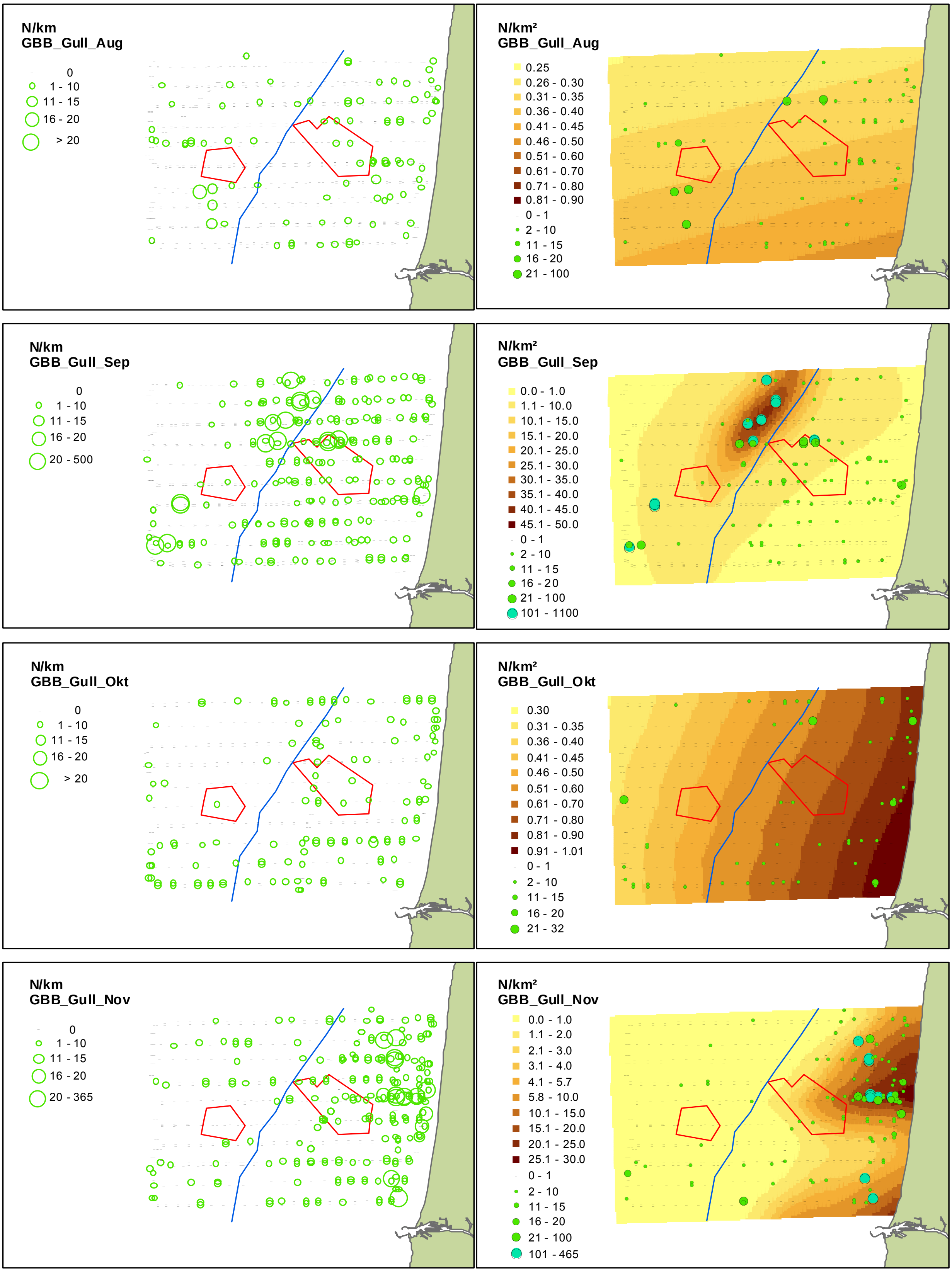
Maps Herring Gull 1 & 2 (this page and overleaf). Total **distribution** (left panels) is mapped by calculating total numbers seen per km traveled (open circles). **Densities** (right panels; filled circles) are calculated as the sum of all birds seen "in transect" divided by the surface area watched per 5 minute count. Model results (where appropriate) are also given in the right-hand panels, as shades of brown (high densities) to yellow (low densities). A set of two maps is given for each survey separately. Note that datapoints with extremely high densities have been depicted by using a different color.



N/km
Herring_Gull_Aug
0
1 - 10
11 - 15
16 - 20
21 - 40
N/km²
Herring_Gull_Aug
0.00 - 0.10
0.11 - 2.00
2.01 - 3.00
3.01 - 4.00
4.01 - 5.00
5.01 - 6.00
6.01 - 7.00
7.01 - 8.00
8.01 - 9.00
9.01 - 14.47
0
1 - 10
11 - 15
16 - 20
21 - 40
N/km
Herring_Gull_Sep
0
1 - 10
11 - 15
16 - 20
21 - 440
N/km²
Herring_Gull_Sep
0.08 - 0.10
0.11 - 1.00
1.01 - 2.00
2.01 - 3.00
3.01 - 4.00
4.01 - 5.00
5.01 - 6.00
6.01 - 7.00
7.01 - 8.00
8.01 - 9.32
0 - 1
2 - 10
11 - 15
16 - 20
21 - 100
101 - 300
N/km
Herring_Gull_Okt
0
1 - 10
11 - 15
16 - 20
21 - 330
N/km²
Herring_Gull_Okt
0.00 - 0.20
0.21 - 1.00
1.01 - 2.50
2.51 - 5.00
5.01 - 10.00
10.01 - 15.00
15.01 - 20.00
20.01 - 25.00
25.01 - 34.11
0 - 1
2 - 10
11 - 15
16 - 20
21 - 100
101 - 200
N/km
Herring_Gull_Nov
0
1 - 10
11 - 15
16 - 20
21 - 1300
N/km²
Herring_Gull_Nov
0.00 - 1.00
1.01 - 10.00
10.01 - 20.00
20.01 - 25.00
25.01 - 50.00
50.01 - 75.00
75.01 - 100.00
100.01 - 150.00
150.01 - 200.00
200.01 - 250.00
0 - 1
2 - 10
11 - 15
16 - 20
21 - 100
101 - 1600



Maps Greater Black-backed Gull 1 & 2 (this page and overleaf). Total **distribution** (left panels) is mapped by calculating total numbers seen per km traveled (open circles). **Densities** (right panels; filled circles) are calculated as the sum of all birds seen "in transect" divided by the surface area watched per 5 minute count. Model results (where appropriate) are also given in the right-hand panels, as shades of brown (high densities) to yellow (low densities). A set of two maps is given for each survey separately. Note that datapoints with extremely high densities have been depicted by using a different color.


N/km
GBB_Gull_Aug
0
1 - 10
11 - 15
16 - 20
> 20
N/km²
GBB_Gull_Aug
0.25
0.26 - 0.30
0.31 - 0.35
0.36 - 0.40
0.41 - 0.45
0.46 - 0.50
0.51 - 0.60
0.61 - 0.70
0.71 - 0.80
0.81 - 0.90
0 - 1
2 - 10
11 - 15
16 - 20
21 - 100
N/km
GBB_Gull_Sep
0
1 - 10
11 - 15
16 - 20
20 - 500
N/km²
GBB_Gull_Sep
0.0 - 1.0
1.1 - 10.0
10.1 - 15.0
15.1 - 20.0
20.1 - 25.0
25.1 - 30.0
30.1 - 35.0
35.1 - 40.0
40.1 - 45.0
45.1 - 50.0
0 - 1
2 - 10
11 - 15
16 - 20
21 - 100
101 - 1100
N/km
GBB_Gull_Okt
0
1 - 10
11 - 15
16 - 20
> 20
N/km²
GBB_Gull_Okt
0.30
0.31 - 0.35
0.36 - 0.40
0.41 - 0.45
0.46 - 0.50
0.51 - 0.60
0.61 - 0.70
0.71 - 0.80
0.81 - 0.90
0.91 - 1.01
0 - 1
2 - 10
11 - 15
16 - 20
21 - 32
N/km
GBB_Gull_Nov
0
1 - 10
11 - 15
16 - 20
20 - 365
N/km²
GBB_Gull_Nov
0.0 - 1.0
1.1 - 2.0
2.1 - 3.0
3.1 - 4.0
4.1 - 5.7
5.8 - 10.0
10.1 - 15.0
15.1 - 20.0
20.1 - 25.0
25.1 - 30.0
0 - 1
2 - 10
11 - 15
16 - 20
21 - 100
101 - 465

Kittiwake *Rissa tridactyla*

Kittiwakes *Rissa tridactyla*, like Greater Black-backed Gulls do not breed in the Netherlands and are mainly winter visitors. They may be seen as a pelagic, open sea species when not tied to the breeding colonies (Stone *et al.* 1995) that normally occur in low densities in Dutch coastal waters (Camphuysen & van Dijk 1983; Baptist & Wolf 1993; Camphuysen & Leopold 1994; Platteeuw *et al.* 1994). Numbers are particularly low in the breeding season and avoid coastal waters at most times, but may be storm-driven into Dutch nearshore winters. They do join fishing vessels to feed, but are easily out-competed by the larger *Larus* gulls and must often resort to feeding very close to the stern, where the larger, less agile gulls dare not go (Camphuysen *et al.* 1995)

Long-term trend and variation

Between surveys in successive years, Kittiwakes show no trend in occurrence in most survey periods (Appendix 3) but a remarkable "jump" is apparent in the Feb/Mar series in 1996 (but note low sample sizes). Densities in the SE North Sea are probably mainly governed by developments elsewhere, particularly in the northern North Sea where large-scale breeding failures in recent years, after two decades of increasing numbers of breeders, probably mark a major turning point in developments. If conditions in the north remain poor, influxes followed by wrecks may be expected in Dutch waters in the near future.

Phenology

Kittiwakes were indeed rare of even absent in summer (Table 41; Maps Kittiwake). From October to February the species was more numerous. Kittiwakes stayed mainly in the deeper parts of the study area, but sometimes ventured closer inshore (particularly in November) and flocked around fishing vessels.

Table 41. Total numbers of Kittiwakes seen in all surveys in the nearshore (0-20 m deep) and offshore parts of the study area. The total numbers seen in association with fishing vessels are given separately, on the right. Note that large numbers of Kittiwakes visited trawlers in nearshore waters in November.

month	0-20 m	>20 m	with trawlers 0-20 m	with trawlers >20 m
2	28	80	0	24
4	25	169	0	46
5	1	47	0	23
6		0	0	0
8	1	6	0	0
9	3	12	0	0
10	58	131	0	1
11	843	441	7	338

Flying heights

Kittiwakes rarely got up to rotor heights and usually kept to lower airspace (Table 42).

Table 42. Distribution of flying heights of Black-headed and Common Gulls taken together, in the study area, over the months as assessed during our surveys (no data on altitude recorded in September or October).

month	0-2	2-10	10-25	25-50	50-100	100-200	>200 m asl
2		14	30	7			
4		8	25	12			
5		12	11				
6							
8		4	1				
9		2	5	1			
10	21	75	45	8			
11	11	120	198	27			
Totals	**32**	**235**	**315**	**55**	**0**	**0**	**0**

Feeding behaviour

Many Kittiwakes were apparently looking for feeding opportunities when present in the study area. Some 149 birds were engaged in natural feeding modes (taking prey from the surface or a little deeper), while most seen feeding did so around fishing vessels. Large numbers were also not feeding at the time but resting or maintaining their plumage (Table 43), but 168 of the 239 "resting" ones did so in the wake of a trawler, presumably after feeding there.

Table 43. Total numbers of Kittiwakes (summed over all surveys) engaged in different types of behaviour.

Actively searching	263
Dipping	85
Shallow plunging	16
Surface pecking	24
Surface seizing	4
Scavenging	20
Scavenging at fishing vessel	188
Preening or bathing	50
Resting or apparently asleep	239

Distribution patterns, numbers and densities; occurrence in NSW and Q7

The distribution maps for Kittiwakes show that they may occur anywhere in the study area, but occur mostly in low densities. Only in November were numbers relatively high and at that time, flocks of considerable size may also occur at future windfarm sites. In the other survey months Kittiwakes were mostly found in the western half of the study area (in October relatively many were seen along one of the northernmost transects and although this greatly affected model outcomes, this should be seen as a-typical). Most Kittiwakes were associated with fishing vessels, however (to be expelled when the parks become operational) and most did not fly at rotor heights, so this species should probably considered a low-risk one. Total estimated numbers in all DONAR blocks are given in Table 44.

Table 44. Estimated total numbers of Kittiwakes for the 11 DONAR polygons (see Figure 1). The upper panel gives total numbers based on the field measurements (average density per DONAR polygon multiplied with the polygon surface area). Modelled totals are only available for months with sufficient data (25 or more 5-minute counts with at least one bird inside the counting strip) and are based on the average (± 1 SD) densities per 250x250 m grid cell. In the graph below the numbers from the upper panel (Measured) are graphically presented.

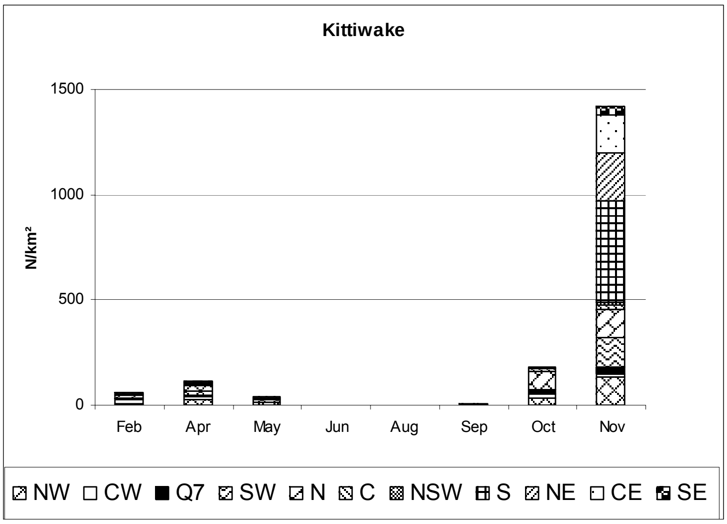
Kittiwake

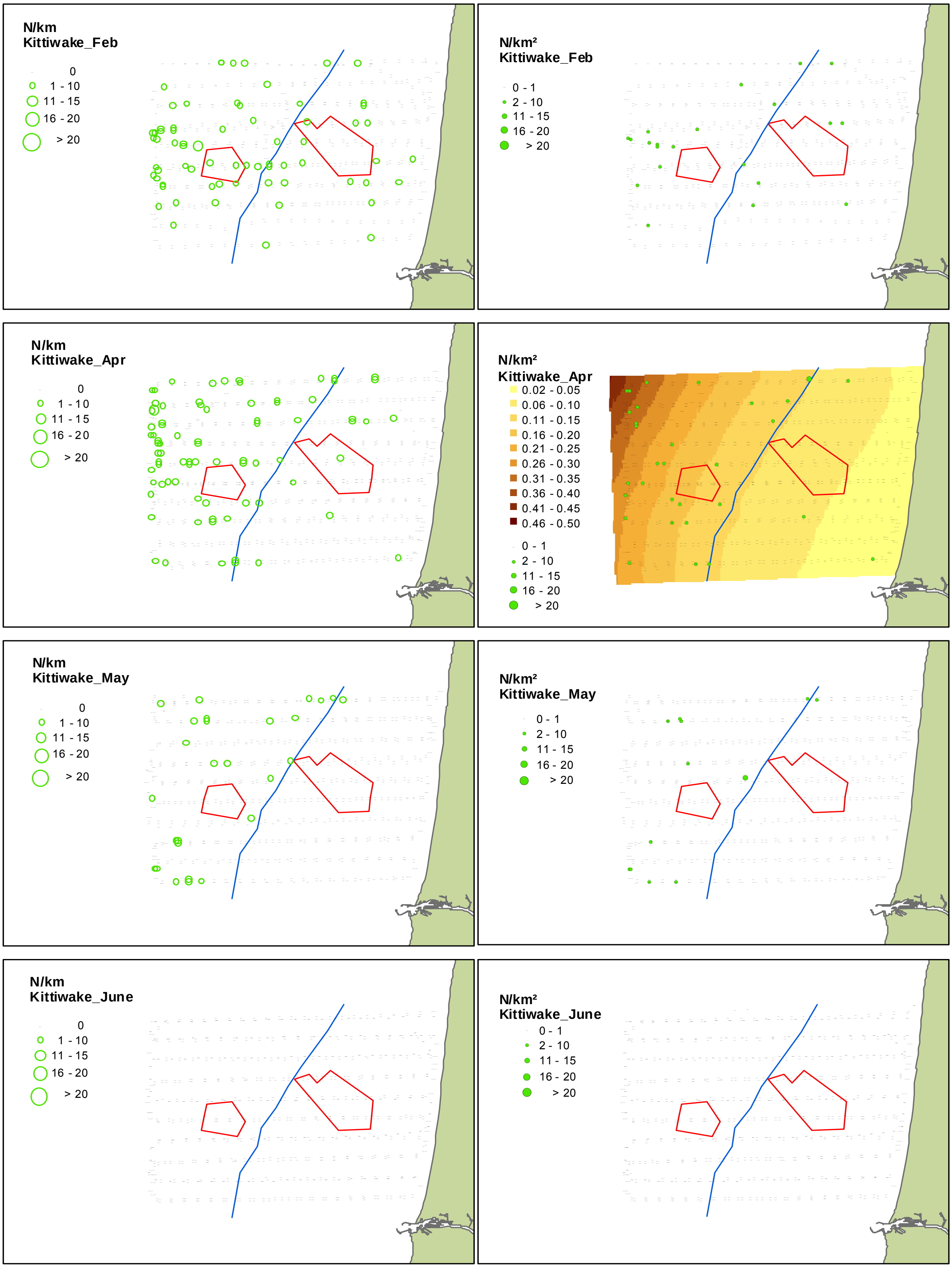
Measured

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C	6 ± 45	0	12 ± 112	0	0	0	10 ± 44	25 ± 63
CE	2 ± 21	0	0	0	0	0	0	181 ± 1090
CW	18 ± 48	10 ± 40	0	0	0	0	21 ± 62	12 ± 43
N	13 ± 59	30 ± 162	4 ± 34	0	0	2 ± 25	91 ± 289	131 ± 499
NE	0	0	0	0	0	0	3 ± 21	230 ± 1043
NSW	0	0	0	0	0	0	0	14 ± 50
NW	10 ± 67	27 ± 125	15 ± 100	0	2 ± 23	6 ± 70	33 ± 102	134 ± 637
Q7	0	13 ± 55	0	0	0	0	17 ± 56	32 ± 99
S	4 ± 27	10 ± 68	0	0	0	0	4 ± 28	478 ± 1780
SE	3 ± 24	7 ± 70	0	0	0	0	0	36 ± 155
SW	3 ± 24	17 ± 83	12 ± 46	0	0	0	0	144 ± 527

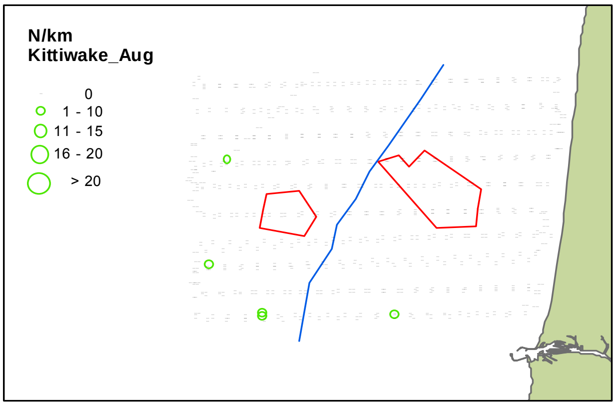
Modelled

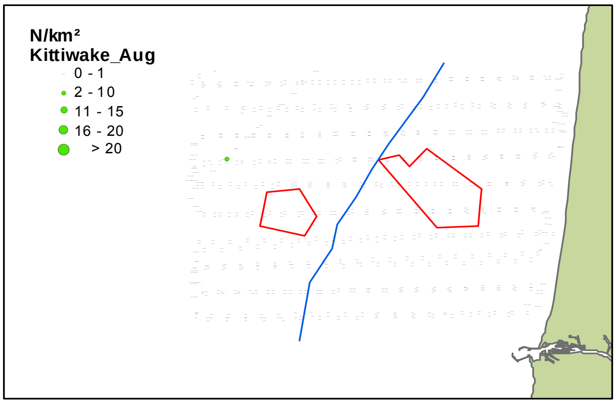
Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C		9 ± 2					10 ± 7	119 ± 24
CE		4 ± 1					11 ± 7	98 ± 59
CW		12 ± 2					8 ± 5	29 ± 6
N		14 ± 4					46 ± 26	221 ± 106
NE		3 ± 1					20 ± 11	110 ± 41
NSW		3 ± 0					6 ± 2	66 ± 17
NW		33 ± 8					54 ± 32	97 ± 30
Q7		6 ± 1					5 ± 4	30 ± 6
S		7 ± 2					1 ± 0	391 ± 128
SE		3 ± 1					1 ± 0	111 ± 87
SW		15 ± 3					2 ± 0	167 ± 73

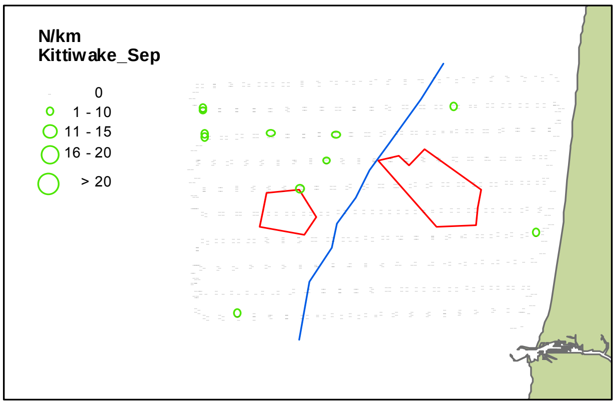


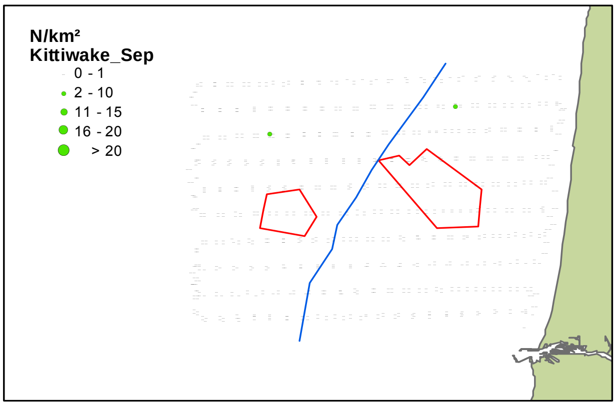


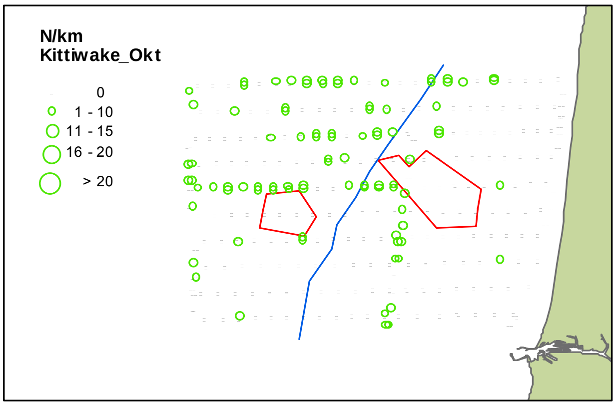
Maps Kittiwake 1 & 2 (this page and overleaf). Total **distribution** (left panels) is mapped by calculating total numbers seen per km traveled (open circles). **Densities** (right panels; filled circles) are calculated as the sum of all birds seen “in transect” divided by the surface area watched per 5 minute count. Model results (where appropriate) are also given in the right-hand panels, as shades of brown (high densities) to yellow (low densities). A set of two maps is given for each survey separately.

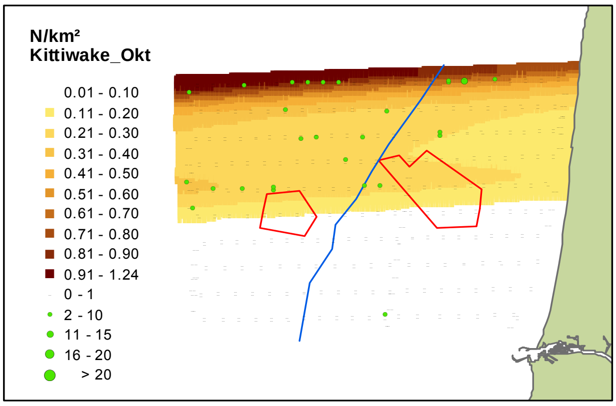

N/km
Kittiwake_Aug
0
1 - 10
11 - 15
16 - 20
> 20

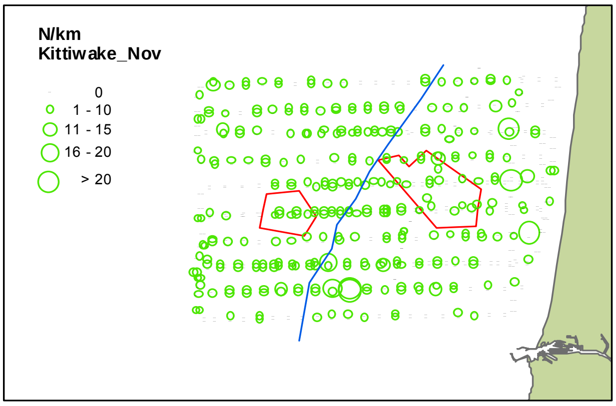

N/km²
Kittiwake_Aug
0 - 1
2 - 10
11 - 15
16 - 20
> 20

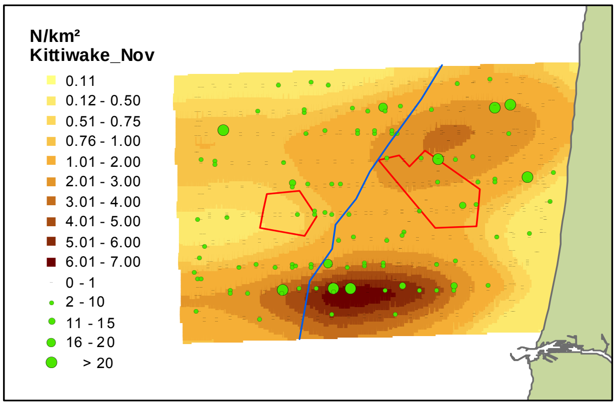

N/km
Kittiwake_Sep
0
1 - 10
11 - 15
16 - 20
> 20


N/km²
Kittiwake_Sep
0 - 1
2 - 10
11 - 15
16 - 20
> 20


N/km
Kittiwake_Okt
0
1 - 10
11 - 15
16 - 20
> 20


N/km²
Kittiwake_Okt
0.01 - 0.10
0.11 - 0.20
0.21 - 0.30
0.31 - 0.40
0.41 - 0.50
0.51 - 0.60
0.61 - 0.70
0.71 - 0.80
0.81 - 0.90
0.91 - 1.24
0 - 1
2 - 10
11 - 15
16 - 20
> 20


N/km
Kittiwake_Nov
0
1 - 10
11 - 15
16 - 20
> 20


N/km²
Kittiwake_Nov
0.11
0.12 - 0.50
0.51 - 0.75
0.76 - 1.00
1.01 - 2.00
2.01 - 3.00
3.01 - 4.00
4.01 - 5.00
5.01 - 6.00
6.01 - 7.00
0 - 1
2 - 10
11 - 15
16 - 20
> 20

Sandwich Tern *Sterna sandvicensis*

Terns are summer visitor in the North Sea region. Adults come to our waters to breed in summer, while young birds largely remain in the African wintering quarters during the first (northern) summer after they were born (Møller 1981; Brenninkmeijer & Stienen 1997; Wernham *et al.* 2002). Along the Dutch coast, the first Sandwich Terns arrive in March and the last normally leave again by October/November (Camphuysen & van Dijk 1983; Platteeuw *et al.* 1994). As the nearest breeding colonies are situated in the Wadden Sea and Delta area, and because Sandwich Terns are present off Noord-Holland, which is beyond foraging range of breeders, all summer, birds seen in the study area during the breeding season are either non-breeders or early or late migrating birds.

Long-term trend and variation
Between surveys in successive years, Sandwich Tern numbers in the study area, as assessed by aerial surveys show much variation. Most remarkable perhaps, is the (near) total absence of Sandwich Terns in some years, in spring and summer. Such incidents are not corroborated by seawatching results (Dutch Seabird Group database) or population developments in the Dutch breeding colonies, and may thus be related to chance and small sample sizes.

Phenology
Sandwich Terns were absent from October through February. Peak numbers were seen during spring (April) and autumn (or rather: late summer, August) migration (Maps Sandwich Tern). Much smaller numbers, probably mainly non-breeding sub-adult birds, were seen over the summer. In September numbers had already dropped considerably (Table 45). From May through September, Sandwich Terns had a coastal distribution, conform earlier surveys. In April however, Sandwich Terns were encountered all over the the study area, a phenomenon that has been recorded before, particularly from aerial surveys (Baptist & Wolf 1993). In the case of the present April survey the Sandwich Terns seemed to occur in offshore waters in larger relative numbers than normal, which was also seen for other, normally coastal species such as divers and Little Gulls.

Table 45. Total numbers of Sandwich Terns seen in all surveys in the nearshore (0-20 m deep) and offshore parts of the study area.

month	0-20 m	>20 m
2	0	0
4	132	128
5	69	6
6	73	1
8	272	5
9	31	1
10	0	0
11	0	0

Flying heights

Sandwich Terns are very aerial birds that spent very little time swimming, at least in temperate waters. Of all birds that were noted as touching the water, only 6 (in April) were actually resting at sea, one parent (September) was feeding a young bird, alighting briefly at sea and one other bird crashed into the sea while trying to get away from a chasing Arctic Skua *Stercorarius parasiticus*, also in September. All other "swimming" Sandwich Terns did so very briefly only, while performing shallow or deeper plunge dives to catch fish. Actual percentages of birds in flight are therefore even higher than as given in Table 46. Flying heights were typically not very high, only some spring and autumn birds got over 25 m asl and only two were spotted flying higher than 50 m asl (Table 47).

Table 46. Total numbers of Sandwich Terns seen flying, respectively swimming in all surveys periods.

month	n-flying	n-swimming or plunge-diving	% in flight
2			
4	207	53	80
5	67	8	89
6	59	15	80
8	272	5	98
9	27	5	84
10			
11			
Totals	**632**	**86**	**88**

Table 47. Distribution of flying heights of Sandwich Terns in the study area, over the months as assessed during our surveys (no data on altitude recorded in September or October).

month	0-2	2-10	10-25	25-50	50-100	100-200	>200 m asl
2							
4	5	41	79	9			
5	3	43	13				
6	6	18	22				
8		47	110	6	2		
9	1	3	9	2			
10							
11							
Totals	**15**	**152**	**233**	**17**	**2**	**0**	**0**

Feeding behaviour

Several different types of feeding behaviour were noted over the surveys. Most foraging birds were looking for feeding opportunities (flying with bill pointing down, which is clearly visible in Sandwich Terns), or plunge-diving for small fish. One adult in August, and two more in September were seen flying with fish in the direction of the coast, but by this time the young would have fledged so this behaviour may be equivalent to "Feeding young at sea", as noted for another bird in September (Table 48).

Table 48. Numbers of Sandwich Terns engaged in different types of (post)foraging behaviour, summed over all surveys.

Actively searching	456
Deep plunging	9
Shallow plunging	20
Dipping	7
Feeding young at sea	1
Flying with fish	3
Under attack by kleptoparasite	2
Resting or apparently asleep	6

Distribution patterns, numbers and densities; occurrence in NSW and Q7

The distribution maps of all sightings (left panels in Maps Sandwich Terns) indicate that Sandwich Terns were mostly seen over nearshore waters in most summer months, but that they would be present within the NSW and even Q7 contours in both migration periods. However, terns are birds that rely heavily on eyesight and this, together with the recorded altitudes in flight, suggest that Sandwich Terns are probably not very vulnerably. Little is known about what terns do at night, however. They do roost ashore in large numbers, in the vicinity of the study area for instance on the offshore sand-bank Razende Bol or on quiet stretches of beach, if available (Munsterman 1978; Smit *et al.* 1981; van Dijk *et al.* 1998; van Roomen *et al.* 2003). Given the rarity of swimming in terns in Dutch waters, and the difficulty that feeding would pose on these birds in darkness, it seems unlikely that Sandwich Terns remain at sea during the night. However, during mist-nets catches in the Wadden Sea in late summer, Sandwich Terns are regularly caught at night, showing that at least some movement takes place in darkness. Total estimated numbers for all DONAR blocks are given in Table 49.

Table 49. Estimated total numbers of Sandwich Terns for the 11 DONAR polygons (see Figure 1). The upper panel gives total numbers based on the field measurements (average density per DONAR polygon multiplied with the polygon surface area). Modelled totals are only available for months with sufficient data (25 or more 5-minute counts with at least one bird inside the counting strip) and are based on the average (± 1 SD) densities per 250x250 m grid cell. In the graph below the numbers from the upper panel (Measured) are graphically presented.

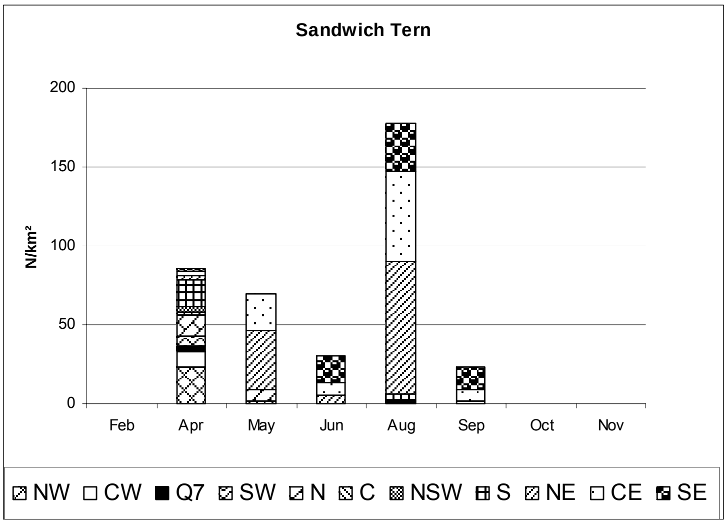
Sandwich Tern

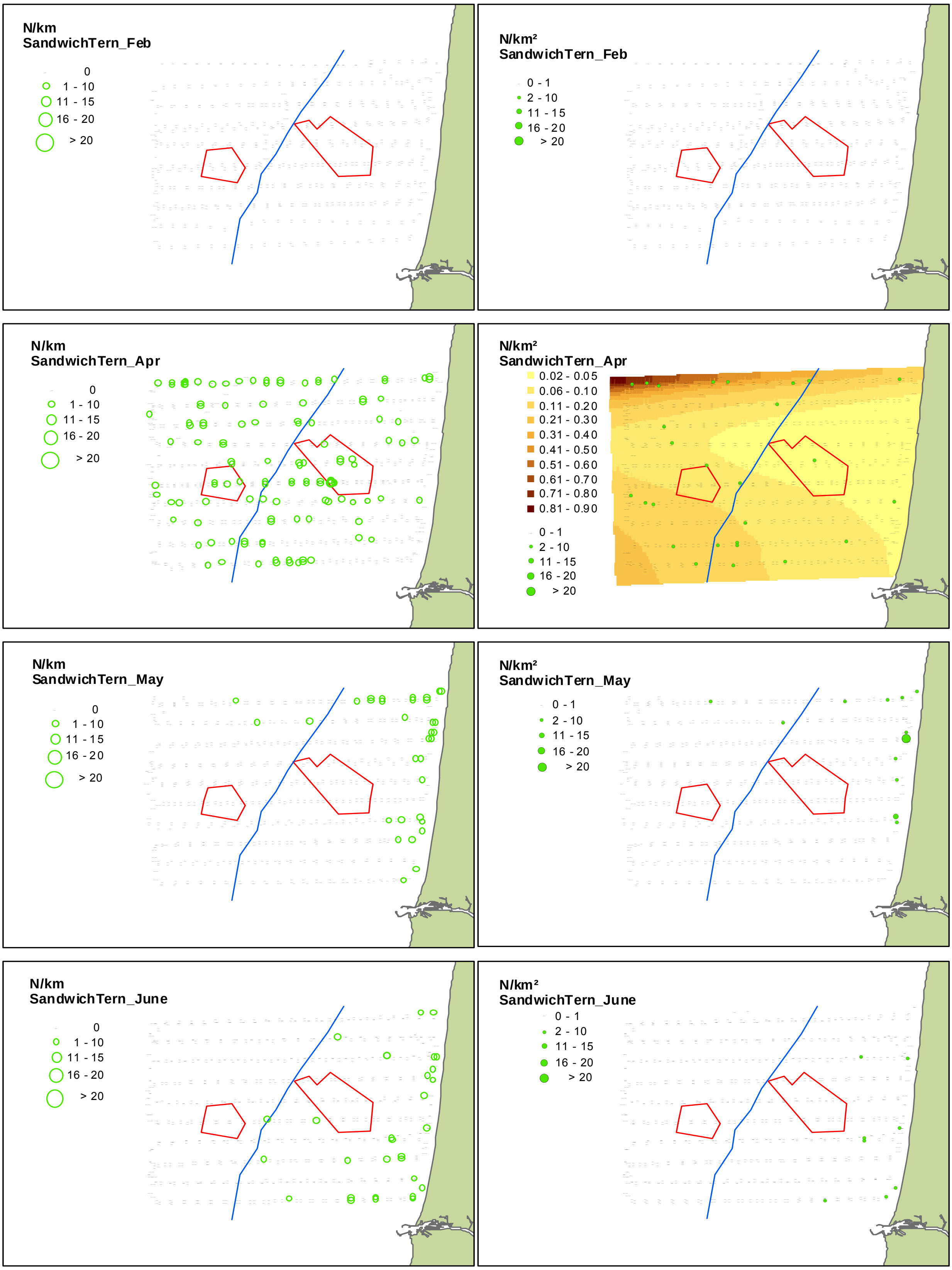
Measured

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C	0	2 ± 17	0	0	0	0	0	0
CE	0	3 ± 36	24 ± 138	8 ± 47	57 ± 427	7 ± 39	0	0
CW	0	10 ± 56	0	0	0	2 ± 13	0	0
N	0	13 ± 88	7 ± 57	0	0	0	0	0
NE	0	2 ± 15	37 ± 173	5 ± 33	84 ± 397	0	0	0
NSW	0	4 ± 24	0	0	0	0	0	0
NW	0	23 ± 119	2 ± 24	0	0	0	0	0
Q7	0	4 ± 26	0	0	2 ± 14	0	0	0
S	0	17 ± 69	0	0	4 ± 40	0	0	0
SE	0	2 ± 19	0	17 ± 93	31 ± 142	14 ± 91	0	0
SW	0	6 ± 42	0	0	0	0	0	0

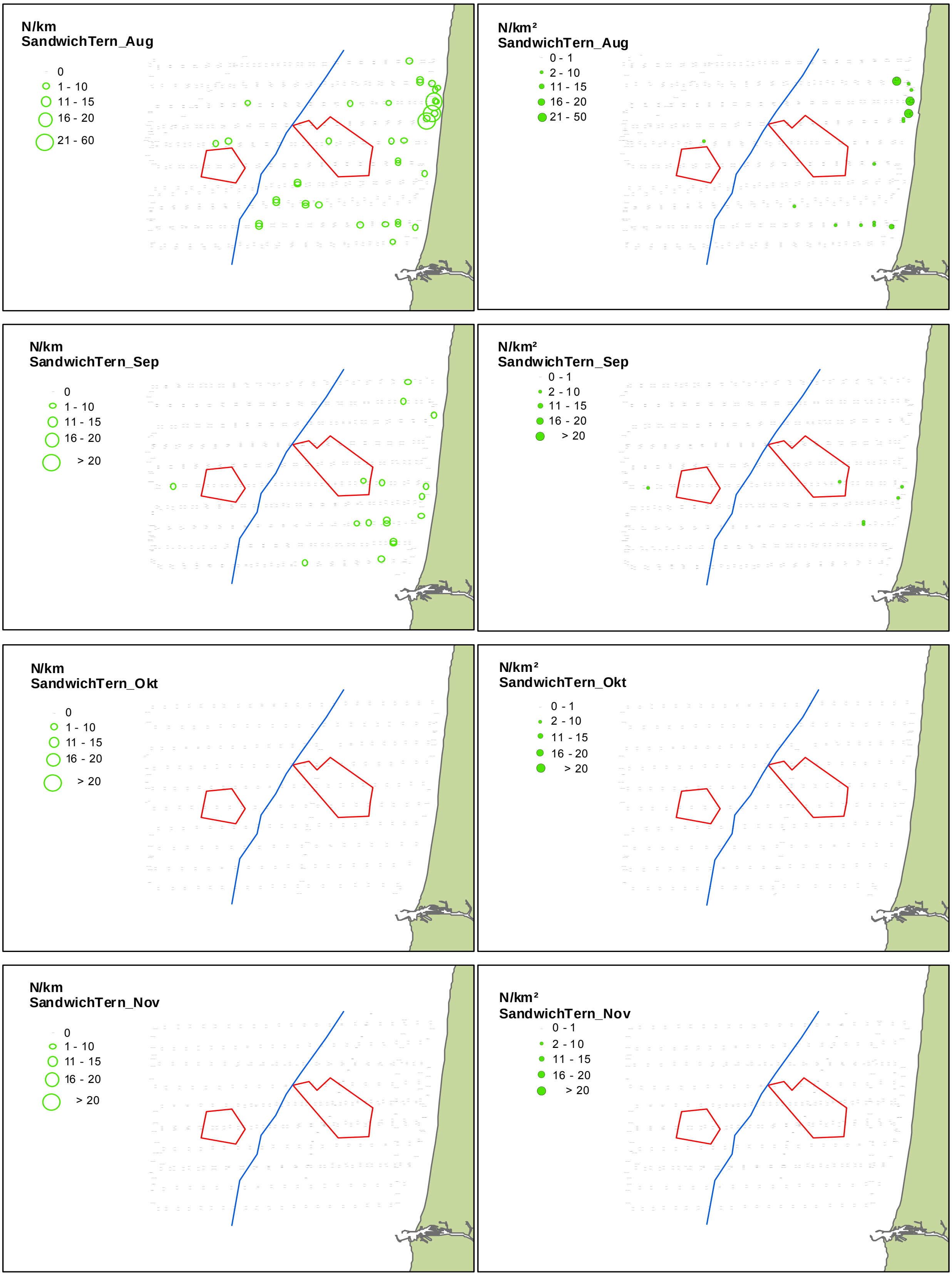
Modelled

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C		5 ± 1						
CE		3 ± 1						
CW		6 ± 2						
N		13 ± 11						
NE		4 ± 3						
NSW		1 ± 0						
NW		23 ± 21						
Q7		4 ± 1						
S		9 ± 2						
SE		5 ± 1						
SW		15 ± 3						





Maps Sandwich Tern 1 & 2 (this page and overleaf). Total **distribution** (left panels) is mapped by calculating total numbers seen per km traveled (open circles). **Densities** (right panels; filled circles) are calculated as the sum of all birds seen "in transect" divided by the surface area watched per 5 minute count. Model results (where appropriate) are also given in the right-hand panels, as shades of brown (high densities) to yellow (low densities). A set of two maps is given for each survey separately.


N/km
SandwichTern_Aug
0
1 - 10
11 - 15
16 - 20
21 - 60
N/km²
SandwichTern_Aug
0 - 1
2 - 10
11 - 15
16 - 20
21 - 50
N/km
SandwichTern_Sep
0
1 - 10
11 - 15
16 - 20
> 20
N/km²
SandwichTern_Sep
0 - 1
2 - 10
11 - 15
16 - 20
> 20
N/km
SandwichTern_Okt
0
1 - 10
11 - 15
16 - 20
> 20
N/km²
SandwichTern_Okt
0 - 1
2 - 10
11 - 15
16 - 20
> 20
N/km
SandwichTern_Nov
0
1 - 10
11 - 15
16 - 20
> 20
N/km²
SandwichTern_Nov
0 - 1
2 - 10
11 - 15
16 - 20
> 20

"Commic" Terns: Common and Arctic Terns *Sterna hirundo & S. paradisaea*

Like Sandwich Terns, both Common and Arctic Terns are summer visitor in the North Sea region. Although their breeding range extends much further north and their population sizes are much larger than in Sandwich Terns, this does not result in a longer migration period over Dutch waters. Most Commic Terns were seen over nearshore waters, but as large numbers (particularly of Arctic Terns) migrate through the North Sea to and from colonies in e.g. Shetland and Orkney, quite a few offshore records were also made.

Long-term trend and variation
The RIKZ aerial surveys in the study area do not indicate any trends over the years (Appendix 3). Most Commic Terns were seen in nearshore waters and in April/May and August/September in all years. Although numbers seen from the air peak in the latter period, this peak is no match for the huge numbers seen in the present ship-board surveys in August (see Table 50, below).

Phenology
Commic Terns were largely absent from October through February. Peak numbers were seen during autumn (or rather: late summer, August) migration (Maps Commic Tern; Table 50). The species was present in low numbers over the breeding season. Relative numbers over deeper waters in May indicated that in that month many Commic Terns were still migrating through the area. In June, Commic Terns were mainly confined to nearshore waters and now most may have been Common Terns from nearby colonies on the mainland.

Table 50. Total numbers of Commic Terns seen in all surveys in the nearshore (0-20 m deep) and offshore parts of the study area.

month	0-20 m	>20 m
2		
4	43	22
5	75	75
6	56	3
8	1164	51
9	22	
10		
11	1	

Flying heights
Both Common and Arctic Terns are very aerial birds that spent very little time swimming, at least in temperate waters. Of all birds that were noted as touching the water, only 14 (in May) were actually resting at sea. All other "swimming" Commic Terns did so very briefly only, while performing shallow plunge dives to catch fish. Actual percentages of birds in flight are therefore even higher than as given in Table 51. Flying heights were typically not very high, and even lower than in Sandwich Terns: only six birds in August got over 25 m asl and none were spotted flying higher than 50 m asl (Table 51).

Table 51. Total numbers of Commic Terns seen flying, respectively swimming in all surveys periods.

month	n-flying	n-swimming or plunge-diving	% in flight
2			
4	54	11	83
5	114	36	76
6	42	17	71
8	1181	34	97
9	22		100
10			
11	1		
Totals	**1414**	**98**	94

Table 52. Distribution of flying heights of Commic Terns in the study area, over the months as assessed during our surveys (no data on altitude recorded in September or October).

month	0-2	2-10	10-25	25-50	50-100	100-200	>200 m asl
2							
4	3	21	18				
5	1	27	76				
6	5	24	2				
8	46	182	596	6			
9		3					
10							
11		1					
Totals	**55**	**258**	**692**	**6**	**0**	**0**	**0**

Feeding behaviour

Several different types of feeding behaviour were noted over the surveys. Most foraging birds were looking for feeding opportunities (flying with bill pointing down), or shallow diving for small fish. Commic Terns were only rarely (20 birds in total) seen around fishing vessels, amidst the far more numerous gulls (Table 53.

Table 53. Numbers of Commic Terns engaged in different types of (post)foraging behaviour, summed over all surveys.

Actively searching	996
Shallow plunging	60
Dipping	21
Scavenging at fishing vessel	20
Under attack by kleptoparasite	1
Resting or apparently asleep	14

Distribution patterns, numbers and densities; occurrence in NSW and Q7

The distribution maps of all sightings (left panels in Maps Commic Terns) indicate that although Commic Terns were seen over nearshore waters, a considerable proportion of the sightings was made beyond the -20 m isobath, particularly during spring migration, in April and May (see also Table 50). In spring, they were seen at distances from shore where the NSW and Q7 contours are situated, although none were actually seen within either contour in any of these months. Like Sandwich Terns, both Common and Arctic Terns are probably not much at risk from future wind farm developments in Dutch waters. Total estimated numbers for all DONAR blocks are given in Table 54.

Table 54. Estimated total numbers of Sandwich Terns for the 11 DONAR polygons (see Figure 1). The upper panel gives total numbers based on the field measurements (average density per DONAR polygon multiplied with the polygon surface area). Modelled totals are only available for months with sufficient data (25 or more 5-minute counts with at least one bird inside the counting strip) and are based on the average (± 1 SD) densities per 250x250 m grid cell. In the graph below the numbers from the upper panel (Measured) are graphically presented.

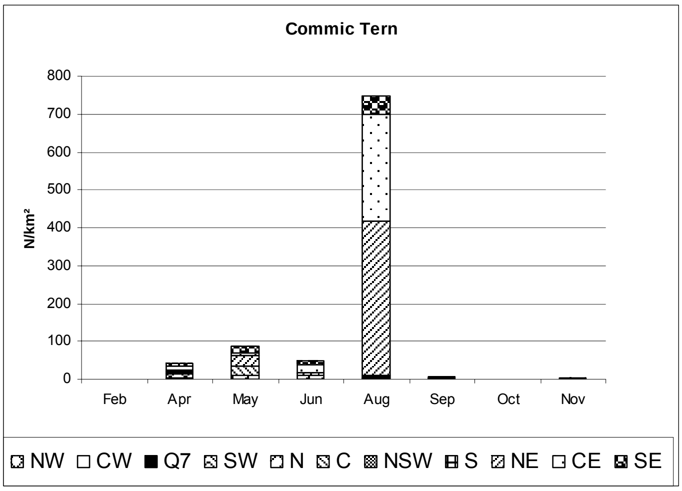
Commic Tern

Measured

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C	0	2 ± 17	23 ± 205	0	0	0	0	0
CE	0	10 ± 77	4 ± 38	19 ± 132	282 ± 2553	0	0	0
CW	0	0	0	0	0	0	0	0
N	0	2 ± 25	11 ± 124	11 ± 119	6 ± 53	0	0	3 ± 30
NE	0	3 ± 29	30 ± 190	8 ± 40	405 ± 2935	2 ± 17	0	0
NSW	0	0	0	0	0	0	0	0
NW	0	5 ± 45	0	0	0	0	0	0
Q7	0	0	0	0	0	0	0	0
S	0	4 ± 36	0	0	4 ± 37	2 ± 21	0	0
SE	0	7 ± 70	20 ± 120	9 ± 58	48 ± 207	2 ± 21	0	0
SW	0	8 ± 74	0	0	2 ± 16	0	0	0

Modelled

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C					0 ± 0			
CE					261 ± 447			
CW					0 ± 0			
N					0 ± 1			
NE					753 ± 1772			
NSW					0 ± 0			
NW					0 ± 0			
Q7					0 ± 0			
S					0 ± 0			
SE					125 ± 242			
SW					0 ± 0			



Maps “Commic” terns 1 & 2 (this page and overleaf). Total **distribution** (left panels) is mapped by calculating total numbers seen per km traveled (open circles). **Densities** (right panels; filled circles) are calculated as the sum of all birds seen “in transect” divided by the surface area watched per 5 minute count. Model results (where appropriate) are also given in the right-hand panels, as shades of brown (high densities) to yellow (low densities). A set of two maps is given for each survey separately. Note that datapoints with extremely high densities have been depicted by using a different color.


N/km
CommicTern_Aug
0
1 - 10
11 - 15
16 - 20
21 - 405
N/km²
CommicTern_Aug
0.0 - 5.0
5.1 - 10.0
10.1 - 20.0
20.1 - 30.0
30.1 - 40.0
40.1 - 50.0
50.1 - 100.0
100.1 - 200.0
200.1 - 250.0
250.1 - 300.0
0 - 1
2 - 1
2 - 15
16 - 20
21 - 100
101 - 412
N/km
CommicTern_Sep
0
1 - 10
11 - 15
16 - 20
> 20
N/km²
CommicTern_Sep
0 - 1
2 - 10
11 - 15
16 - 20
> 20
N/km
CommicTern_Okt
0
1 - 10
11 - 15
16 - 20
> 20
N/km²
CommicTern_Okt
0 - 1
2 - 10
11 - 15
16 - 20
> 20
N/km
CommicTern_Nov
0
1 - 10
11 - 15
16 - 20
> 20
N/km²
CommicTern_Nov
0 - 1
2 - 10
11 - 15
16 - 20
> 20

Guillemot *Uria aalge*

Auk do not breed in The Netherlands and retreat to their breeding colonies on cliff coasts in the breeding season. Guillemots are the most abundant auk species in Dutch waters with total estimated numbers exceeding 200,000. Most wintering visitors come from colonies in the west and northwest of the North Sea although some come from other colonies, such as Helgoland in the German Bight (de Wijs 1985; Camphuysen & Leopold 2004). From August to April, Guillemots can be found in considerable numbers off the Noord-Holland coast, both offshore and at times also in diffuse concentrations closer inshore (Camphuysen & Leopold 1994).

Long-term trend and variation

The RIKZ aerial survey data for the study area show a rather uniform presence of "razormots" (thought to be mainly Guillemots) during mid-winter and a more erratic presence in other months (excepting summer when these birds are largely absent from the general area) , without a clear trend over the years.

Phenology

Guillemots were largely absent in May, June and August and started to return to the study area in September (Table 55. Peak numbers were seen during autumn migration, in November. The species was most numerous in deeper offshore waters, except in October, when most were seen in the central part of the study area (Maps Guillemot).

Table 55. Total numbers of Guillemots seen in all surveys in the nearshore (0-20 m deep) and offshore parts of the study area.

month	0-20 m	>20 m
2	127	361
4	13	58
5		
6	1	
8		
9	4	7
10	168	78
11	223	1090

Flying heights

Guillemots spend a lot of time on the water, swimming and (pursuit) diving. Percentages of birds seen flying are generally rather low (Table 56), although mass-movements may occur from time to time (Camphuysen & van Dijk 1983; Platteeuw *et al*. 1994). When flying, Guillemots usually stick to very low altitudes (Table 57).

Table 56. Total numbers of Guillemots seen flying, respectively swimming in all surveys periods.

month	n-flying	n-swimming
2	128	360
4	9	62
5		1
6		
8		
9	10	1
10	133	113
11	99	1214
Totals	379	1751

Table 57. Distribution of flying heights of Guillemots in the study area, over the months as assessed during our surveys (no data on altitude recorded in September or October)

month	0-2	2-10	10-25	25-50	50-100	100-200	>200 m asl
2	33	64	1				
4	5	1					
5	1						
6							
8							
9	6	2					
10	94	27		2			
11	46	33	1				
Totals	**185**	**127**	**2**	**2**	**0**	**0**	**0**

Feeding behaviour

Guillemots feed by pursuit diving: they dive while swimming on the water's surface and propel themselves by their wings when under water. It is often difficult to see exactly why a Guillemot dives, as many also dive to get away from an approaching ship. We recorded 173 dives as "probably feeding dives) and also saw three Guillemots sticking their heads into the water, peering down (pre-dive prey searching). Preening/bathing was noted for 23 birds. Most prey are rather small fish that are swallowed under water. Guillemots also take rather large fish as prey, such as herring and whiting up to 27 cm (Ouwehand *et al.* in press) and such large prey may be brought to the surface as handling them under water may take rather long. However, the only prey seen was a small flatfish, in itself a rather remarkable and rare prey in Guillemots.

Distribution patterns, numbers and densities; occurrence in NSW and Q7

The distribution maps for Guillemot) clearly indicate that this species may be present anywhere in the study area in considerable densities, from October through April. It mostly shows a NW-SE gradient in its modelled densities (Maps Guillemot). Although it is an unlikely collision victim, habitat loss may be a relevant problem for this species as the future windfarm are located in areas that are rather intensively used by Guillemots. Total estimated numbers for all DONAR blocks are given in Table 58. Note that these numbers are not corrected for birds missed by the observers. The correction factor for missed birds should be 1.83 (Appendix 4).

Table 58. Estimated total numbers of Guillemots (without corrections for birds missed by the observers) for the 11 DONAR polygons (see Figure 1). The upper panel gives total numbers based on the field measurements (average density per DONAR polygon multiplied with the polygon surface area). Modelled totals are only available for months with sufficient data (25 or more 5-minute counts with at least one bird inside the counting strip) and are based on the average (± 1 SD) densities per 250x250 m grid cell. In the graph below the numbers from the upper panel (Measured) are graphically presented.

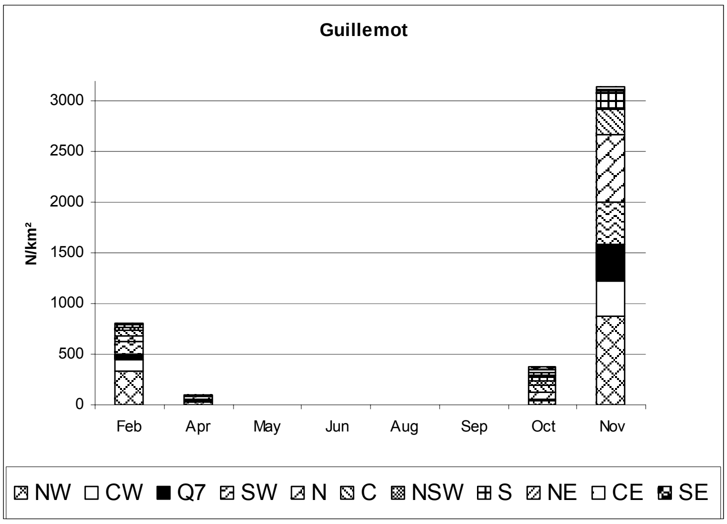
Guillemot

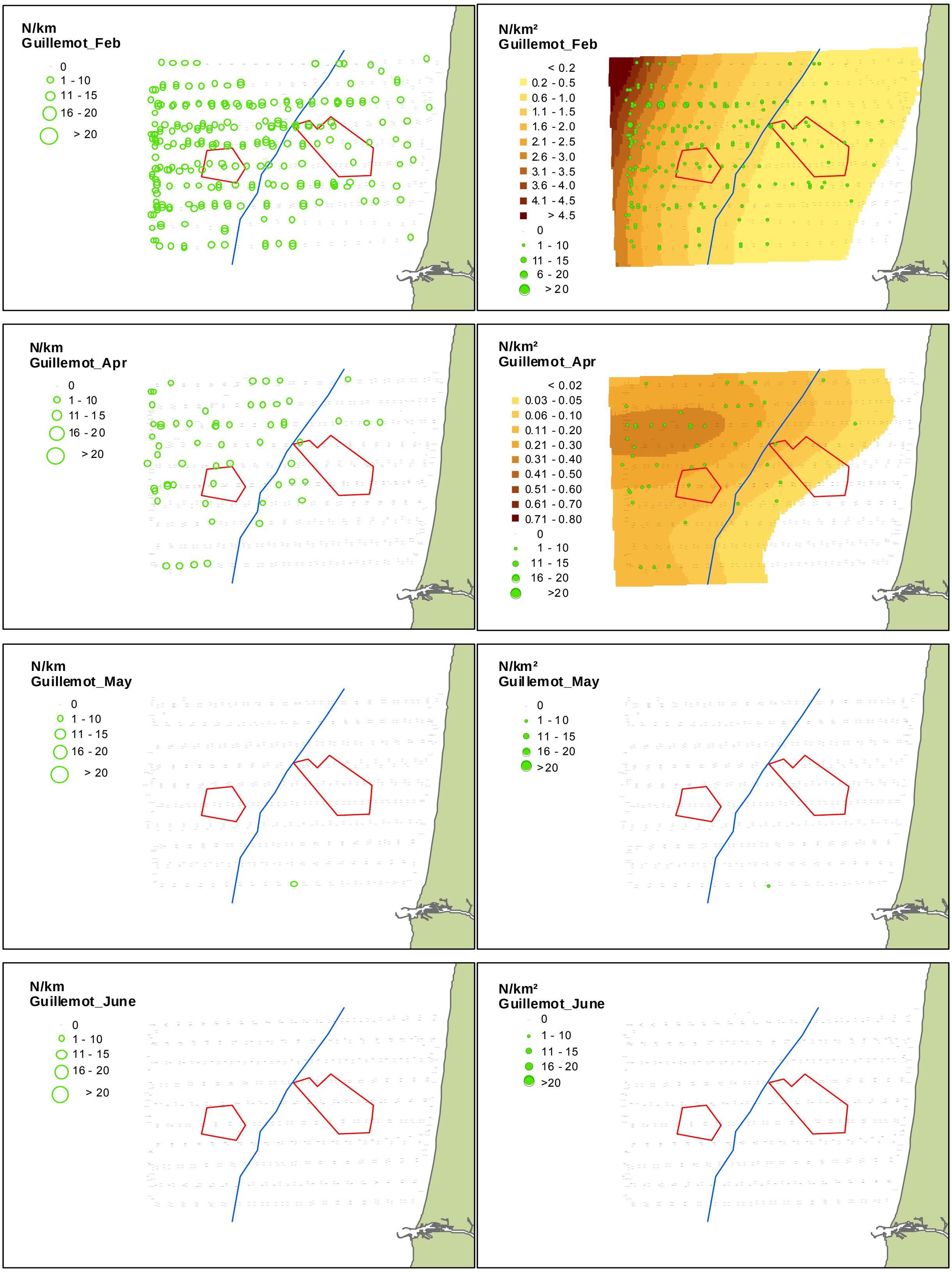
Measured

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C	51 ± 106	11 ± 50	0	0	0	0	73 ± 152	253 ± 557
CE	14 ± 51	0	0	0	0	0	30 ± 85	23 ± 83
CW	117 ± 137	12 ± 34	0	0	0	0	10 ± 33	346 ± 409
N	57 ± 134	24 ± 101	0	0	0	0	75 ± 176	665 ± 1722
NE	0	2 ± 15	0	0	0	0	20 ± 51	12 ± 49
NSW	30 ± 50	2 ± 11	0	0	0	0	35 ± 105	20 ± 49
NW	327 ± 435	33 ± 108	0	0	0	0	40 ± 135	875 ± 1042
Q7	56 ± 100	5 ± 19	0	0	0	0	0	367 ± 414
S	25 ± 81	0	2 ± 22	0	0	0	61 ± 123	165 ± 266
SE	3 ± 25	0	0	0	0	0	26 ± 110	32 ± 128
SW	131 ± 182	9 ± 47	0	0	0	0	0	416 ± 574

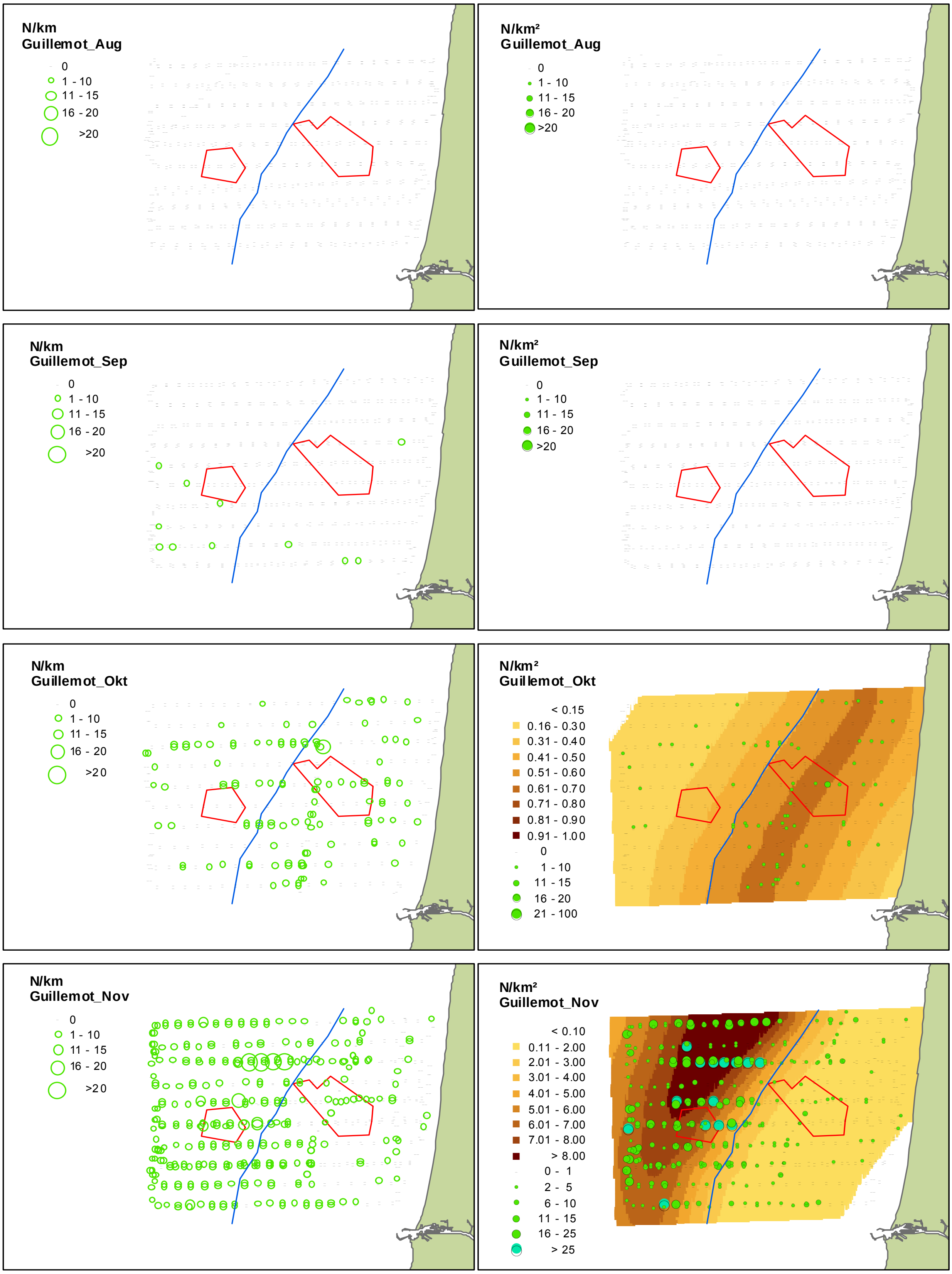
Modelled

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C	47 ± 17	8 ± 5					43 ± 7	272 ± 163
CE	13 ± 4	1 ± 1					45 ± 6	28 ± 15
CW	121 ± 28	11 ± 3					12 ± 1	355 ± 35
N	77 ± 36	19 ± 9					61 ± 13	617 ± 372
NE	11 ± 3	2 ± 1					35 ± 3	41 ± 20
NSW	11 ± 3	2 ± 1					20 ± 1	49 ± 27
NW	325 ± 132	38 ± 6					28 ± 6	953 ± 177
Q7	48 ± 9	7 ± 2					14 ± 2	288 ± 41
S	38 ± 15	3 ± 2					54 ± 4	118 ± 78
SE	9 ± 3	0 ± 0					35 ± 6	12 ± 7
SW	133 ± 52	9 ± 2					28 ± 6	489 ± 90





Maps Common Guillemot 1 & 2 (this page and overleaf). Total **distribution** (left panels) is mapped by calculating total numbers seen per km traveled (open circles). **Densities** (right panels; filled circles) are calculated as the sum of all birds seen "in transect" divided by the surface area watched per 5 minute count. Model results (where appropriate) are also given in the right-hand panels, as shades of brown (high densities) to yellow (low densities). A set of two maps is given for each survey separately. Note that datapoints with extremely high densities have been depicted by using a different color.


N/km
Guillemot_Aug
0
1 - 10
11 - 15
16 - 20
>20
N/km²
Guillemot_Aug
0
1 - 10
11 - 15
16 - 20
>20
N/km
Guillemot_Sep
0
1 - 10
11 - 15
16 - 20
>20
N/km²
Guillemot_Sep
0
1 - 10
11 - 15
16 - 20
>20
N/km
Guillemot_Okt
0
1 - 10
11 - 15
16 - 20
>20
N/km²
Guillemot_Okt
< 0.15
0.16 - 0.30
0.31 - 0.40
0.41 - 0.50
0.51 - 0.60
0.61 - 0.70
0.71 - 0.80
0.81 - 0.90
0.91 - 1.00
0
1 - 10
11 - 15
16 - 20
21 - 100
N/km
Guillemot_Nov
0
1 - 10
11 - 15
16 - 20
>20
N/km²
Guillemot_Nov
< 0.10
0.11 - 2.00
2.01 - 3.00
3.01 - 4.00
4.01 - 5.00
5.01 - 6.00
6.01 - 7.00
7.01 - 8.00
> 8.00
0 - 1
2 - 5
6 - 10
11 - 15
16 - 25
> 25

Razorbills *Alca torda*
Razorbills, like Guillemots are winter visitors in the south-eastern North Sea, but they are generally less numerous (Camphuysen & Leopold 1994; Offringa & Meire 1996). During the T-0 surveys reported here, Razorbills were only seen in appreciable numbers from October to April (Tables 59, 60)

Phenology
Razorbills were largely absent from May through September and returned thus later than the Guillemots (Table 55, 59). Peak numbers were seen during mid-winter, in February, but densities were never high and low sample sizes precluded spatial modelling for most months. The species was most numerous in deeper offshore waters, due west of the Q7 contour in February (Maps Razorbill), while in November, when numbers were also relatively high, most were seen in the central part of the study area.

Table 59. Total numbers of Razorbills seen in all surveys in the nearshore (0-20 m deep) and offshore parts of the study area.

month	0-20 m	>20 m
2	36	54
4	5	18
5	1	
6		
8		
9		
10	9	5
11	14	21

Flying heights
Razorbills, like Guillemots spend a lot of time on the water, and when airborne, usually remain close to the water (Table 60, 61).

Table 60. Total numbers of Razorbills seen flying, respectively swimming in all surveys periods.

month	n-flying	n-swimming
2	23	67
4	7	16
5	1	
6		
8		
9		
10	1	13
11	8	27
Totals	**40**	**123**

Table 61. Distribution of flying heights of Razorbills in the study area, over the months as assessed during our surveys (no data on altitude recorded in September or October)

month	0-2	2-10	10-25	25-50	50-100	100-200	>200 m asl
2	9	15					
4	2		1				
5	1						
6							
8							
9							
10							
11	2	3					
Totals	**14**	**18**	**1**	**0**	**0**	**0**	**0**

Feeding behaviour

Razorbills feed in much the same way as do Guillemots, by pursuit diving. They take smaller prey (Ouwehand *et al.* in press) and no such prey were seen at the surface. A total of 27 Razorbills was seen diving for prey from the surface.

Distribution patterns, numbers and densities; occurrence in NSW and Q7

The distribution maps for Razorbill indicate that this species may occur in low densities within both the Q7 and the NSW contours, over the winter. Given the low densities and lack of any records of high-altitude flight, this species does not seem vulnerable of collisions. Total estimated numbers for all DONAR blocks are given in Table 62. Note that these numbers are not corrected for birds missed by the observers. The correction factor for missed birds should be 1.63 (Appendix 4).

Table 62. Estimated total numbers of Razorbills (without corrections for birds missed by the observers) for the 11 DONAR polygons (see Figure 1). The upper panel gives total numbers based on the field measurements (average density per DONAR polygon multiplied with the polygon surface area). Modelled totals are only available for months with sufficient data (25 or more 5-minute counts with at least one bird inside the counting strip) and are based on the average (± 1 SD) densities per 250x250 m grid cell. In the graph below the numbers from the upper panel (Measured) are graphically presented.

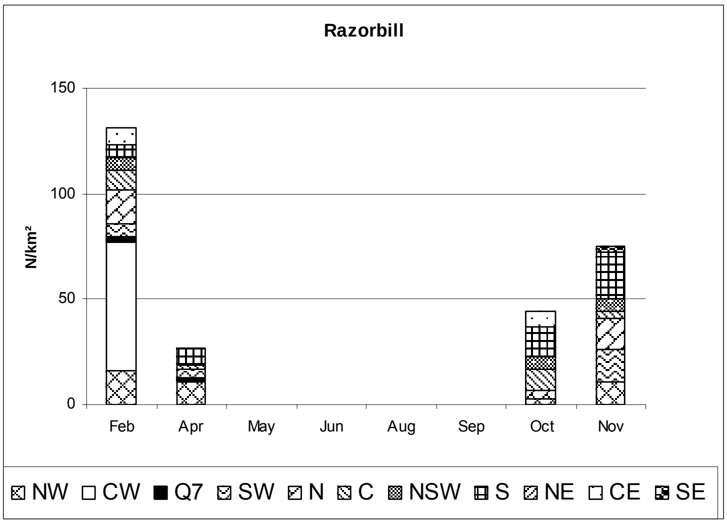
Razorbill

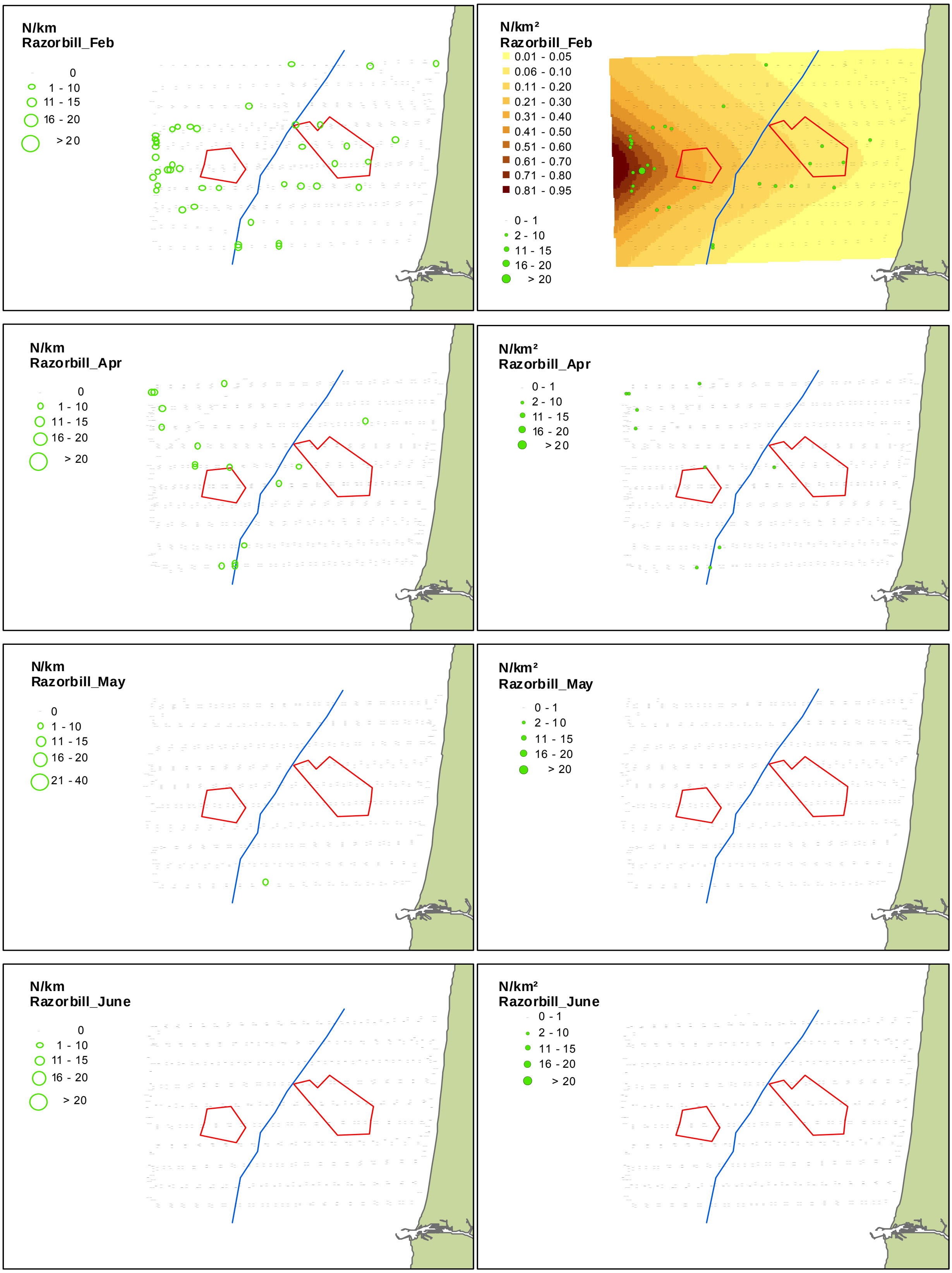
Measured

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C	9 ± 55	2 ± 17	0	0	0	0	10 ± 76	3 ± 22
CE	8 ± 50	0	0	0	0	0	7 ± 38	0
CW	61 ± 170	0	0	0	0	0	0	0
N	16 ± 118	0	0	0	0	0	4 ± 34	15 ± 63
NE	0	0	0	0	0	0	0	0
NSW	6 ± 24	0	0	0	0	0	6 ± 32	6 ± 27
NW	16 ± 89	11 ± 67	0	0	0	0	3 ± 29	11 ± 69
Q7	3 ± 22	2 ± 11	0	0	0	0	0	0
S	6 ± 34	8 ± 57	0	0	0	0	14 ± 71	22 ± 96
SE	0	0	0	0	0	0	0	3 ± 25
SW	6 ± 33	4 ± 36	0	0	0	0	0	15 ± 71

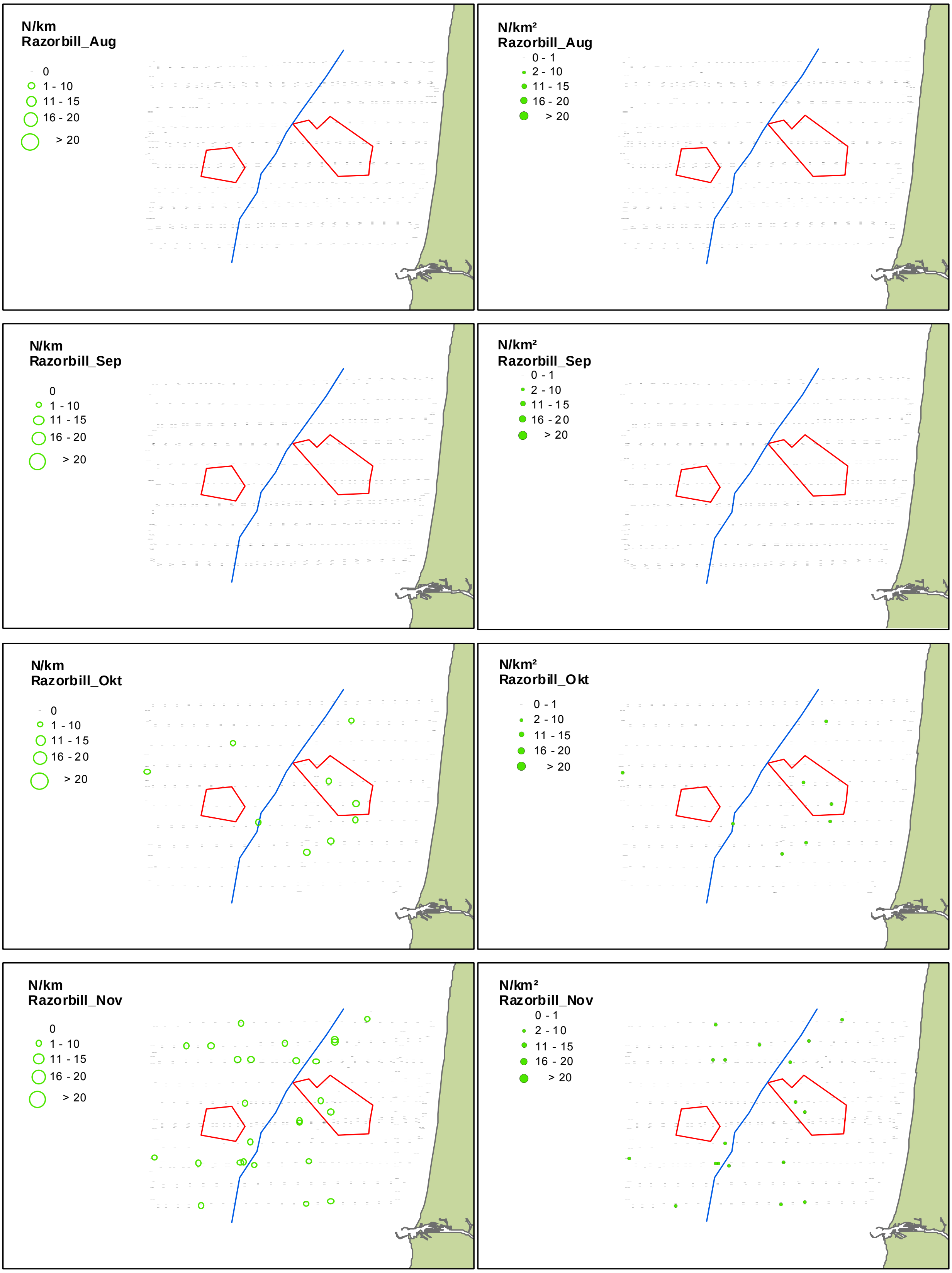
Modelled

Sub-area	Feb	Apr	May	Jun	Aug	Sep	Oct	Nov
C	13 ± 4							
CE	4 ± 1							
CW	31 ± 7							
N	8 ± 4							
NE	1 ± 0							
NSW	3 ± 0							
NW	31 ± 15							
Q7	14 ± 2							
S	7 ± 3							
SE	2 ± 1							
SW	21 ± 10							





Maps Razorbill 1 & 2 (this page and overleaf). Total **distribution** (left panels) is mapped by calculating total numbers seen per km traveled (open circles). **Densities** (right panels; filled circles) are calculated as the sum of all birds seen “in transect” divided by the surface area watched per 5 minute count. Model results (where appropriate) are also given in the right-hand panels, as shades of brown (high densities) to yellow (low densities). A set of two maps is given for each survey separately.


N/km
Razorbill_Aug
0
1 - 10
11 - 15
16 - 20
> 20
N/km²
Razorbill_Aug
0 - 1
2 - 10
11 - 15
16 - 20
> 20
N/km
Razorbill_Sep
0
1 - 10
11 - 15
16 - 20
> 20
N/km²
Razorbill_Sep
0 - 1
2 - 10
11 - 15
16 - 20
> 20
N/km
Razorbill_Okt
0
1 - 10
11 - 15
16 - 20
> 20
N/km²
Razorbill_Okt
0 - 1
2 - 10
11 - 15
16 - 20
> 20
N/km
Razorbill_Nov
0
1 - 10
11 - 15
16 - 20
> 20
N/km²
Razorbill_Nov
0 - 1
2 - 10
11 - 15
16 - 20
> 20

DISCUSSION

This report summarises data from eight subsequent so-called T-0 cruises, aimed at describing the distribution and densities of seabirds at sea, in an area where in the near future windfarms will be built. It is important to realize, that all eight surveys are only single samples of a little known variety of possible situations for that particular month, in other words, year-to-year variation (or year-effect in statistical terms) or within-month variation could not be studied. We know from additional sources, such as the on-going seawatching scheme of the Dutch Seabird Group, from the specific set of seawatching data collected at an offshore platform situated at a location comparable with the present study area (Meetpost Noordwijk; see Appendix 7) and from the bi-monthly RIKZ aerial surveys (Baptist & Wolf 1993 and Appendix 3 in this report), that this variation is considerable and acts on the scale of hours, days, weeks, seasons and years. Therefore, any set of T-0 cruises can at best provide a snap-shot of seabird presence and densities in a given study area. A different timing of such surveys would, in all likelihood, have resulted in different distribution patterns, as well as in different estimates for total numbers present.

In the present study the dedicated surveys cover a single week, within a single year each. Even within the months selected for the surveys (within-month) variation in seabird presence or passage through the area may be considerable as the sea watches of the Dutch Seabird Group from the Dutch shores (Camphuysen & van Dijk 1983; Platteeuw *et al.* 1994) and from Meetpost Noordwijk (Appendix 7 of this report) have demonstrated. Between-years variation must also be considerable, but is harder to describe. The dataset used to examine seabird numbers within the study area over a range of years, the RIKZ bi-monthly aerial surveys, contains relatively few data for a small site such as the present study area and variation found may partly be related to sample sizes. It appears, however, that densities may vary at least by a factor ten, between different days of a given calendar month and this amount of variation is corroborated by the seawatching results.

Can seabirds surveys then ever supply reliable and meaningful estimates of numbers of seabirds residing in a given study area, in this case an area around a future windfarm? Or, put differently, can a single T-0 study be used for a comparison of numbers before and after the wind turbines have been built? Given the amount of variation in numbers present, any additional effect of wind turbines, as based on numbers of birds in (parts of) the study area as based on a simple before-after comparison, will be hard, if not impossible to detect. Even without the additional year-to-year variation and within-month variation, the standard deviations around mean estimated densities or numbers in survey blocks were generally high (see Tables at the end of each species account within this report). Seabird counts typically show a bimodal distribution, in that many counts are made with zero "densities" while other counts have high numbers of birds in them. Such bimodality within a relatively small area such as the current study area is caused by several different factors:

1. the area, while small on a North Sea wide scale is still large enough to comprise a rather wide range of depths, salinities, temperatures and distances to shore where for instance resting sites are situated. This is clearly visible in clines of densities of most species. Some are clearly nearshore species (e.g. grebes) and others are offshore species, that avoid nearshore waters (e.g. Fulmars). Other species show intermediate preferences and the study area shows a clear cline from a coastal seabird community towards an offshore seabird community. Modelling the distribution patterns takes care of some of this variation, but the responses of seabirds to e.g. variation in local hydrography can not be incorporated in a description of densities in terms of a geographical grid.
2. hydrographical features vary greatly over time and anomalies may occur while also shifts in water masses (even within one survey week) occur more regularly, i.e. on a daily (tidal) basis. The position of fronts (for instance the outer border of the "coastal river") varies greatly through the area and as the distribution of many seabirds is related to such transition zones, also seabird distributions shift greatly within this area. Such changes in water masses, and presumably of seabird presence, varies within days as is clearly visible in the recorded patterns of sea surface temperatures and salinities during several of our cruises (Appendix 2), it may vary on a time-scale of days or weeks (for instance in response to storms or to variations in river discharges that impact the coastal river) and it may vary on ever larger time scales. For instance, water temperatures throughout the North Sea were exceptionally high in September and October 2002 (as compared to the long-term (1971-93) average, when the first two surveys of the present study were undertaken (Edwards *et al.* 2004), but impacts of such anomalies on seabirds numbers within a small area of the Dutch mainland coast remain unclear.
3. on an even larger time and spatial scale, there is growing evidence that climate changes have profound effects on the North Sea ecosystem at large (e.g. Beaugrand *et al.* 2003), including seabirds. The North Sea of the late 1970's and early 1980's, when RIKZ aerial surveys and seawatching from the Dutch mainland coast and from Meetpost Noordwijk commenced, was very different from the present situation. There is every reason to believe that in the (near?) future, i.e. within the foreseen life-span of offshore wind turbines, other major regime shifts of the North Sea ecosystem will take place and the present T-0 studies cannot fully take such events into account.
4. On small as well as on large time-scales, there is great variation in the distribution of fishing activities in the study area. Fishing greatly affects the distribution of scavenging seabird species such as gulls. Similarly, the availability of natural foods, such as near-surface fish schools, varies greatly in time, causing flocks (and thus high densities) of birds to congregate at different places at different times. Such flocks may or may not be recorded as "in transect" during the surveys and thus greatly influence distribution maps and estimates of seabird densities.

Such clumped distributions will always result in low precision estimates. There are certain advanced statistical methods to deal with this problem, such as block bootstrapping, by permutations with random time/space shifts, by sandwich estimators or GEE and by Bayesian geostatististical generalized linear modelling (Diggle *et al.* 1998, Banerjee *et al.* 2004). However the low correlations did not really warrant in our view application of such methods at this time, but for the T1 study, we advice a fully Bayesian geostatistical analysis to determine the effects of the windfarms. Given the amount of variance in the present, T-0 dataset, we would "guestimate" that only changes in the order of 50-100% (densities becoming half or double the present densities) would be found (in as statistical sense) if T-0 and T-1 densities are compared. Note however, that such differences are often present in the RIKZ aerial survey dataset for the study area (Appendix 3).

Even so, we recommend to carry out the T-1 surveys in a manner, that mimics the T-0 approach as closely as possible to be able to make best use of the T-0 data in a direct comparison. This means that ships of similar size should be used, with a two-platform approach with two teams of two observers (preferably manned by the same principal observers). The survey timing should be as similar to the T-0 timing as possible and the same transect lines should be used. It may be useful to adopt a denser (additional) survey scheme in the windfarm sites, if it is felt that more survey data are needed there. In the T-0 approach, this was not really an issue, as no turbines were yet in place making a more even coverage over the whole study area more useful to describe distribution patterns. Power analyses may be used to optimise survey design in this respect for the T-1 studies to come.

In our view, comparing T-0 and T-1 densities are unlikely to be very useful, unless major differences will occur in response to the wind turbines, such as a total clearing of the area by certain seabird species, that were now reasonably wide-spread throughout the study area. A much more promising approach to look for *impacts of windfarms on seabird distribution and densities*, is to look for *deviations* in distribution patterns over the study area at large, and to examine if the pattern within a windfarm site deviates from the expected pattern, as based on the results for the whole study area, after clinal effects of location (distance to the -20 m isobath and YFIELD) have been removed. Synoptic recordings of behaviours of the seabirds concerned will further corroborate any deviations found. Similarly, recording key environmental parameters, such as sea surface temperature and salinity, is important as such features may greatly influence seabirds presence and behaviour on locations and times included in the survey. It should always be possible to check if certain deviations from a general pattern are linked to a temporal hydrographical phenomenon. Only if such factors can be ruled out, can anomalies of seabird distribution patterns within a windfarm site be safely attributed to the presence of the turbines. Likewise, the distribution of certain feeding opportunities (fish schools as apparent from seabird behaviour, or discarding fishing ships) should be monitored during the T-1 surveys.

The T-zero studies showed which species of birds were present in the area, and at what times and (general) densities. Without the turbines being in place, no large, consistent deviations in density patterns were found within the Q7 or NSW contours, at least not across many species or surveys (Appendix 6). However, in some cases, "effects" of location (either NSW or Q7 or both) were significant, suggesting that intrinsically different densities of seabirds would occur there. In most cases these concerned species that scavenge behind fishing trawlers, and the uneven distribution of trawlers over the are is likely to account for this. Only in divers in April, did we find a significant effect of a windfarm location (Q7). This was caused by a (short-lived) concentration of divers within a small frontal zone at the southern border of Q7. Such phenomena may safely be attributed to chance.

Our surveys had a rigorous design in that track line were closely together and orientated perpendicularly on the coast and, presumably on any gradient in abiotic factors in the area, as well as patterns in seabird densities (c.f. Camphuysen *et al.* 2004). Also, coverage was large in relation to the size of the study area (Tables 2 and 4). Our modelling indicated that a slight tilt in orientation of (a)biotic patterns was apparent in the area and we took that into account by modelling distribution in relation to the -20 m isobath, rather than to an E-W running X-axis. Modelling spatial densities was not (nearly) always possible, due to low sample sizes, even though effort was high with two transects run on both sides of the ship and counts lasting only 5 (instead of the standard 10) minutes. One may consider, that seabird species not fulfilling the criterion, that at least 25 counts with a positive density in a given month, are not worth considering as risks of damage will also low. However, our effort was limited in time and restricted to good to moderate weather conditions and species that were rarely seen during the surveys may have be more abundant between surveys or in other years. Modelling also suffered from temporary anomalies, such as birds (such as divers in April) concentrating briefly at a certain spot, or birds flocking around (moving!) fishing vessels. Statistical modelling can cope with this, in that a prediction may be generated, but predicting future distribution patters becomes nearly impossible, as hot-spot locations for such situations will be different during any future survey.

A final discussion point is the usage of correction factors for birds missed by observers. We calculated such factors for those birds, that spend a lot of time on the water, are dark-backed and get away from ships partly by diving: Red/Black-throated Divers, Great Crested Grebes, Great Cormorants, Guillemots and Razorbills (Appendix 4). Large differences exist between observers, but by keeping observer teams the same (for as much as possible) over subsequent surveys, general patterns will not be compromised much. Correction factors have not been applied to the results given in the maps or tables with estimated total numbers of birds, but this can easily be done by multiplication. The correction factors found in this study are mostly larger than found in earlier studies. This is because a new factor (observer team) was added as compared to earlier, one-team only studies (Skov *et al.* 1995; Stone *et al.* 1995; Garthe 2003). Both observer and the correct assignment of perpendicular distances classes (particularly for birds seen far ahead of the ship) will need further attention in future, if correction factors need to be fully applied in density estimations.

In conclusion, distribution patterns have been described for the most numerous species of seabirds occurring over the year in an area, encompassing two future windfarms. In many cases the distributions were not uniform, but related to geographical features, as well as to (temporal) feeding opportunities. Large and consistent anomalies within general distribution patterns at the future windfarm sites were not found, and if such deviations from the overall patterns will be found after the windfarms have become operational should be seen as evidence that the turbines have an effect. Other factors, such as hydrographical peculiarities or the presence/absence of fishing vessels should be taken into account when such deviations are described. All birds present could be at risk from both collision and disturbance, once the turbines have become operational. The risk is relatively large in species with a limited total population size, particularly if their distribution range is limited to nearshore waters: divers, scoters, Little Gull). The risk of collisions (not fully assessed in this study) is greatest for species reaching altitudes in flight that coincide with the future rotor heights. Such birds are probably mostly at risk at times when ship-based or aerial surveys cannot be conducted, i.e, during adverse weather conditions (mist, storm) or at night. The other risk factor, disturbance, is probably greatest for species that are easily disturbed (divers, scoters), but habituation may occur in future and the effects of disturbance need to be assessed in the T-1 follow-up studies.

REFERENCES

Banerjee, S., Carlin, B. P., and Gelfand, A. E. 2004. Hierarchical modeling and analysis for spatial data. Boca Raton, FL, Chapman & Hall.

Baptist H.J.M. & Wolf P.A. 1993. Atlas van de vogels van het Nederlands Continentaal Plat. Rapport DGW-93.013, Dienst Getijdewateren, Rijkswaterstaat, Middelburg, 168pp.

Beaugrand G., Brander K.M., Lindley J.A., Souissi S. & Reid C., 2003. Plankton effect on cod recruitment in the North Sea. Nature 426: 661-664.

Berghahn R. & Rösner H.-U, 1992. A method to quantify feeding of seabirds on discards from the shrimp fishery in the North Sea. Neth. J. Sea Res. 28: 347-350.

Berrevoets C.M. & Arts F.A. 2003. Midwintertelling van zee-eenden in de Waddenzee en de Nederlandse kustwateren, januari 2003. Rapport RIKZ/2003.008, Rijksinstituut voor Kust en Zee, Middelburg.

Brenninkmeijer A. & Stienen E.W.M. 1997. Migratie van de Grote Stern *Sterna sandvicensis* in Denemarken en Nederland. IBN-rapport 302: 57p Buckley P. & Jones E. 1982. Remarkable movement of Fulmars off the Clare coast. Irish Birds 2: 195-196.

Buckland S.T., Anderson D.R., Burnham K.P. & Laake J.L. 1993. Distance sampling: estimating abundance of biological populations. Chapman & Hall, London.

Buckley P. & Jones E. 1982. Remarkable movement of Fulmars off the Clare coast. Irish Birds 2(2): 195-196.

Camphuysen C.J. & Derks P.J.T. 1989. Voorkomen en sterfte van de Fuut *Podiceps cristatus* voor de Nederlandse kust 1974-86. Limosa 62:57-62.

Camphuysen C.J. & van Dijk J. 1983. Zee- en kustvogels langs de Nederlandse kust, 1974-79. Limosa special issue 56: 81-230.

Camphuysen C.J. & Garthe S. 2004. Recording foraging seabirds at sea: standardised recording and coding of foraging behaviour and multi-species foraging associations. Atlantic Seabirds 5: 1-23.

Camphuysen C.J. & Leopold M.F. 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., Keijl G.O. & den Ouden J.E. 1982. Meetpost Noordwijk 1978-1981, Gaviidae-Ardeidae. CvZ MpN-verslag nr. 1, Amsterdam.

Camphuysen C.J., Ensor K., Furness R.W., Garthe S., Hüppop O., Leaper G., Offringa H. & Tasker M.L., 1993. Seabirds feeding on discards in winter in the North Sea. Final report to the European Comm., study contr. 92/3505, NIOZ-report no. 8, Netherl. Inst. for Sea Res., Texel. 142 p.

Camphuysen C.J., Calvo B., Durinck J., Ensor K., Follestad A., Furness R.W., Garthe S., Leaper G., Skov H., Tasker M.L. & Winter C.J.N., 1995. Consumption of discards by seabirds in the North Sea. Final report to the European Comm., study contr. BIOECO/93/10, NIOZ-Rapport 1995-5, Netherl. Inst. for Sea Res., Texel, 260 p.

Camphuysen C.J., C.M. Berrevoets, H.J.W.M. Cremers, A., Dekinga, R. Dekker, B.J. Ens, T.M. van der Have, R.K.H. Kats,. Kuiken, M.F. Leopold, J. van der Meer & T. Piersma 2002. Mass mortality of common eiders (Somateria mollissima) in the Dutch Wadden Sea, winter 1999/2000: starvation in a commercially exploited wetland of international importance. Biological Conservation 106: 303-317.

Camphuysen C.J., A.D. Fox, M.F. Leopold & I.K. Petersen 2004. Towards standardised seabirds at sea census techniques in connection with environmental impact assessments for offshore wind farms in the U.K.. Report commissioned by COWRIE for the Crown Estate, London. Royal Netherlands Institute for Sea Research, Texel, 38pp.

Craeymeersch J.A. & Perdon J. 2004. De halfgeknotte strandschelp *Spisula subtruncata*, in de Nederlandse kustwateren in 2003. RIVO rapport C040/04.

Debout G. 1982. Moevements exceptionnels de quelques espèces d'oiseaux marins au cours de l'hiver 1980-1981. Le Cormoran 24: 227-230

de Jong M.L., Ens B.J. & Kats R.K.H. 2003. Aantallen Eidereenden in en rond het Waddengebied in de winter van 2002/2003. Alterra Rapport 794: 35pp.

Dien J. & Ringleben H. 1966. Der Einflug pelagischer Vogelarten nach Deutschland im Herbst 1963 mit Hinweisen auf Nachbarländer. Die Vogelwarte 23: 181-190.

Dierschke V. 2002. Durchzug von Sterntauchern *Gavia stellata* und Prachttauchern *G. arctica* in der Deutschen Bucht bei Helgoland. Vogelwelt 123: 203-211.

Diggle, P. J., Tawn, J. A., and Moyeed, R. A. 1998. Model-Based Geostatistics. Applied Statistics. 47: 299-350.

Edwards M., Richardson A., Batten S. & John A.G.W., 2004. Ecological status report: results from the CPR survey 2002/2003. SAHFOS Technical Report 1: 1-8. (Available from: www.sahfos.org).

Garthe S., 2003. Erfassung von Rastvögeln in der deutschen AWZ von Nord- und Ostsee. Abschlussbericht für das F+E-Vorhaben FKZ: 802 85 280 K1 (Bundesamt für Naturschutz, Bonn).

Garthe S. & Hüppop O. 1993. Gulls and Fulmars following ships and feeding on discards at night. Ornis Svecica 3: 159-161.

Garthe S. & Kubetzki U., Hüppop O. & Freyer T. 1999. Zur Ernährungsökologie von Herings-, Silber- und Sturmmöwe (*Larus fuscus, L. argentatus* und *L. canus*) auf der Nordseeinsel Amrum während der Brutzeit. Seevögel 20: 52-58.

Garthe S. & Hüppop O. 2004. Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index. J. Appl. Ecology 41: 724-734.

Genstat Committee 2002. Genstat Release 6.1 The Guide to GenStat., Oxford, VSN International Ltd.

Hastie, T., and Tibshirani, R. 1990. Generalized Additive Models. London, Chapman and Hall.

Hüppop O., Exo K-M. & Garthe S. 2003. Empfehlungen für projektbezogene Untersuchungen möglicher bau- und betriebsbedingter Auswirkungen von Offshore-Windenergieanlagen auf Vögel. Ber. Vogelschutz 39: 77-94.

Joensen A.H. 1961. Massedød af Mallemuk (*Fulmarus glacialis* (L.)) og Ride (*Rissa tridactyla* (L.)) i danske farvande 1959. Dansk orn. Foren. Tidsskr. 55: 212-218.

Keyl G.O. & Leopold M.F., 1997. Massaal fouragerende Dwergmeeuwen *Larus minutus* voor de Hollandse kust in april 1996. Sula 11: 17-20.
Komdeur J., Bertelsen J. & Cracknell G. (eds) 1992. Manual for aeroplane and ship surveys of waterfowl and seabirds. IWRB Special Publ. No. 19, Slimbridge, 37pp.
Krüger T. & Garthe S. 2001. Flight altitudes of coastal birds in relation to wind direction and speed. Atlantic Seabirds 3: 203-216.
Larsson E. 1960. Stormfågelfynd från svenska våstkusten våren 1959. Fauna och Flora 55: 57-63.
Lemke W. & Schlenker R. 1968. Sturmgäste in der Deutschen Bucht im Herbst 1967. Corax 2: 194-200.
Lensink R., Gasteren H. van, Hustings F., Buurma L. Duin G. van, Linnartz L., Vogelzang F. & Witkamp C. 2002. Vogeltrek over Nederland, 1976-1993. Schuyt & Co Uitg., Haarlem, 432.
Leopold M.F., 1996. *Spisula subtruncata* als voedselbron voor zee-eenden in Nederland. BEON rapport 96-2.
Leopold M.F. & Camphuysen C.J. 2002a. T-zero seabirds and cetaceans surveys in the windfarm sites NSW and Q7. Cruise Report of the first survey, carried out by Alterra, CSR and Bureau Waardenburg, 23-27 September 2002. Unpublished report to RIKZ.
Leopold M.F. & Camphuysen C.J. 2002b. T-zero seabirds and cetaceans surveys in the windfarm sites NSW and Q7. Cruise Report of the second survey, carried out by Alterra, CSR, Bureau Waardenburg, & Ecologic 21-25 October 2002. Unpublished report to RIKZ.
Leopold M.F. & Camphuysen C.J. 2003a. T-zero seabirds and cetaceans surveys in the windfarm sites NSW and Q7. Cruise Report of the third survey, carried out by Alterra, CSR and Bureau Waardenburg, 7-11 April 2003. Unpublished report to RIKZ.
Leopold M.F. & Camphuysen C.J. 2003b.T-zero seabirds and cetaceans surveys in the windfarm sites NSW and Q7. Cruise Report of the fourth survey, carried out by Alterra, CSR & Bureau Waardenburg, 19-23 May 2003. Unpublished report to RIKZ.
Leopold M.F. & Camphuysen C.J. 2003c.T-zero seabirds and cetaceans surveys in the windfarm sites NSW and Q7. Cruise Report of the fifth survey, carried out by Alterra & Bureau Waardenburg, 23-27 June 2003. Unpublished report to RIKZ.
Leopold M.F. & Camphuysen C.J. 2003d.T-zero seabirds and cetaceans surveys in the windfarm sites NSW and Q7. Cruise Report of the sixth survey, carried out by Alterra, CSR & Bureau Waardenburg, 11-15 August 2003. Unpublished report to RIKZ.
Leopold M.F. & Camphuysen C.J. 2003e.T-zero seabirds and cetaceans surveys in the windfarm sites NSW and Q7. Cruise Report of the seventh survey, carried out by Alterra, NIOZ/CSR & Bureau Waardenburg, 4-7 November 2003. Unpublished report to RIKZ.
Leopold M.F. & Camphuysen C.J. 2004 T-zero seabirds and cetaceans surveys in the windfarm sites NSW and Q7Cruise Report of the eighth and final T-zero

survey, carried out by Alterra, NIOZ & Bureau Waardenburg, 16-19 February 2004. Unpublished report to RIKZ.

Leopold M.F. & Platteeuw M. 1987. Talrijk voorkomen van Jan van Genten *Sula bassana* bij Texel in de herfst: reactie op lokale voedselsituatie. Limosa 60: 105-110.

Leopold M.F., Baptist H.J.M. , Wolf P.A. & Offringa H., 1995. De Zwarte Zeeëend *Melanitta nigra* in Nederland. Limosa 68: 49-64.

Leopold M.F., Smit C.J., Goedhart P.W., van Roomen M., van Winden E. & van Turnhout C. 2004 (in press). Langjarige trends in aantallen wadvogels, in relatie tot de kokkelvisserij en het gevoerde beleid in deze. Final Report EVA II-C2 (Evaluatie Schelpdiervisserij tweede fase); Alterra Report 954.

LWVT 1985. Handleiding tellen van zichtbare vogeltrek. LWVT/SOVON, Arnhem.

Møller A.P. 1981. The migration of European Sandwich Terns *Sterna s. sandvicensis*. Die Vogelwarte 31: 74-94; 149-168.

Munsterman P. 1978. Grote Stern aan het strand van IJmuiden in 1977. Het Vogeljaar 26(1): 18-19.

Offringa H. & Meire P. 1996. Verhouding Zeekoet *Uria aalge* / Alk *Alca torda* in Vlaamse kustwateren. Mergus 10: 333-344.

den Ouden J.E. & Camphuysen C.J. 1983. Meetpost Noordwijk 1978-1981, Anatidae-Scolopacidae. CvZ MpN-verslag nr. 2, Amsterdam.

den Ouden J.E. & van der Ham N.F. 1988. Meetpost Noordwijk 1978-1982, Stercoraridae-Alcidae. CvZ MpN-verslag nr. 3, Alkmaar/Amsterdam.

Ouwehand J., Leopold M.F. & Camphuysen C.J. 2004 (in press). A comparative study of the diet of Guillemots *Uria aalge* and Razorbills *Alca torda* killed during the Tricolor oil incident in the south-eastern North Sea in January 2003. Atlantic Seabirds.

Paine M.D. 1996. Repeated measures designs. Environmental Toxicology and Chemistry 15: 1439-1441.

Pashby B.S. & Cudworth J. 1969. The Fulmar 'wreck' of 1962. Brit. Birds 62: 97-109.

Pedersen M.P. 1988. Forårstræk af Sortand *Melanitta nigra* over Sydvestlylland [Spring migration of Common Scoter *Melanitta nigra* across southwest Jutland.]. Dansk Orn. Foren. Tidsskr. 82: 51-53.

Platteeuw M., 1990. Zwarte Zeeëenden *Melanitta nigra* snijden Nederlandse kust af. Sula 4(2): 70-74.

Platteeuw M., van der Ham N.F. & den Ouden J.E. 1994. Zeetrektellingen in Nederland in de jaren tachtig. Sula 8(1/2, special issue): 1-203.

Sanders C.J. 1993. Spring migration routes of common loons, *Gavia immer*, through the Sault Ste. Marie region of the great lakes. Canadian Field-Naturalist 107: 196-200.

Skov H., Durinck J., Leopold M.F. & Tasker M.L. 1995. Important bird areas in the North Sea, including the Channel and the Kattegat. BirdLife International, Cambridge, 156p.

Smit H., Mes R. & Schuckard R. 1981. De Noorderhaaks, een belangrijke slaapplaats voor meeuwen en sterns?. Watervogels 6: 89-91.

Stone C.J., Webb A., Barton C., Ratcliffe N., Reed T.C., Tasker M.L., Camphuysen C.J. & Pienkowski M.W. 1995. An atlas of seabird distribution in north-west

European waters. Joint Nature Conservation Committee, Peterborough, 326pp.
Tasker M.L., Jones P.H., Dixon T.J. & Blake B.F. 1984. Counting seabirds at sea from ships: a review of methods employed and a suggestion for a standardized approach. Auk 101: 567-577.
Underwood A.J. 1994. On beyond BACI: sampling designs that might reliably detect Environmental distubances. Ecological Applications 4: 3-15.
van der Ham N.F. 1988. Meetpost Noordwijk 1978-1982, CvZ MpN-verslag nr. 4, Columbidae - Emberizidae. Sula 2: 83-90.
van der Meer J. & Camphuysen C.J. 1996. Effect of observer differences on abundance estimates of seabirds from ship-based strip transect surveys. Ibis 138: 433-437.
van Dijk J., Koks B. & Kuiper D. 1998. Razende Bol; op de grens van Noordzee en wad. Graspieper 18: 68-76.
van Eerden M.R. & Voslamber B. 1995. Mass fishing by Cormorants Phalacrocorax carbo sinensis at lake IJsselmeer, The Netherlands: a recent and successful adaptation to a turbid environment. Ardea 83: 199-212.
van Franeker J.A. 2004. Massa-sterfte van noordse stormvogels in de zuidelijke Noordzee. Nieuwsbrief Ned. Zeevogelgroep 5(2): 6-7.
van Roomen M.W.J., van Winden E.A.J., Koffijberg K., Kleefstra R., Ottens G., Voslamber B. & SOVON Ganzen- en zwanenwerkgroep 2003. Watervogels in Nederland in 2001/2002. SOVON-monitoringrapport 2004/01, RIZA-rapport BM04.01. SOVON Vogelonderzoek Nederland, Beek-Ubbergen.
Vlugt D. 1986. Spectaculaire trek langs de Hondsbossche in de periode 27 oktober tot 13 november 1985. Kleine Alk 4: 28-33.
Wernham C., Toms M., Marchant J., Clark J., Siriwardena G. & Baillie S. (eds) 2002. The migration atlas: movements of the birds of Britain and Ireland. T. & A.D. Poyser, London, 884pp.

Appendix 1 Co-ordinates of the ten transect lines in the study area

Transect	Latitude	Longitude	Northing	Easting
A-inshore	52º 42.00' N	4º 37.42' E	5840258	609720
A-offshore	52º 42.00' N	4º 06.00' E	5839589	574334
B-inshore	52º 40.67' N	4º 37.09' E	5837784	609403
B-offshore	52º 40.67' N	4º 06.00' E	5837123	574372
C-inshore	52º 39.33' N	4º 36.76' E	5835292	609087
C-offshore	52º 39.33' N	4º 06.00' E	5834637	574410
D-inshore	52º 38.00' N	4º 36.44' E	5832818	608781
D-offshore	52º 38.00' N	4º 06.00' E	5832173	574447
E-inshore	52º 36.76' N	4º 36.11' E	5830344	608464
E-offshore	52º 36.76' N	4º 06.00' E	5829707	574485
F-inshore	52º 35.33' N	4º 35.78' E	5827852	608147
F-offshore	52º 35.33' N	4º 06.00' E	5827223	574523
G-inshore	52º 34.00' N	4º 35.45' E	5825378	607828
G-offshore	52º 34.00' N	4º 06.00' E	5824758	574560
H-inshore	52º 32.67' N	4º 35.13' E	5822904	607521
H-offshore	52º 32.67' N	4º 06.00' E	5822292	574598
I-inshore	52º 31.33' N	4º 34.80' E	5820412	607202
I-offshore	52º 31.33' N	4º 06.00' E	5819808	574636
J-inshore	52º 30.00' N	4º 34.80' E	5817947	607256
J-offshore	52º 30.00' N	4º 06.00' E	5817342	574673

Appendix 2 Sea surface salinity and temperature distributions in the study area

During the 2003 and 2004 surveys, sea surface salinity and -temperature were constantly measured with a Hydrolab Datasonde©3 Multiprobe Logger (Hydrolab Corporation, Loveland, CO, USA). The instrument was mounted on the hind-deck and sea water was continuously pumped through the flow-cell via a plastic hose connected to a pump that took in seawater for the engine cooling system of the ship. The Multiprobe was connected to a notebook computer that received and stored the data through a communication program (PROCOM), supplied by Rijkswaterstaat. The measurements were stored on the computer with one minute intervals. After each cruise the salinity/temperature datafile was retrieved and synchronized with the GPS-position files of the bird-counts. Before and after each survey, the conductivity probe of the Datasonde was calibrated with standard seawater (34.998 ppt). Measurements were linearly corrected for the differences of the calibration readings from 34.998. Such differences never exceeded 1 ppt. Temperature readings were not calibrated. Salinity and temperature averages for each bird-count interval (generally 5 minutes) were calculated. The results are presented as three dimensional plots of salinity and temperature against geographical position (Figures 7 and 8), but first the general level of the salinities measured were examined, as the results for the April and June surveys seemed odd (Figure 6).

In most surveys, the salinity against time plot (Figure 6) shows a clear zig-zag pattern, as salinities were lower close to the coast and higher further offshore. Also, the data fluctuated between relatively narrow limits (range some 5 ppt per month). Compared with this, the results for June were completely off, showing generally very low values and a wide, rather erratic range. The results for April also showed very low values, but showed the normal zig-zag pattern. These results were compared with Rijkswaterstaat data available on the internet (fortnightly measurements during the years 1977-1983) and to the data collected by Rijkswaterstaat in that same month (April 2003) at the two stations nearest to our study area (Noordwijk and Marsdiep; DONAR database, Geert Koskamp, ABN-RIKZ via e-mail). These measurements suggested no deviation from the normal values in April 2003. Against this background, the data for June were further omitted and the data for April are presented twice, as the original data and after a correction. We felt that for April, a correction was possible, because these data still showed the normal zig-zag pattern, except at a lower level (Figure 6). We assumed a systematic, negative bias in the readings and the data were accordingly corrected upwards, to reach the average level of the assumingly correct measurements taken during the May, August, November and February cruises.

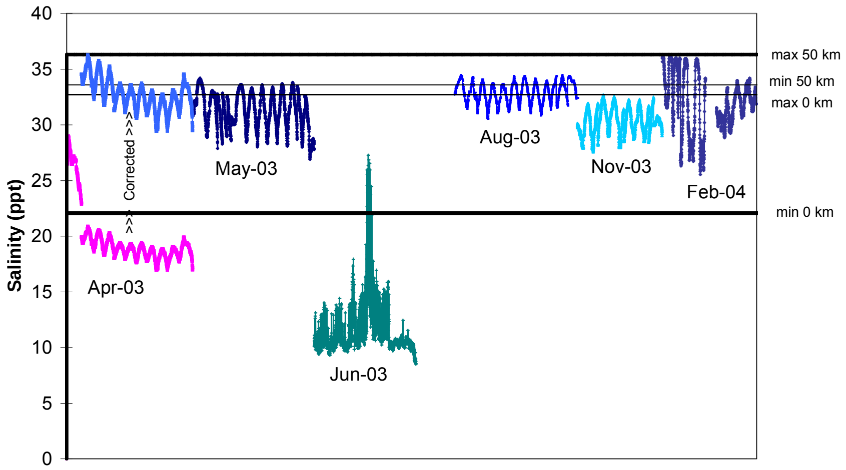


Figure 6. Salinities as measured along the bird-transects, per survey month. For comparison, the levels of minimum and maximum salinities over the years 1977-1983 in the region (RWS data) are given for stations between 0 and 50 km offshore. The data for April and June are too low, those for April could be corrected upwards; those for June had to be omitted.

The trace of the June measurements indicates a large instability of the salinity measurements, on top of a large negative bias, making any attempt to correct the data pointless. During the later cruises measures were taken to avoid air coming into the measuring chamber of the Multiprobe, and the problem did not re-occur. The amplitude of the zig-zags is indicative for difference between nearshore and outer parts of the survey area. It appears that in May and February the differences between the relatively brackish nearshore zone and the relatively saline offshore zone, were greatest. Figure 7 shows, that there was a general tendency for salinity to increase from south-east to north-west. For these plots, all available data were used and differences between first and second runs along the same transect, as well as the order in which the transects were sailed, have sometimes resulted in “fingers” of e.g. salty water intruding into an area that was less saline when the ship worked the neighbouring transects. The plots thus do not show a snap-shot of synoptic data, but give merely an impression of the average situation during the surveys.

Temperatures are mapped using the same procedure in Figure 8. The plots also show a south-east to north-east tendency, mainly in the coldest (February) and warmest months (August). In May the tendency was mainly from relatively warm in the nearshore (eastern) waters to slightly colder due west. The November data show a remarkable “folded-up” pattern, indicating rather large differences between successive passages over the same or adjacent transects or large differences between the first and second half of the survey week.

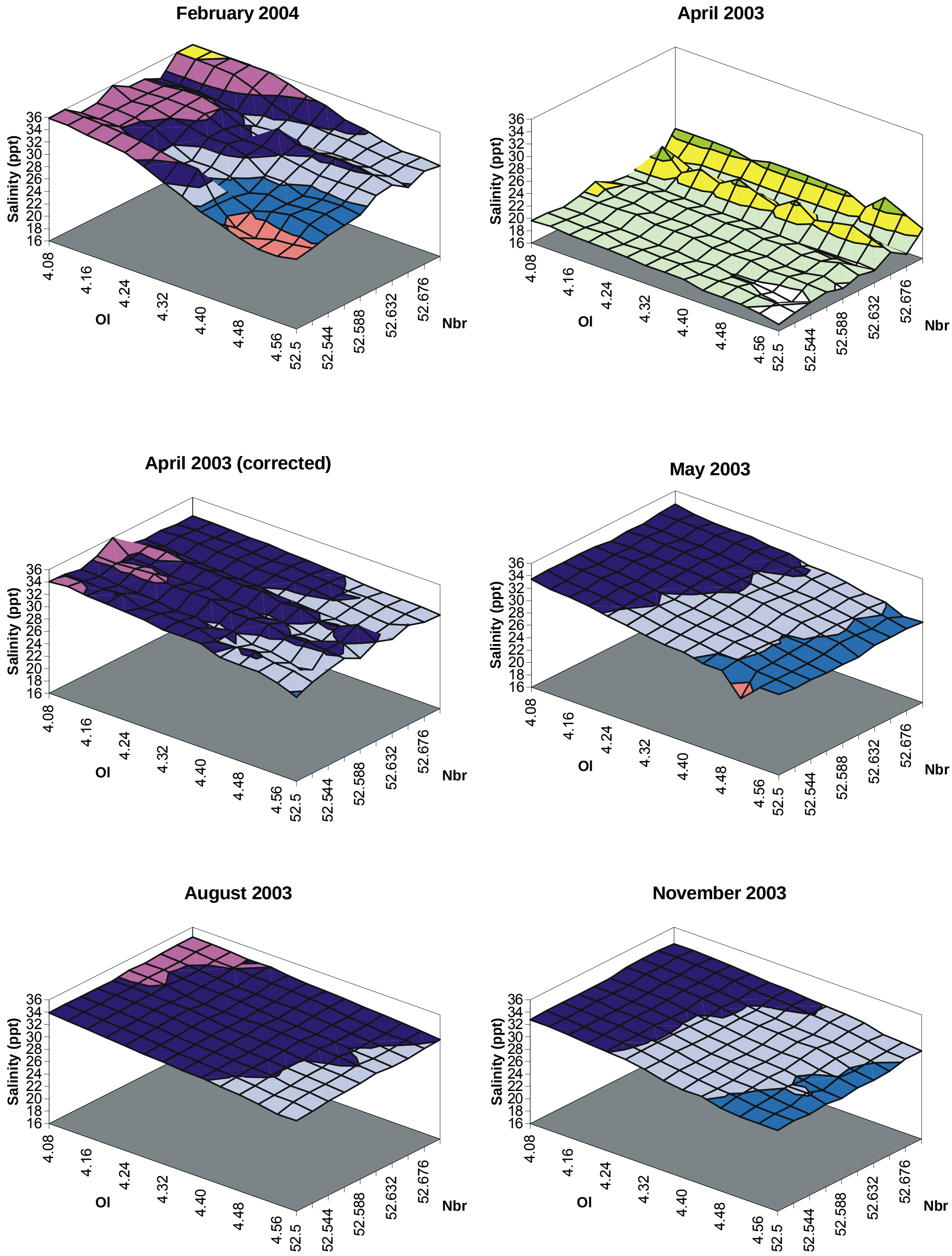


Figure 7. Three-dimensional plots of salinity against geographical coordinates

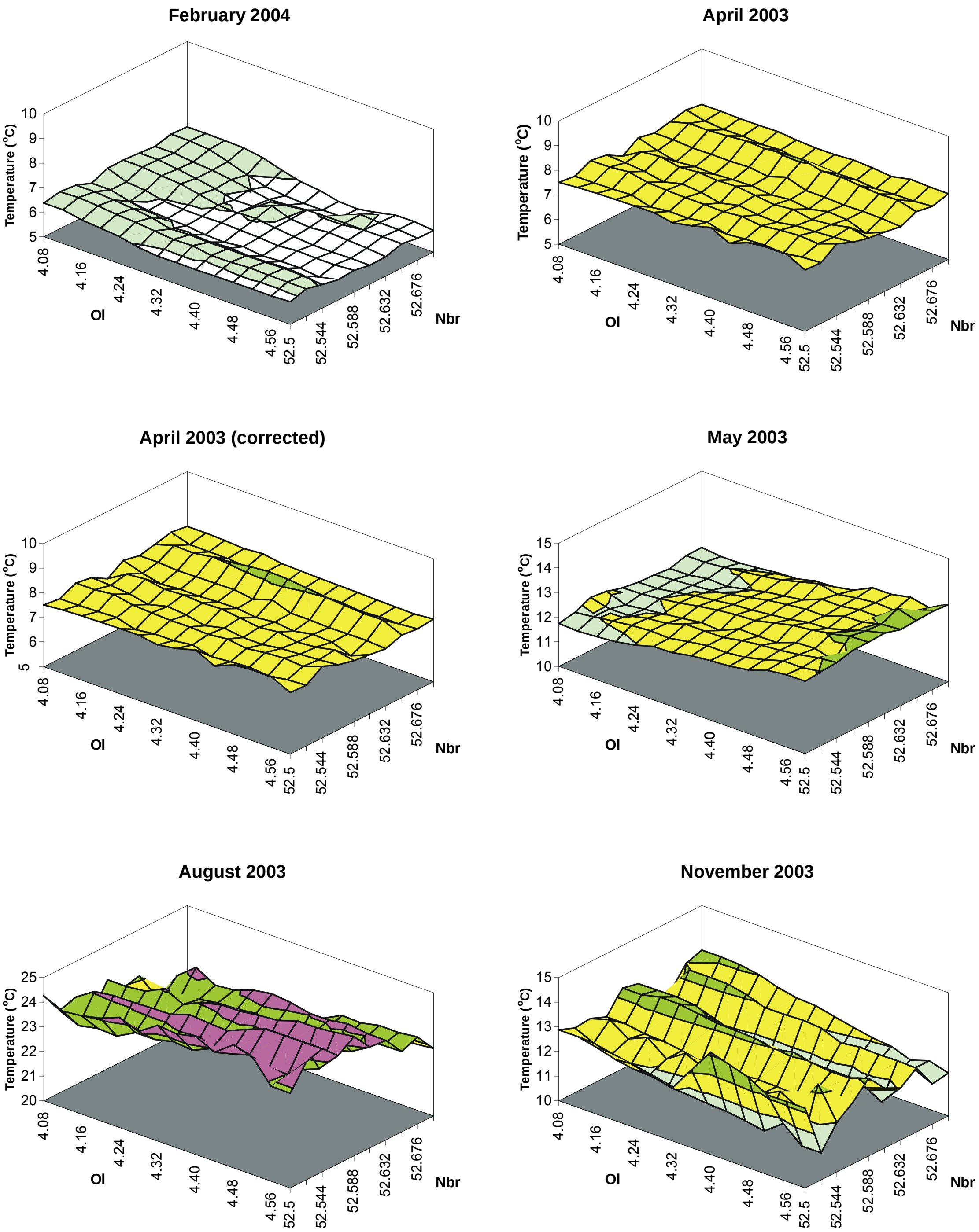


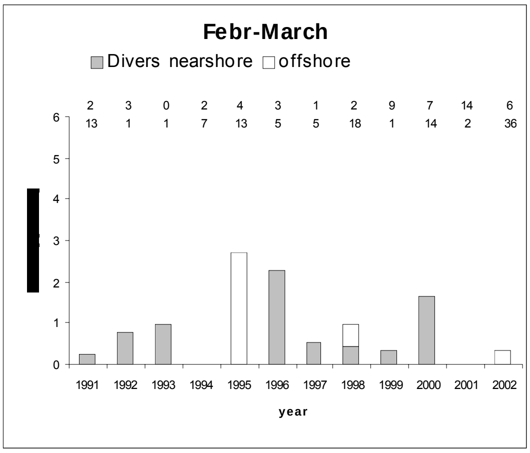
Figure 8. Three-dimensional plots of temperature against geographical coordinates

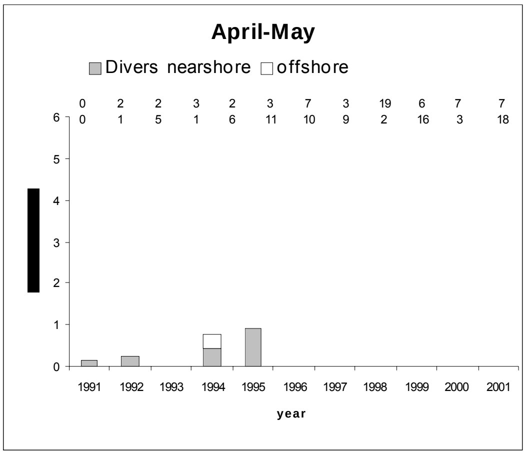
Appendix 3 Trends in average densities of key species of seabirds in the study area in the years 1991-2002, per season

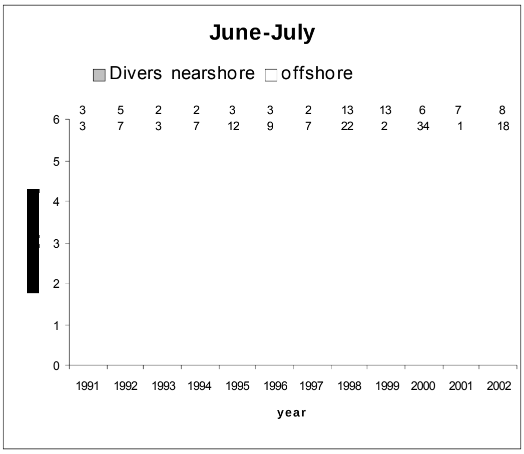
Trends in average densities of key species of seabirds in the study area in the years 1991-2002, per season (aerial survey data RIKZ). For this analysis, the datapoints in the RIKZ database with geographical positions within the contour of the present study area were extracted and separated into a set of nearshore counts and a set of offshore counts. The -20 m isobath used in the distribution models (diagonal line in Figure 2) is used to separate these two strata. Average bird densities were calculated by dividing the sum of all birds for each species, season, year and stratum, by the corresponding amount of effort (km^2 of strips watched from the plane). The seasons are those used by RIKZ for the aerial surveys: Aug/Sep; Oct/Nov; Dec/Jan; Feb/Mar; Apr/May and Jun/Jul. The species of seabirds analysed in this way are the same as treated in full in this report, excepting the Great Crested Grebe for which insufficient data were available. Note that three instead of two lumped categories of species had to be used here. Apart from problems with identifying divers and "commic" terns to species, also Common Guillemots and Razorbills look very similar from a fast flying plane (fast compared to ships speeds) and these two species had to be taken together as "razormots". The list of taxa treated in this Appendix is therefore:

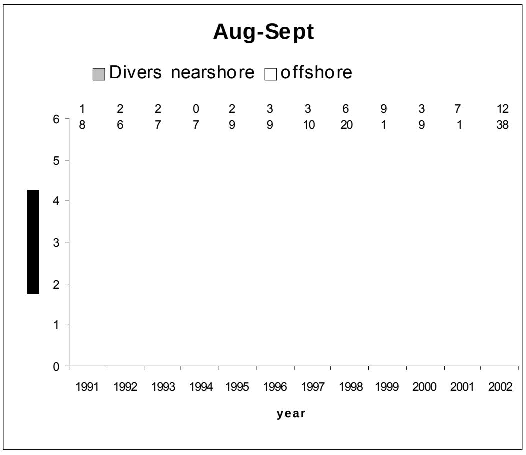
- Red-throated & Black-throated Divers ("divers")
- Northern Fulmar
- Northern Gannet
- Great Cormorant
- Eider
- Common Scoter
- Little Gull
- Common Gull
- Black-headed Gull
- Lesser Black-backed Gull
- Herring Gull
- Greater Black-backed Gull
- Kittiwake
- Sandwich Tern
- Common & Arctic Terns ("commic terns)
- Guillemot & Razorbill ("razormots")

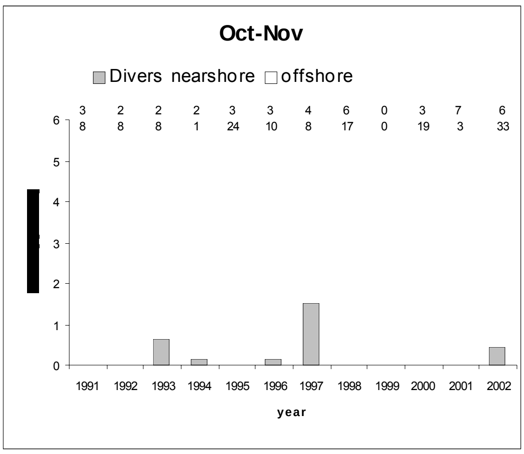
Appendix 3 (continued): densities of **Red-throated and Black-throated Divers** in the nearshore (grey bars) and offshore (white bars) strata in the study area, as derived from aerial counts (data RIKZ), in the years 1991-2002. Sample sizes (numbers of available counts) are given above the bars. Note that no data are available for: May/April 1991; December/January 1993 and October/November 1999 (both nearshore and offshore) and that in addition, no data are available for the offshore stratum for: February/March 1993; August/September 1994 and December/January 1994 and 1995.

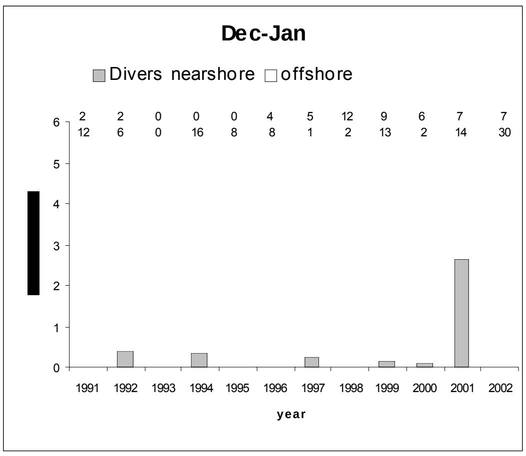




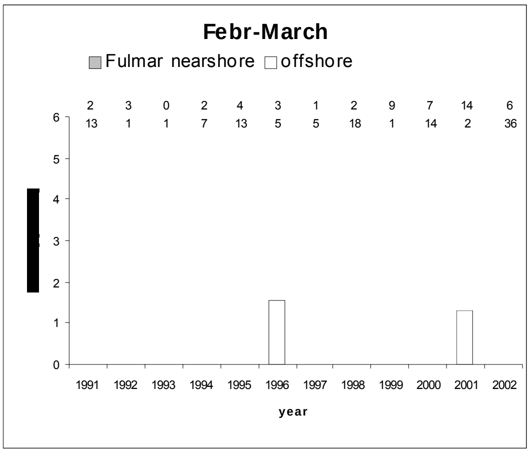


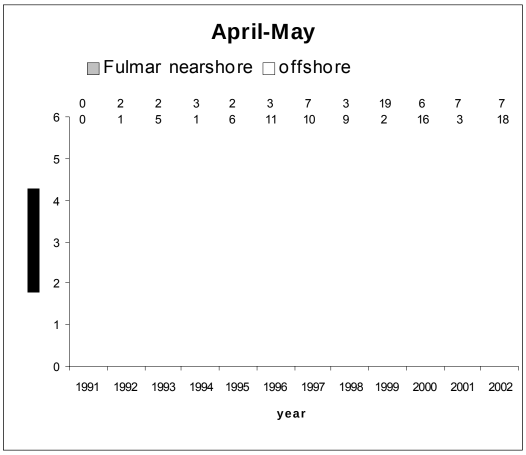


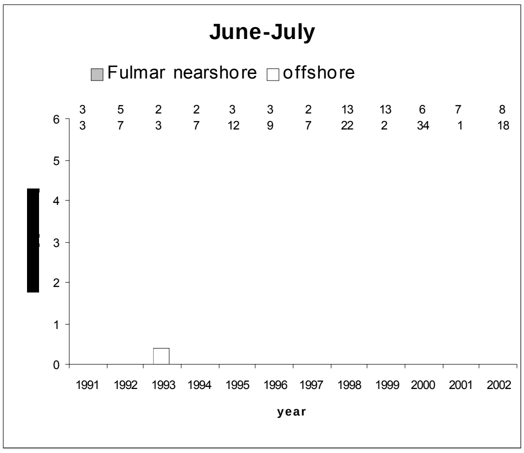


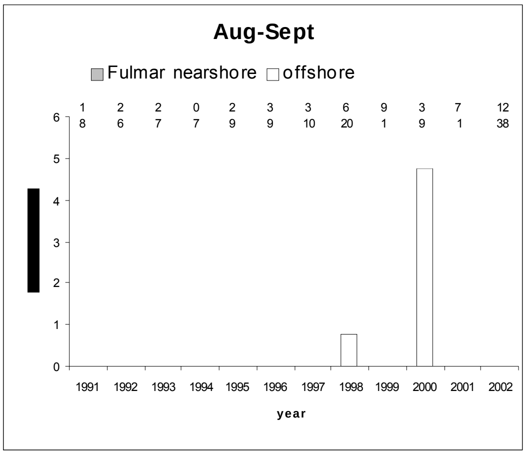


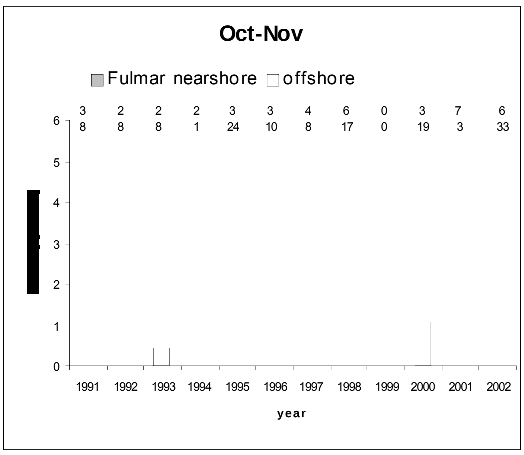
Appendix 3 (continued): densities of **Northern Fulmars** in the nearshore (grey bars) and offshore (white bars) strata in the study area, as derived from aerial counts (data RIKZ), in the years 1991-2002. Sample sizes (numbers of available counts) are given above the bars. Note that no data are available for: May/April 1991; December/January 1993 and October/November 1999 (both nearshore and offshore) and that in addition, no data are available for the offshore stratum for: February/March 1993; August/September 1994 and December/January 1994 and 1995.

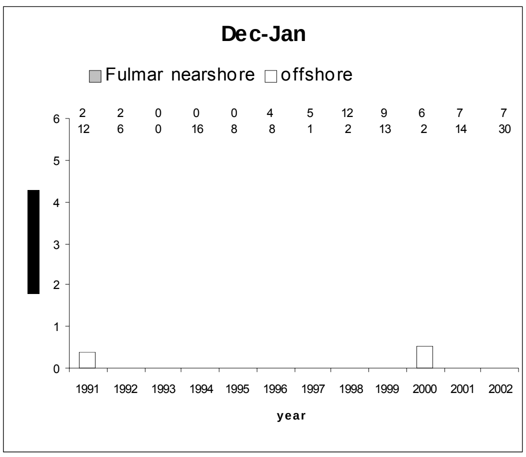




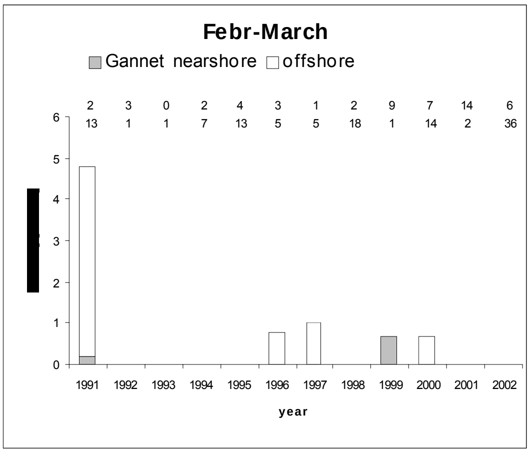


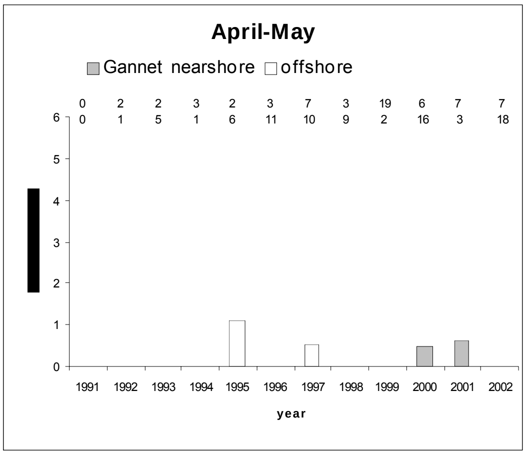


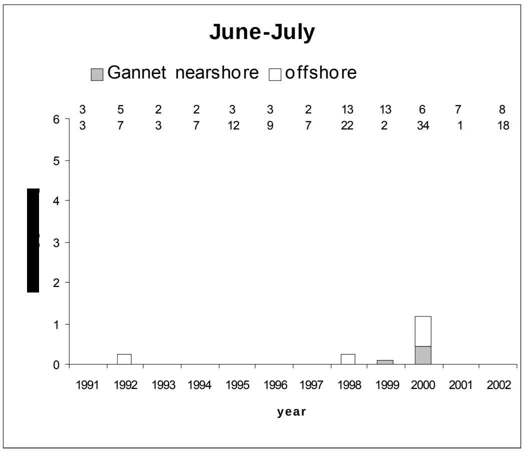


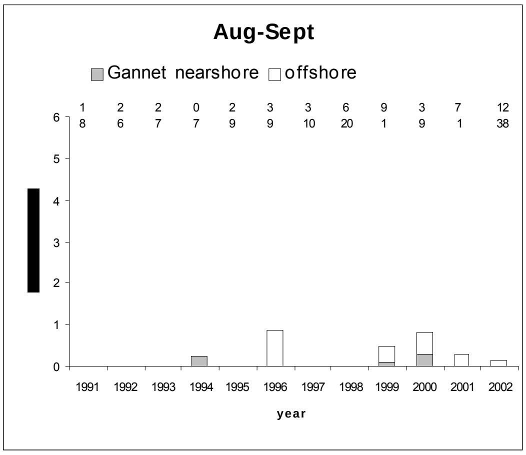


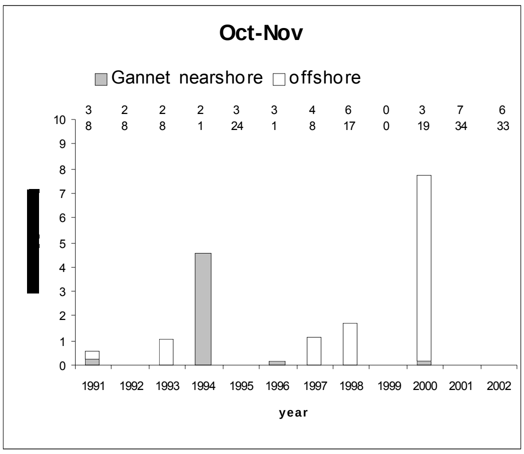
Appendix 3 (continued): densities of **Northern Gannets** in the nearshore (grey bars) and offshore (white bars) strata in the study area, as derived from aerial counts (data RIKZ), in the years 1991-2002. Sample sizes (numbers of available counts) are given above the bars. Note that no data are available for: May/April 1991; December/January 1993 and October/November 1999 (both nearshore and offshore) and that in addition, no data are available for the offshore stratum for: February/March 1993; August/September 1994 and December/January 1994 and 1995.

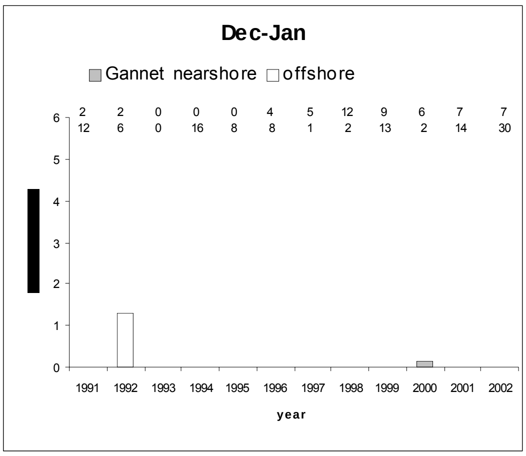




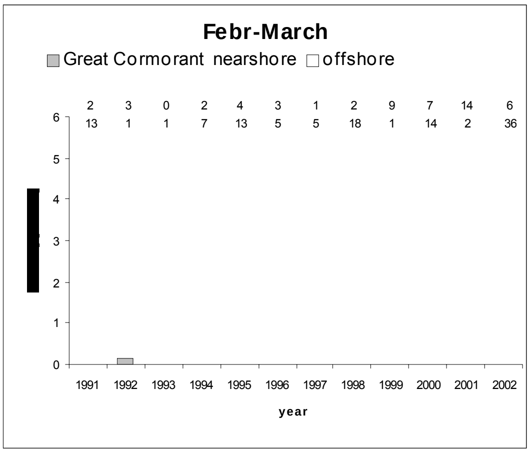


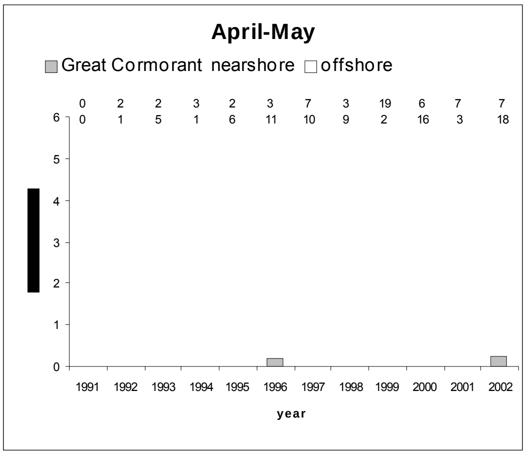


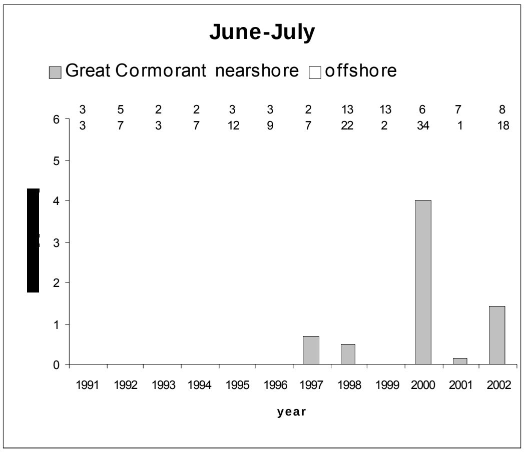


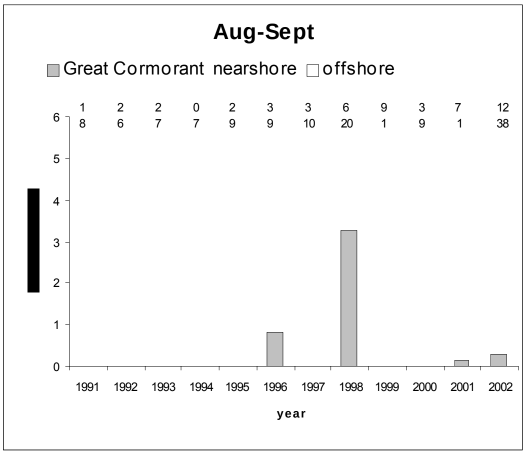


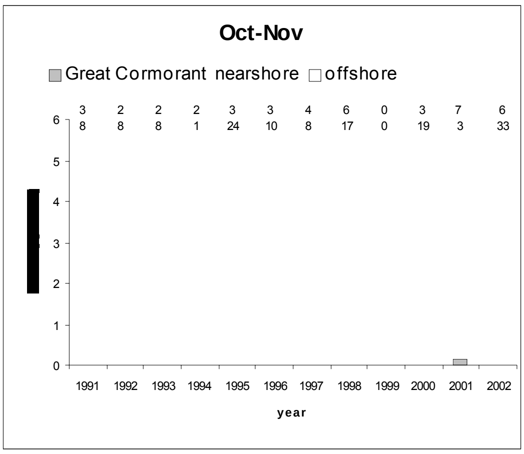
Appendix 3 (continued): densities of **Great Cormorants** in the nearshore (grey bars) and offshore (white bars) strata in the study area, as derived from aerial counts (data RIKZ), in the years 1991-2002. Sample sizes (numbers of available counts) are given above the bars. Note that no data are available for: May/April 1991; December/January 1993 and October/November 1999 (both nearshore and offshore) and that in addition, no data are available for the offshore stratum for: February/March 1993; August/September 1994 and December/January 1994 and 1995.

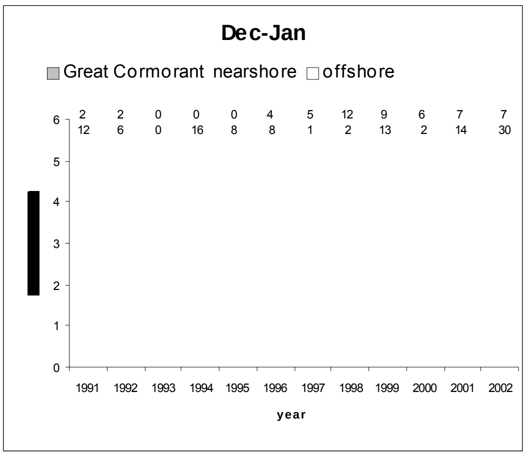




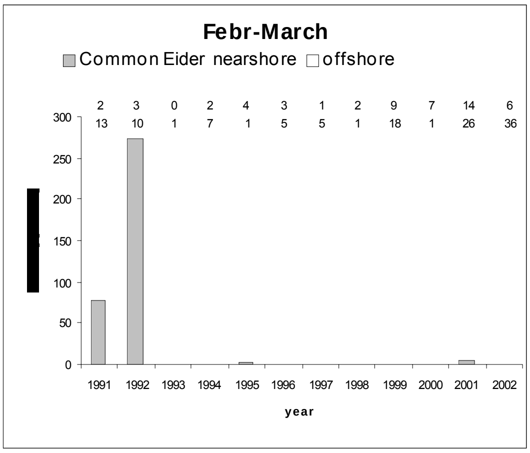


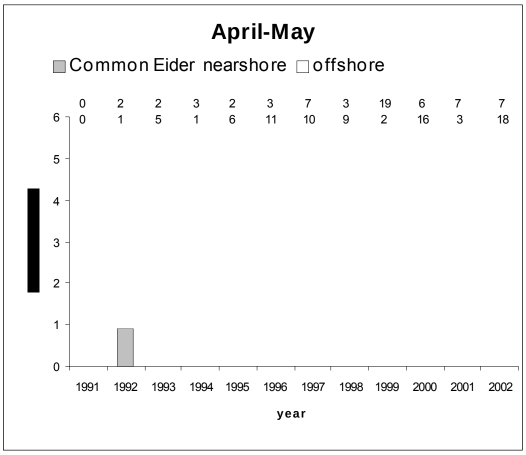


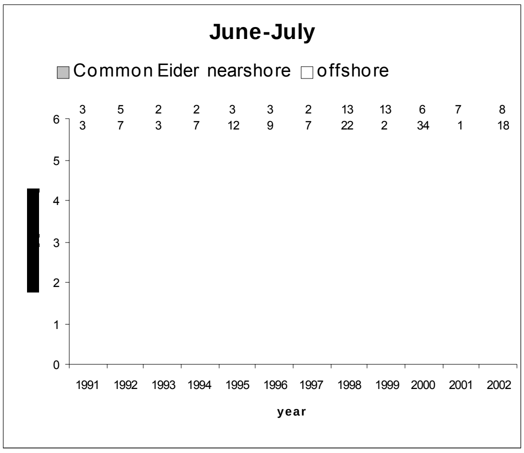


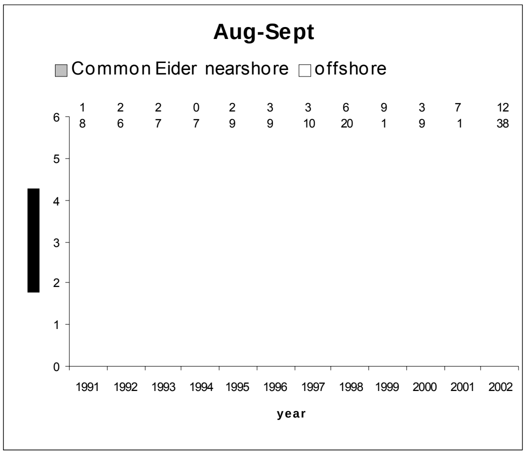


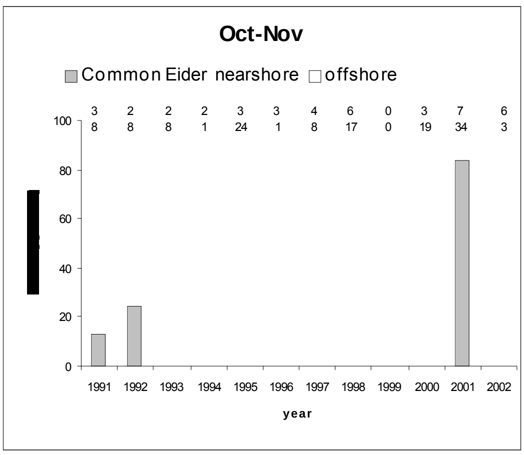
Appendix 3 (continued): densities of **Eiders** in the nearshore (grey bars) and offshore (white bars) strata in the study area, as derived from aerial counts (data RIKZ), in the years 1991-2002. Sample sizes (numbers of available counts) are given above the bars. Note that no data are available for: May/April 1991; December/January 1993 and October/November 1999 (both nearshore and offshore) and that in addition, no data are available for the offshore stratum for: February/March 1993; August/September 1994 and December/January 1994 and 1995.

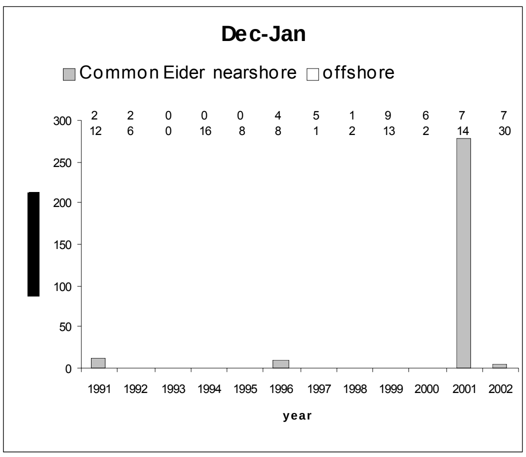




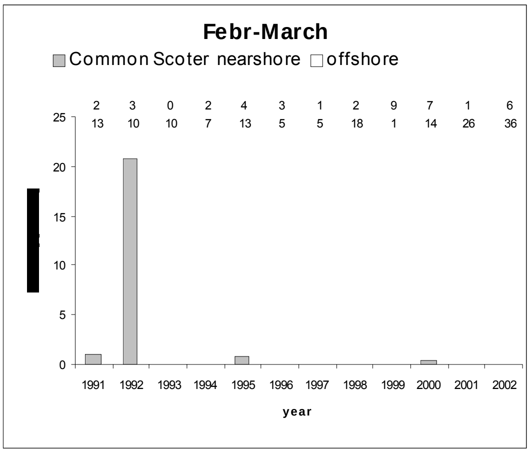


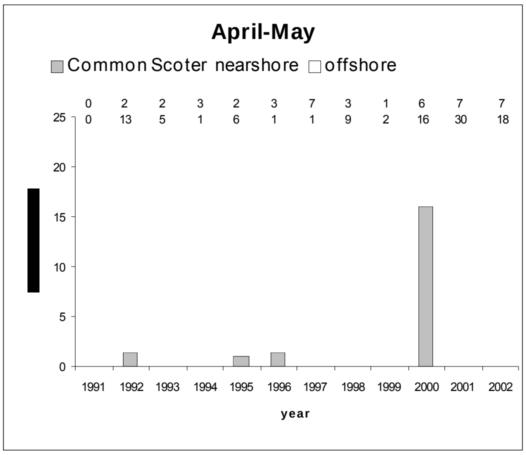


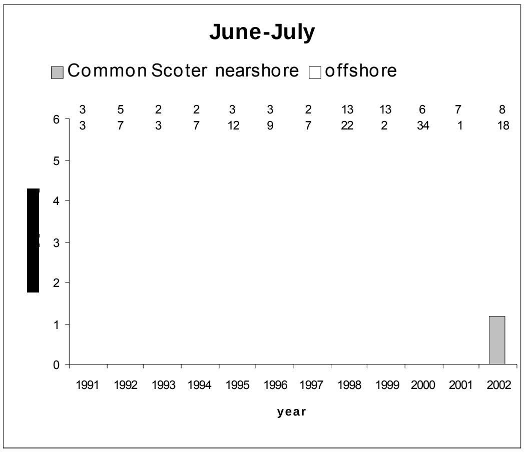


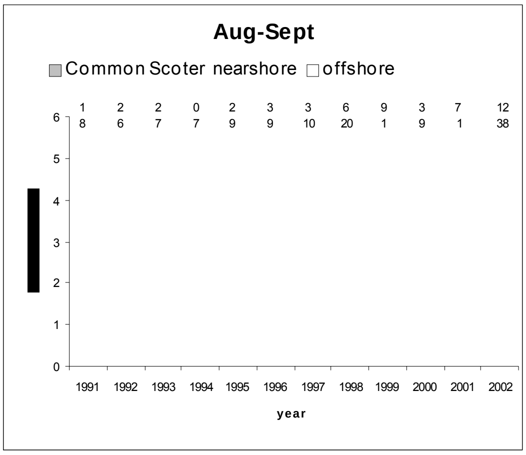


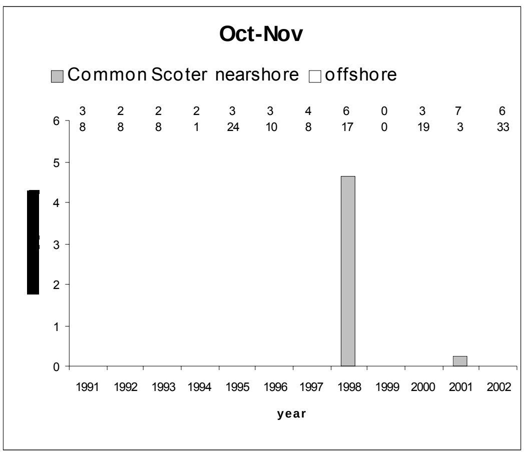
Appendix 3 (continued): densities of **Common Scoters** in the nearshore (grey bars) and offshore (white bars) strata in the study area, as derived from aerial counts (data RIKZ), in the years 1991-2002. Sample sizes (numbers of available counts) are given above the bars. Note that no data are available for: May/April 1991; December/January 1993 and October/November 1999 (both nearshore and offshore) and that in addition, no data are available for the offshore stratum for: February/March 1993; August/September 1994 and December/January 1994 and 1995.

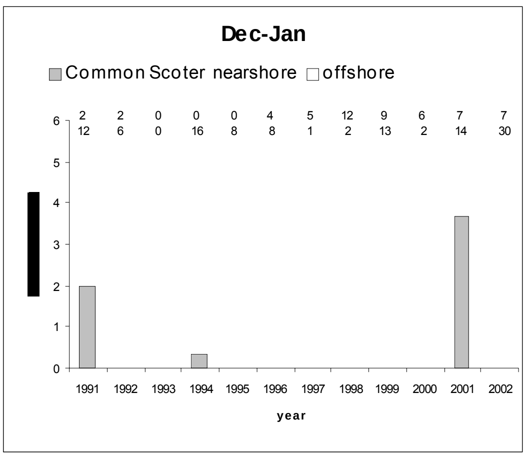




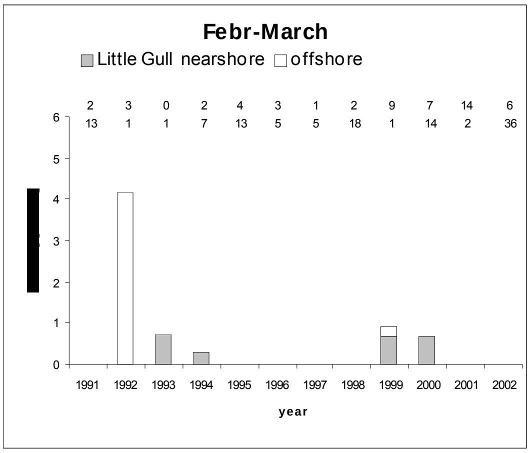


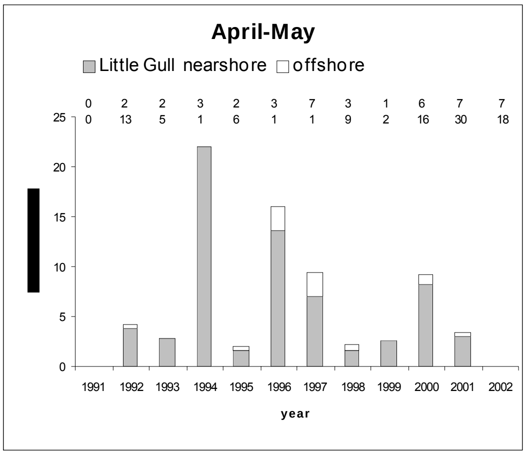


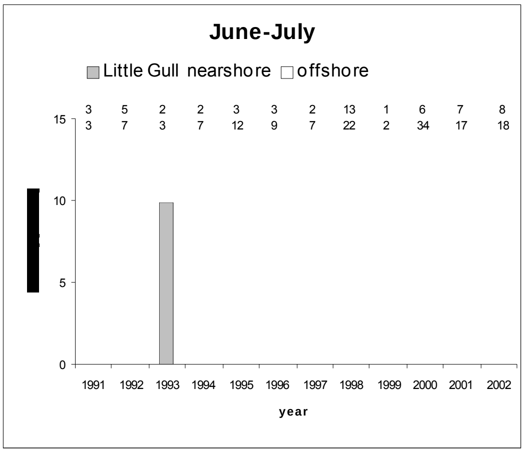


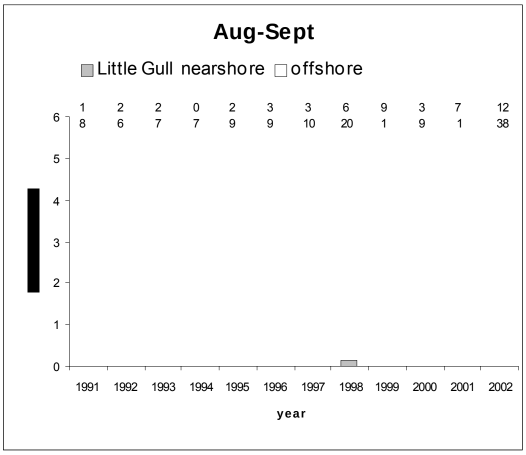


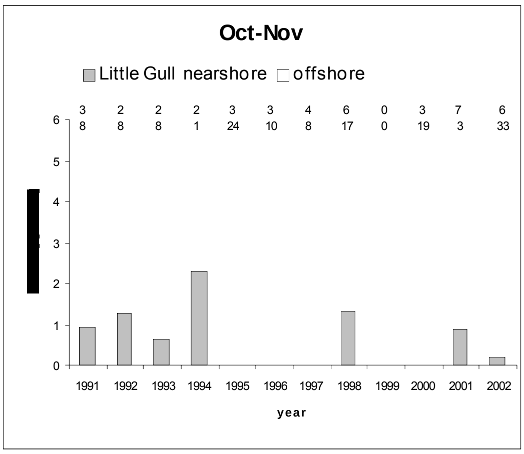
Appendix 3 (continued): densities of **Little Gulls** in the nearshore (grey bars) and offshore (white bars) strata in the study area, as derived from aerial counts (data RIKZ), in the years 1991-2002. Sample sizes (numbers of available counts) are given above the bars. Note that no data are available for: May/April 1991; December/January 1993 and October/November 1999 (both nearshore and offshore) and that in addition, no data are available for the offshore stratum for: February/March 1993; August/September 1994 and December/January 1994 and 1995.

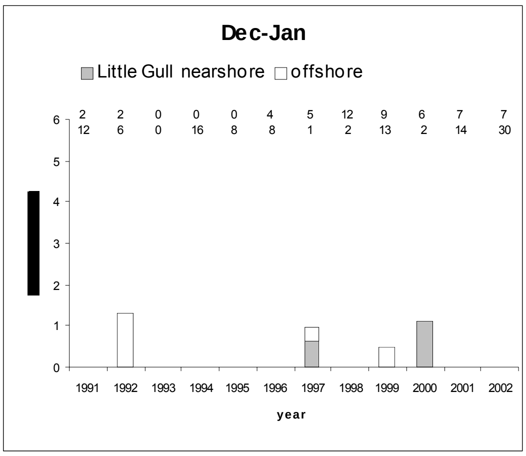




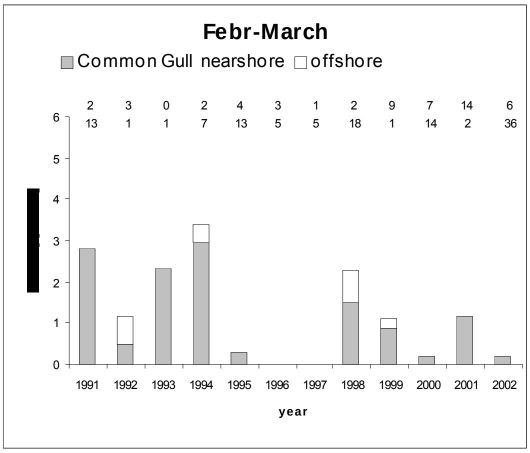


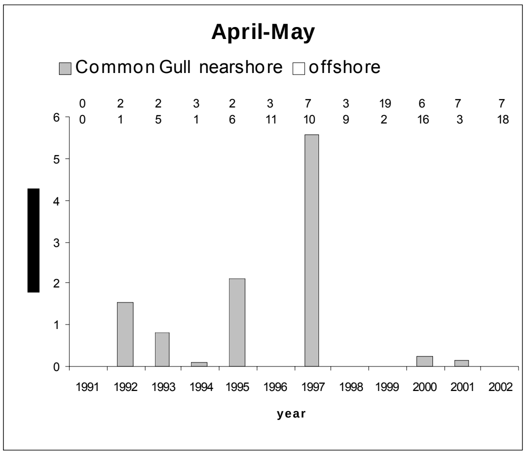


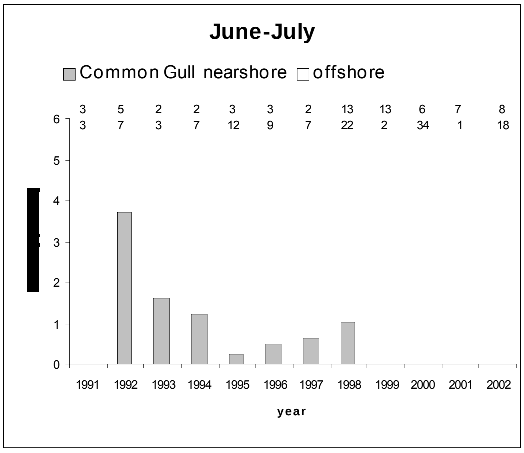


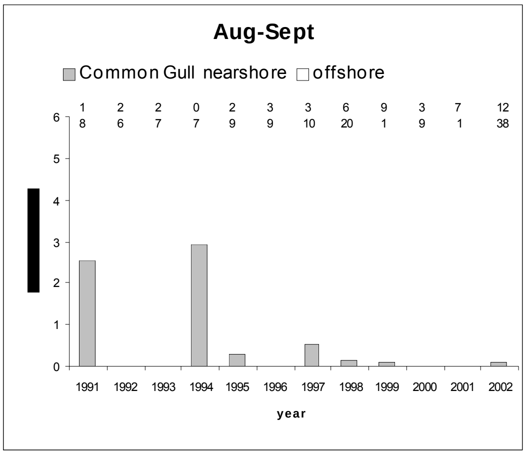


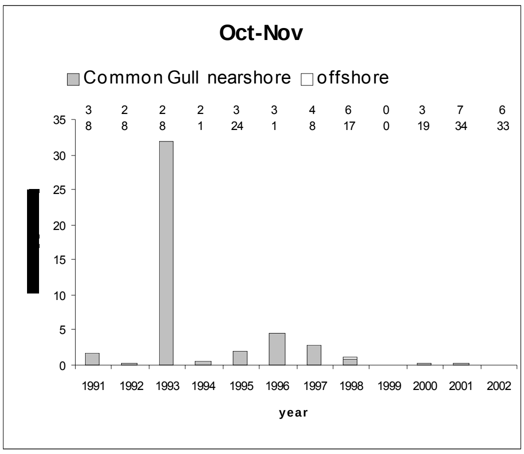
Appendix 3 (continued): densities of **Common Gulls** in the nearshore (grey bars) and offshore (white bars) strata in the study area, as derived from aerial counts (data RIKZ), in the years 1991-2002. Sample sizes (numbers of available counts) are given above the bars. Note that no data are available for: May/April 1991; December/January 1993 and October/November 1999 (both nearshore and offshore) and that in addition, no data are available for the offshore stratum for: February/March 1993; August/September 1994 and December/January 1994 and 1995.

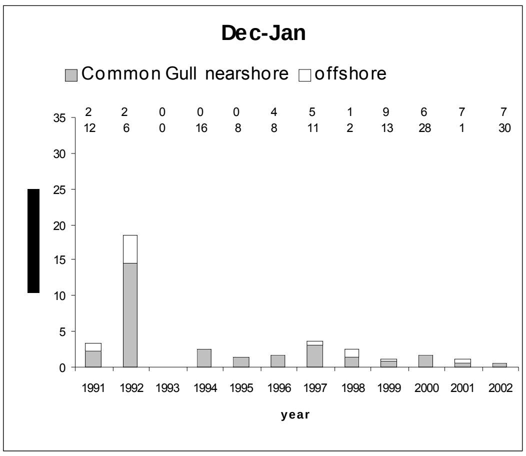




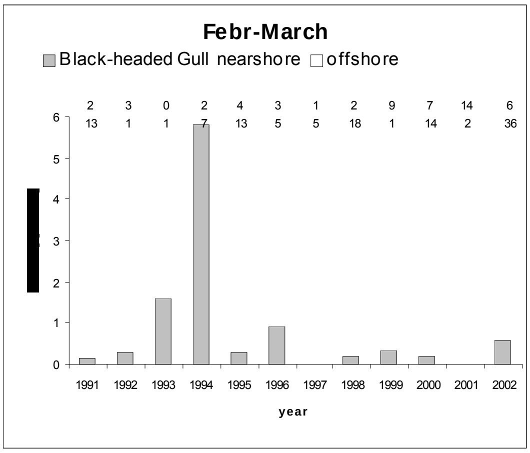


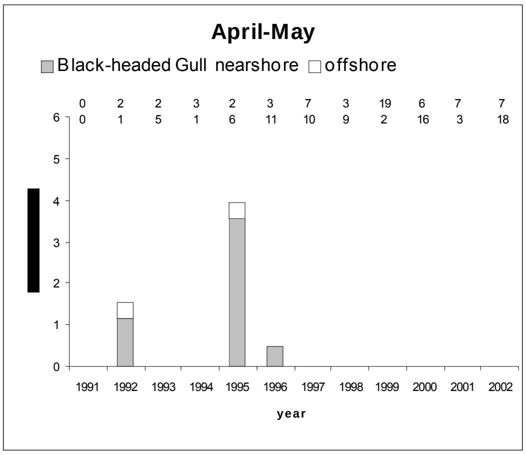


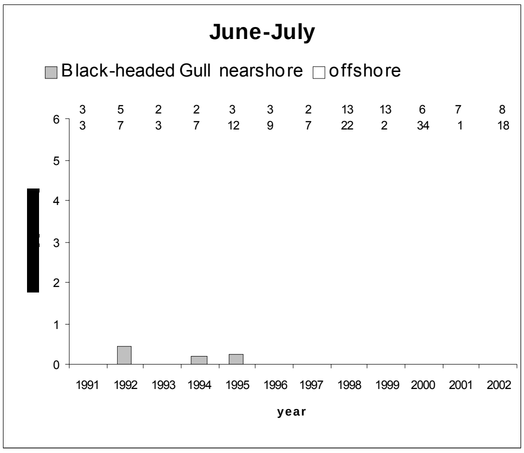


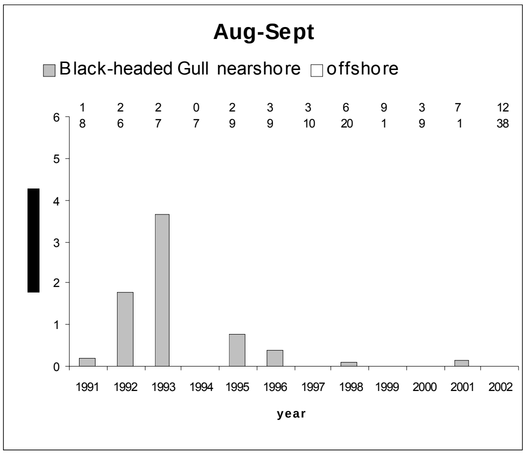


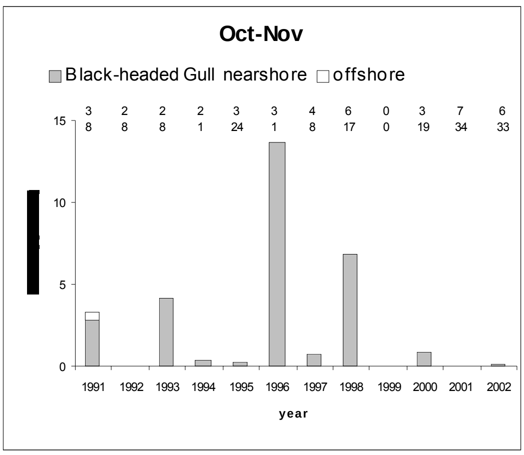
Appendix 3 (continued): densities of **Black-headed Gulls** in the nearshore (grey bars) and offshore (white bars) strata in the study area, as derived from aerial counts (data RIKZ), in the years 1991-2002. Sample sizes (numbers of available counts) are given above the bars. Note that no data are available for: May/April 1991; December/January 1993 and October/November 1999 (both nearshore and offshore) and that in addition, no data are available for the offshore stratum for: February/March 1993; August/September 1994 and December/January 1994 and 1995.

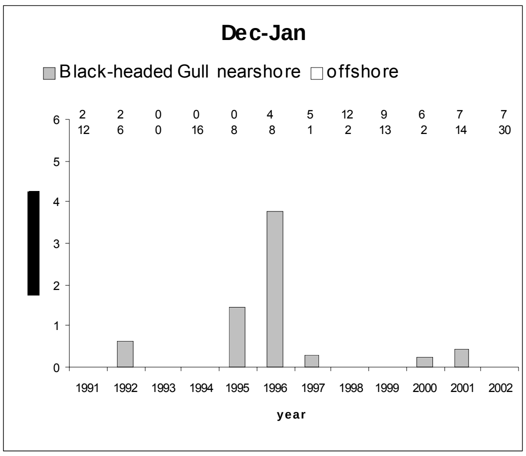




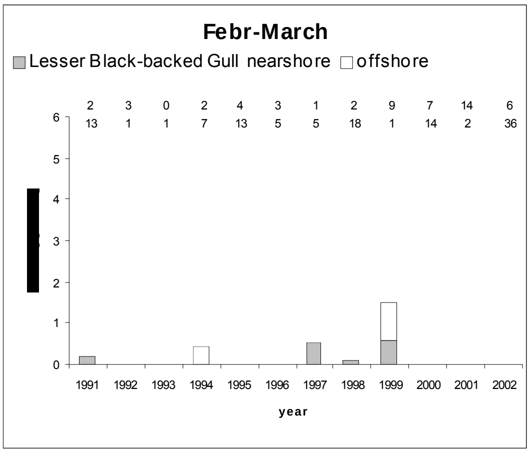


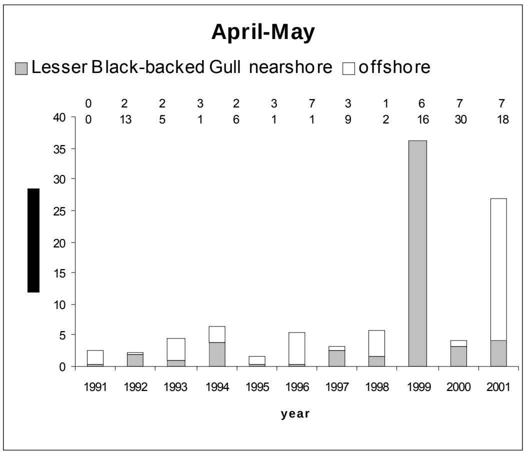


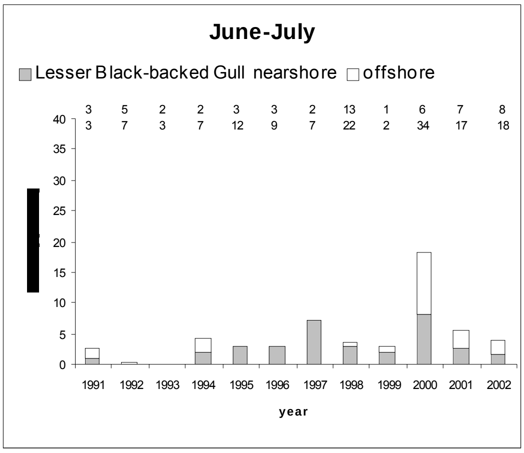


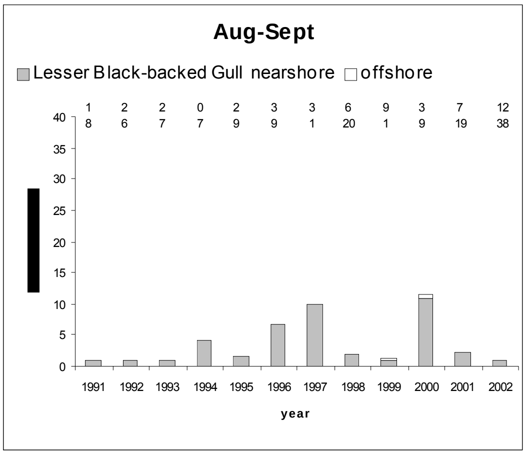


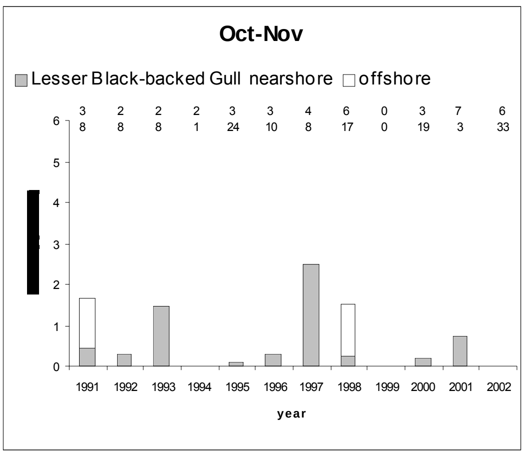
Appendix 3 (continued): densities of **Lesser Black-backed Gulls** in the nearshore (grey bars) and offshore (white bars) strata in the study area, as derived from aerial counts (data RIKZ), in the years 1991-2002. Sample sizes (numbers of available counts) are given above the bars. Note that no data are available for: May/April 1991; December/January 1993 and October/November 1999 (both nearshore and offshore) and that in addition, no data are available for the offshore stratum for: February/March 1993; August/September 1994 and December/January 1994 and 1995.

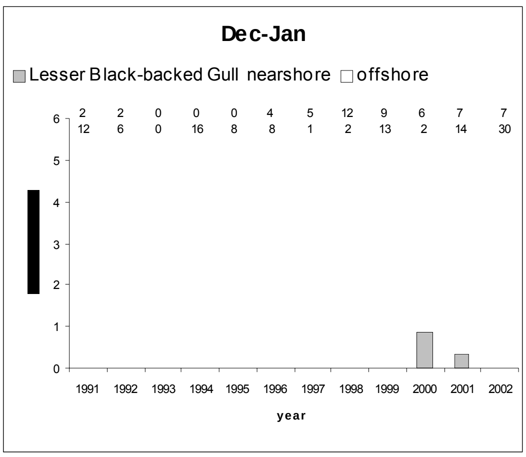




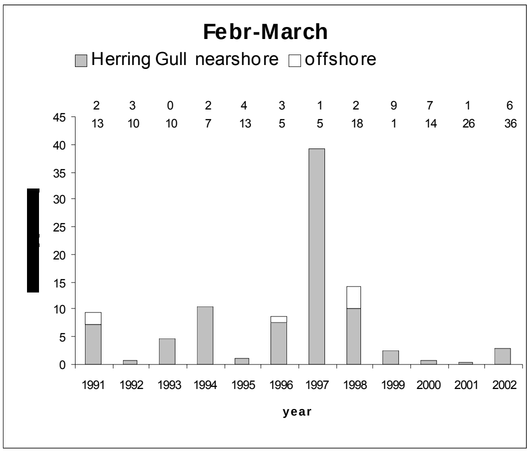


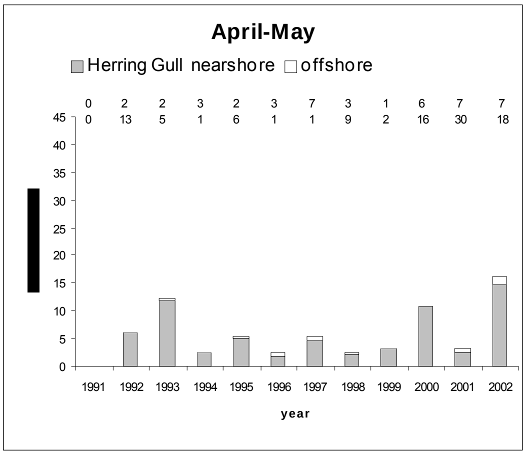


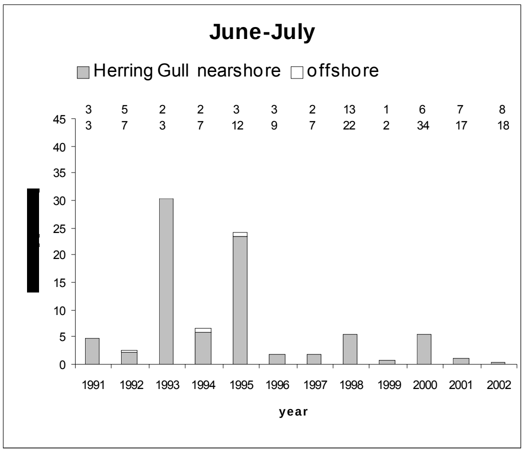


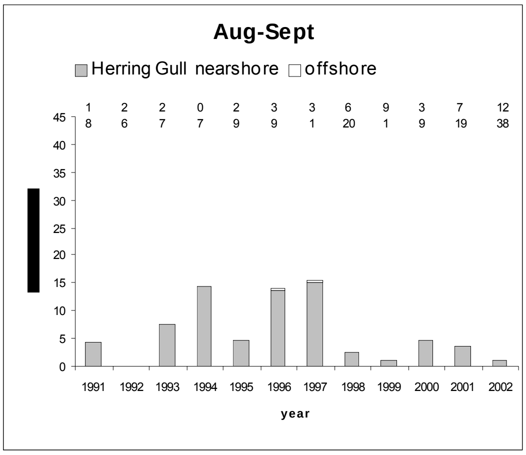


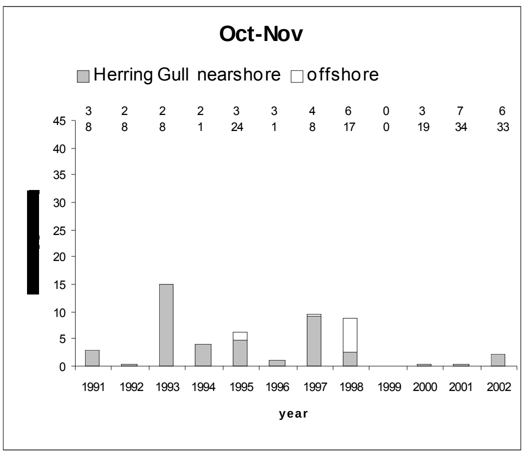
Appendix 3 (continued): densities of **Herring Gulls** in the nearshore (grey bars) and offshore (white bars) strata in the study area, as derived from aerial counts (data RIKZ), in the years 1991-2002. Sample sizes (numbers of available counts) are given above the bars. Note that no data are available for: May/April 1991; December/January 1993 and October/November 1999 (both nearshore and offshore) and that in addition, no data are available for the offshore stratum for: February/March 1993; August/September 1994 and December/January 1994 and 1995.

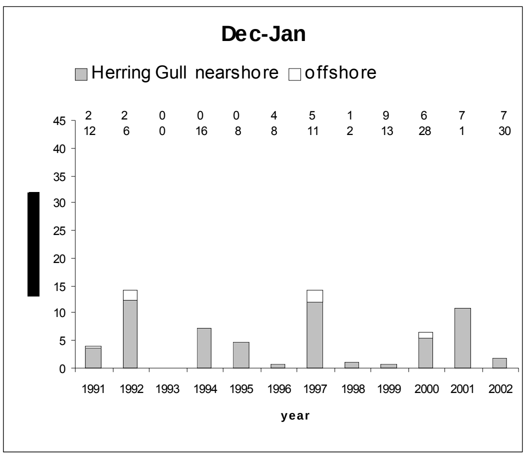




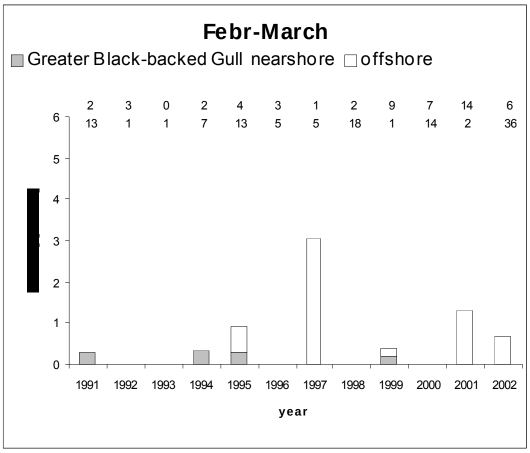


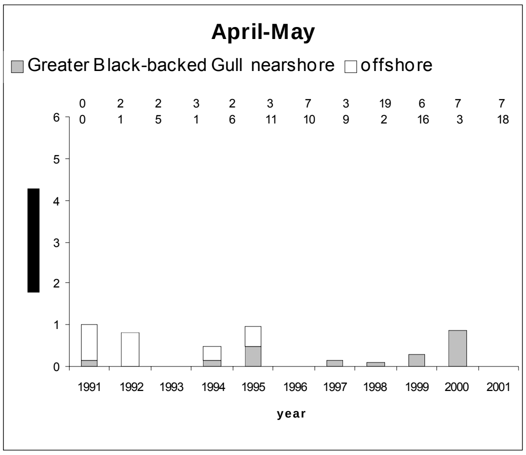


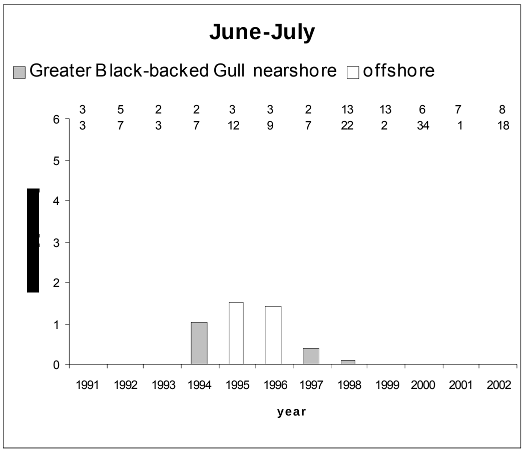


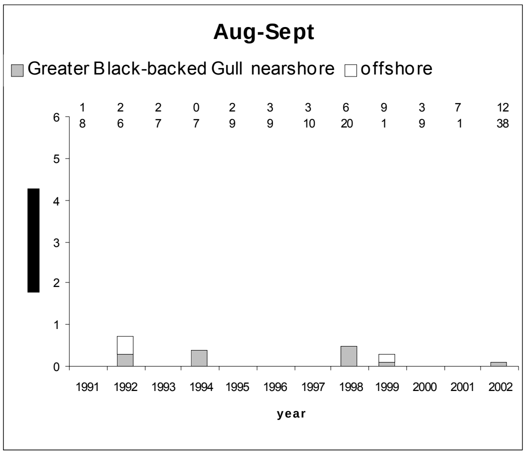


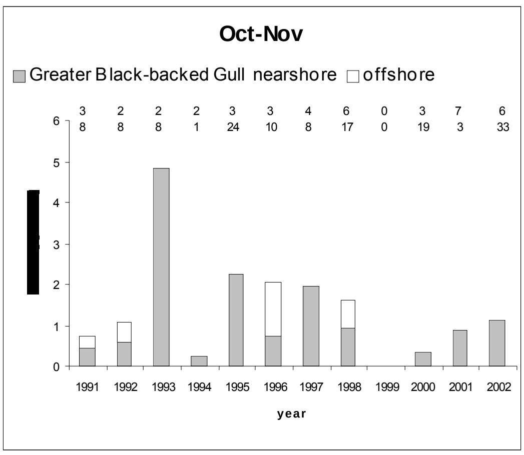
Appendix 3 (continued): densities of **Greater Black-backed Gulls** in the nearshore (grey bars) and offshore (white bars) strata in the study area, as derived from aerial counts (data RIKZ), in the years 1991-2002. Sample sizes (numbers of available counts) are given above the bars. Note that no data are available for: May/April 1991; December/January 1993 and October/November 1999 (both nearshore and offshore) and that in addition, no data are available for the offshore stratum for: February/March 1993; August/September 1994 and December/January 1994 and 1995.

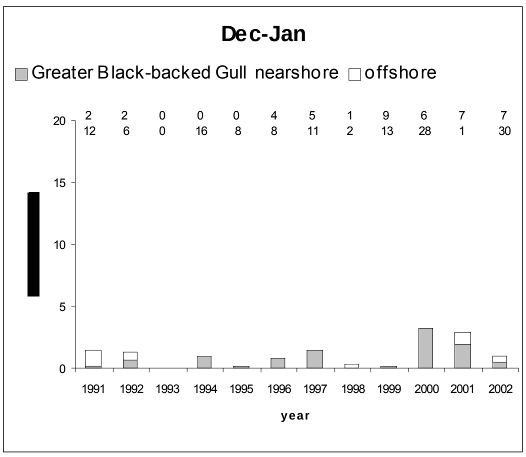




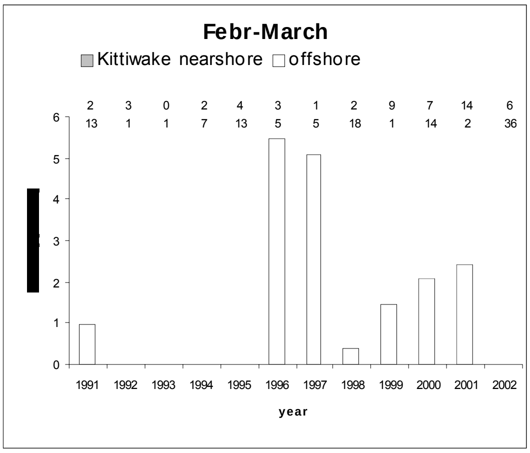


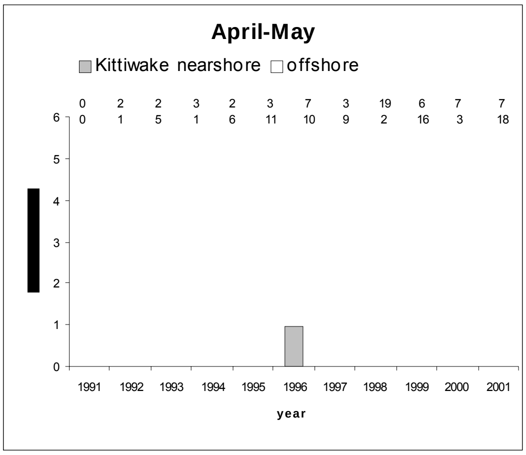


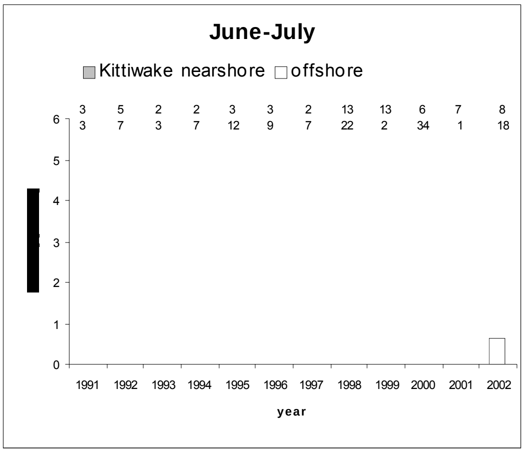


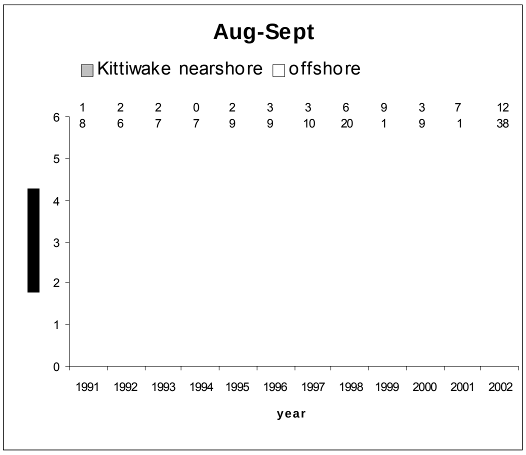


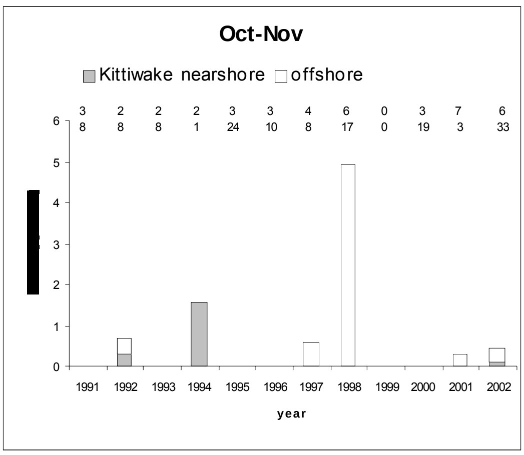
Appendix 3 (continued): densities of **Kittiwakes** in the nearshore (grey bars) and offshore (white bars) strata in the study area, as derived from aerial counts (data RIKZ), in the years 1991-2002. Sample sizes (numbers of available counts) are given above the bars. Note that no data are available for: May/April 1991; December/January 1993 and October/November 1999 (both nearshore and offshore) and that in addition, no data are available for the offshore stratum for: February/March 1993; August/September 1994 and December/January 1994 and 1995.

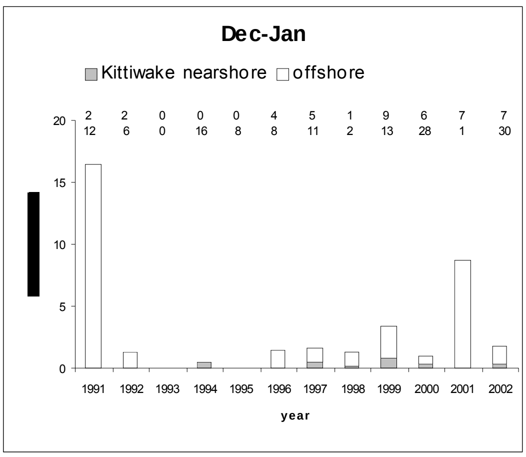




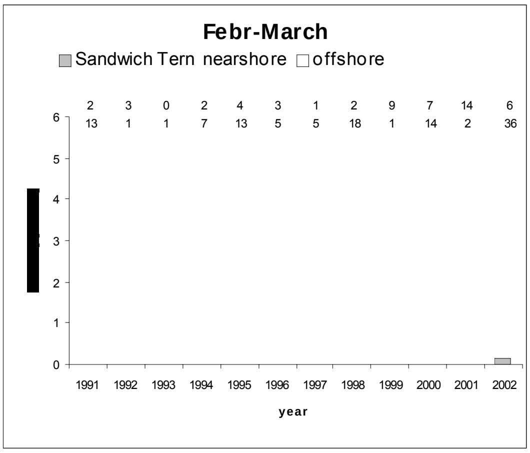


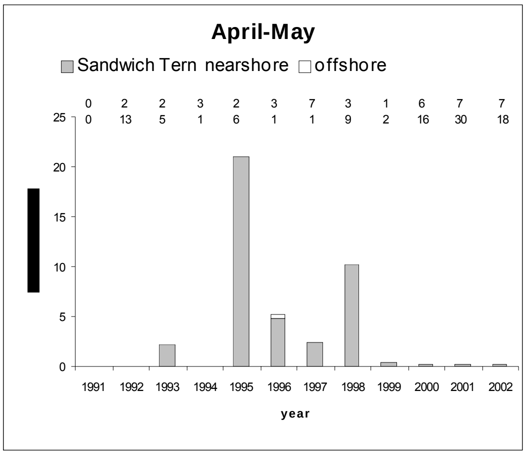


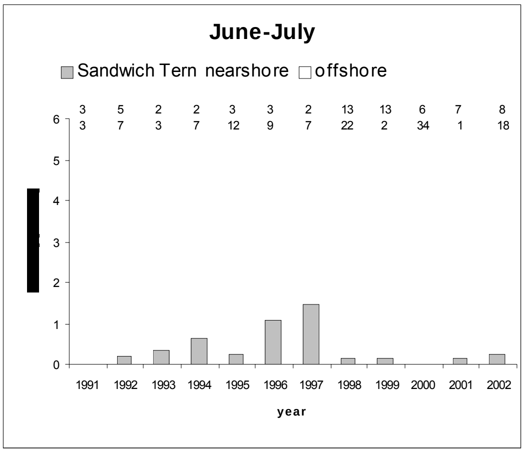


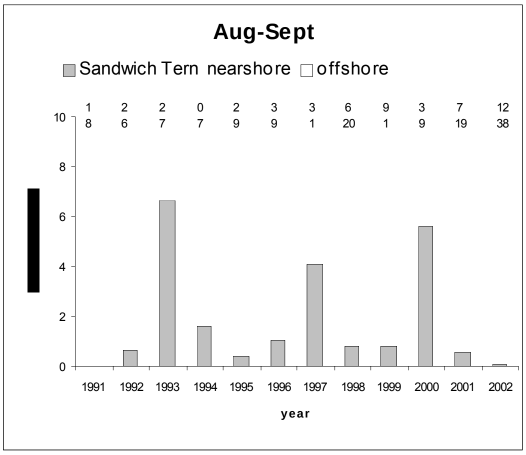


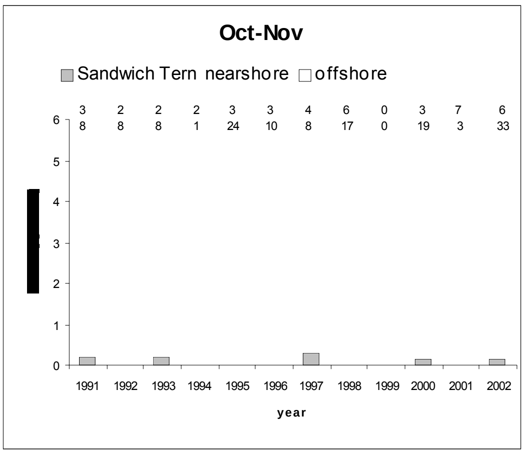
Appendix 3 (continued): densities of **Sandwich Terns** in the nearshore (grey bars) and offshore (white bars) strata in the study area, as derived from aerial counts (data RIKZ), in the years 1991-2002. Sample sizes (numbers of available counts) are given above the bars. Note that no data are available for: May/April 1991; December/January 1993 and October/November 1999 (both nearshore and offshore) and that in addition, no data are available for the offshore stratum for: February/March 1993; August/September 1994 and December/January 1994 and 1995.

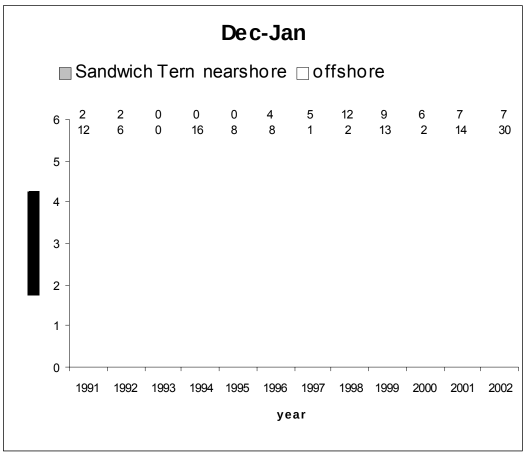




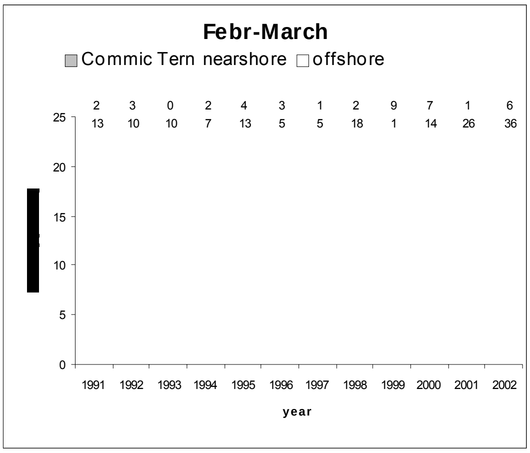


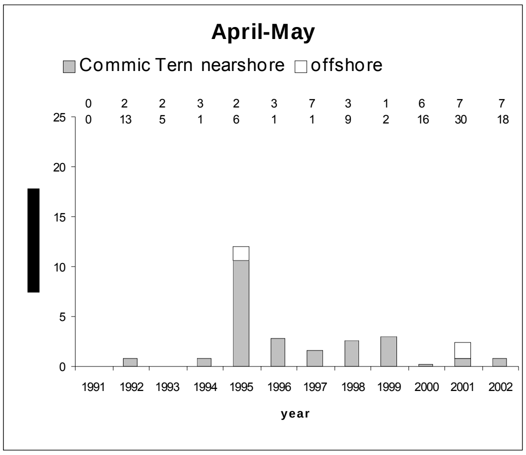


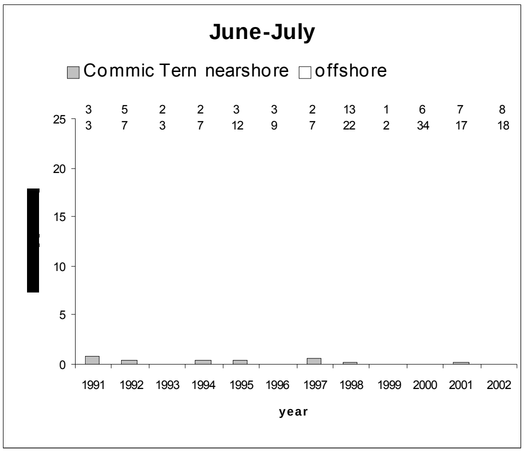


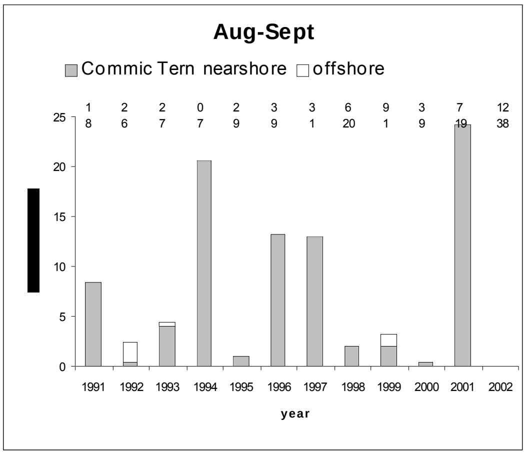


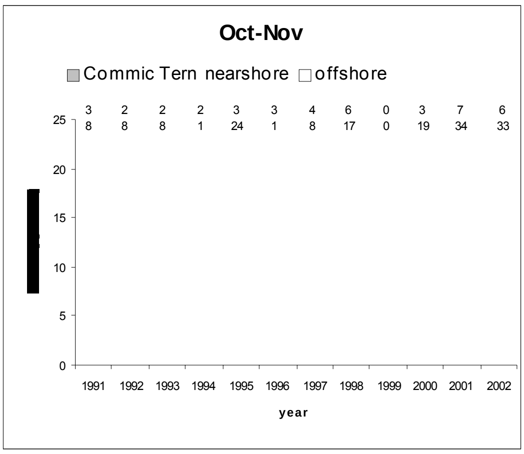
Appendix 3 (continued): densities of **"Commic" Terns** in the nearshore (grey bars) and offshore (white bars) strata in the study area, as derived from aerial counts (data RIKZ), in the years 1991-2002. Sample sizes (numbers of available counts) are given above the bars. Note that no data are available for: May/April 1991; December/January 1993 and October/November 1999 (both nearshore and offshore) and that in addition, no data are available for the offshore stratum for: February/March 1993; August/September 1994 and December/January 1994 and 1995.

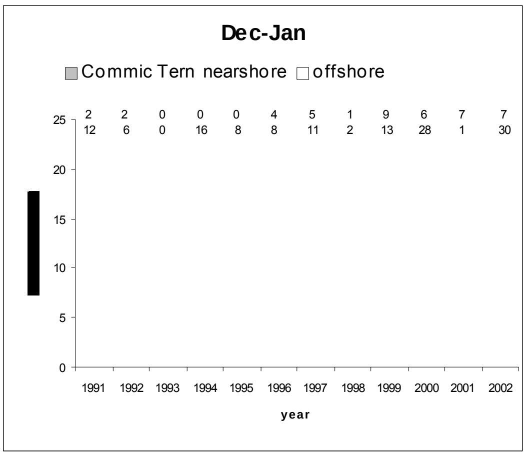




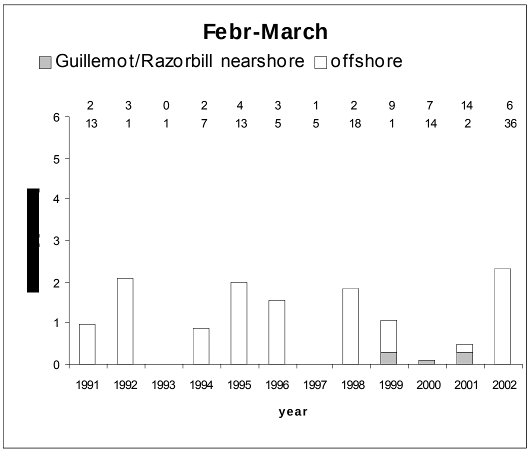


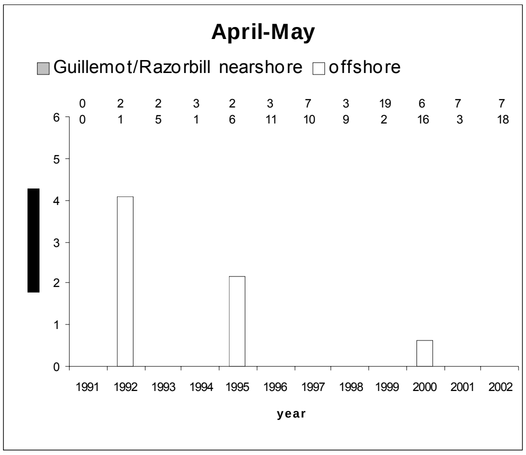


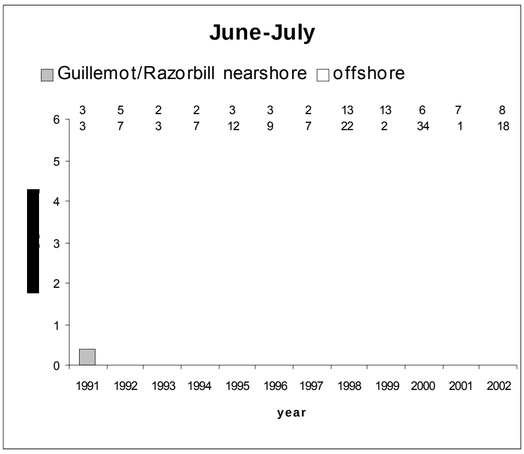


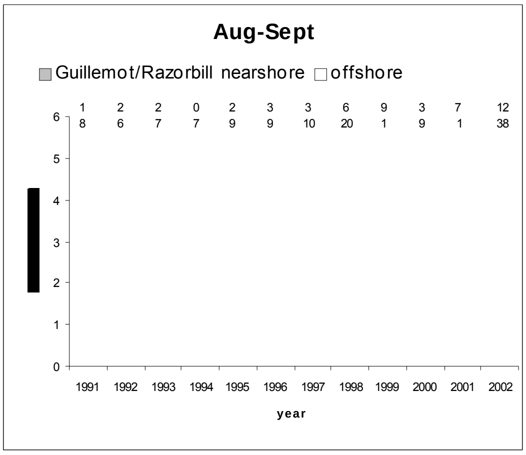


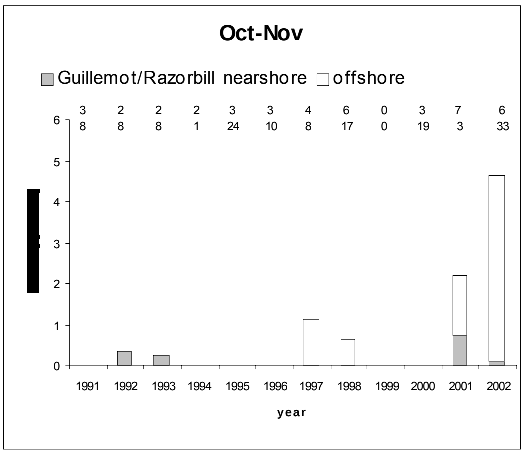
Appendix 3 (continued): densities of **Common Guillemots and Razorbills ("Razormots")** in the nearshore (grey bars) and offshore (white bars) strata in the study area, as derived from aerial counts (data RIKZ), in the years 1991-2002. Sample sizes (numbers of available counts) are given above the bars. Note that no data are available for: May/April 1991; December/January 1993 and October/November 1999 (both nearshore and offshore) and that in addition, no data are available for the offshore stratum for: February/March 1993; August/September 1994 and December/January 1994 and 1995.

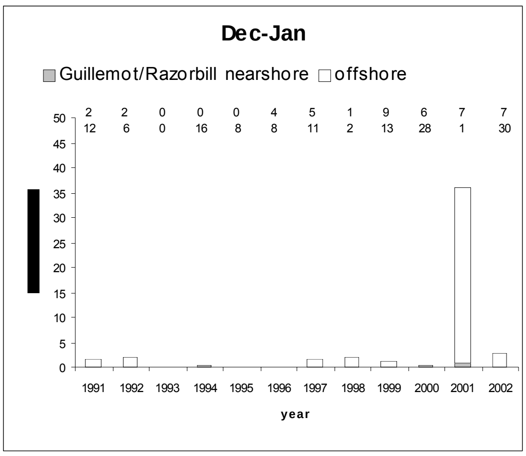












Appendix 4 Distributions of numbers of birds over the different sub-strips

Distributions of numbers of birds over the different sub-strips (see Figure 4) for all surveys combined, excepting June (see below). Bands AB, C and D are all 100 m wide, and if all birds present had actually been seen and correctly assigned to sub-band, numbers in the six columns AB, C and D should have been equal (in statistical terms). Birds assigned to "W" were seen on the water, in transect (anywhere in AB, C or D) and should be superimposed on these categories. Often, such birds belonged to large, widely scattered groups, sometimes comprising several species and age categories, making precise distance estimation difficult. As a possible result, parts of such groups near the trackline may sometimes have been denoted to sub-strip AB, while a relatively large proportion of the C and D birds may have been assigned to W. There seems to be a consistent difference among such birds, in that often the highest numbers were "seen" in band AB on portside. Note that the opposite is generally true for more cryptically coloured birds that often occur singly. Plunge-diving or surface dipping birds (Gannet, Little Gull and terns) did so often well ahead of the ship and this may also have resulted in a bias towards the AB category. Swimming did not or hardly occur in terns and only in large, conspicuous groups in Little Gulls and such birds are unlikely to be missed, as are (comparatively very large) Gannets. Seaducks (Eiderws and Commmon Scoters) finally, typically occurred in large groups that were both conspicuous and so rare, that too few sightings of groups were made to calculate useful correction factors. For these reasons, we do not recommend using corrections for Fulmar, Gannet, and all gulls and terns. For the other species correction factors have been calculated.

In June, the starboard team (Team 1 in the other surveys) was headed by a different observer. In the lower panel the starboard team is named Team 3. With relatively few (cryptic) birds being present in the study area in mid-summer, this change was mainly relevant for the Great Cormorant data gathered. In June, Team 3 say fewer Great Cormorants than Team 2 on portside (correction factor from Team 3 to Team 2 = 1.12), but as Team 1 would probably have seen even more Great Cormorants (upper panel), the total correction factor for the Great Cormorant in June is calculated as (1.12x1.16)=1.30.

	Portside: Team 2					Starboard: Team 1						
	F	W	D	C	AB	AB	C	D	W	F	Total	Correction Factor
divers	1	42	11	4	21	64	21	53	62	32	311	1.26
Gr-C Grebe	2	3	5	0	8	27	9	11	4	7	76	2.16
Fulmar	17	4	6	4	18	18	3	27	25	33	155	
Gannet	32	7	20	14	40	55	31	63	26	92	380	
Cormorant	43	32	49	32	78	128	54	91	28	144	679	1.16
Eider	5	59	30	64	0	26	61	61	188	31	525	
Comm. Scoter	60	220	9	0	0	4	8	6	173	105	585	
Little Gull	72	154	30	25	90	96	37	67	251	123	945	
Common Gull	48	70	32	2	43	9	1	6	44	54	309	
Bl-head. Gull	190	975	84	52	105	102	14	24	677	169	2392	
LBB Gull	1313	2438	408	251	571	474	157	195	4442	1221	11470	
Herring Gull	441	2166	197	110	313	213	56	105	5650	684	9935	
GBB Gull	113	1108	111	97	135	129	44	51	2230	155	4173	
Kittiwake	87	147	48	13	65	96	19	45	86	89	695	
Sandw. Tern	31	1	26	3	19	3	3	16	10	131	243	
Commic terns	81	20	4	3	6	19	1	115	24	451	724	
Guillemot	9	9	116	103	281	414	156	264	8	21	1381	1.83
Razorbill	0	11	24	10	22	29	4	7	2		109	1.63
	Portside: Team 2					Starboard: Team 3						Correction Factor
Cormorant (July)	32	58	36	33	67	52	17	30	5	38	368	(1.12x1.16)= 1.30

Appendix 5 All birds seen during the February (2004) survey, split-up into birds seen along the nearshore (depths < 20 m) and offshore (> 20 m) components of the study area

			NEARSHORE		OFFSHORE		
Euring	**Scientific name**	**English name**	**Total-in**	**Total out**	**Total in**	**Total out**	**Grand Total**
20	Gavia stellata	Red-throated Diver	69	86	2	4	**161**
30	Gavia arctica	Black-throated Diver	4	1			**5**
59	Gavia spec.	unidentified diver	1	22			**23**
90	Podiceps cristatus	Great Crested Grebe	63	24			**87**
100	Podiceps griseigena	Red-necked Grebe		3			**3**
110	Podiceps auritus	Slavonian Grebe		2			**2**
220	Fulmarus glacialis	Northern Fulmar			43	33	**76**
710	Sula bassana	Northern Gannet	5	3	7	19	**34**
720	Phalacrocorax carbo	Great Cormorant	9	10	1		**20**
1610	Anser anser	Greylag Goose		7			**7**
1680	Branta bernicla	Brent Goose		72		2	**74**
1790	Anas penelope	Wigeon		151			**151**
1840	Anas crecca	Common Teal		4			**4**
1890	Anas acuta	Northern Pintail		68			**68**
2030	Aythya fuligula	Tufted Duck	21	3			**24**
2040	Aythya marila	Greater Scaup		115			**115**
2060	Somateria mollissima	Common Eider	411	350			**761**
2120	Clangula hyemalis	Long-tailed Duck		3			**3**
2130	Melanitta nigra	Common Scoter	71	480		63	**614**
2150	Melanitta fusca	Velvet Scoter	4	11			**15**
4500	Haematopus ostralegus	Eurasian Oystercatcher		4			**4**
4860	Pluvialis squatarola	Grey Plover				1	**1**
4970	Calidris alba	Sanderling		11			**11**
5120	Calidris alpina	Dunlin		1		2	**3**
5340	Limosa lapponica	Bar-tailed Godwit				1	**1**
5410	Numenius arquata	Curlew		8			**8**
5780	Larus minutus	Little Gull	3	10	2	2	**17**
5820	Larus ridibundus	Black-headed Gull	9	5		11	**25**
5900	Larus canus	Common Gull	93	235	91	63	**482**
5910	Larus fuscus	Lesser Black-backed Gull	5	7	22	8	**42**
5920	Larus argentatus	Herring Gull	35	98	128	68	**329**
6000	Larus marinus	Great Black-backed Gull	1	11	31	17	**60**
6020	Rissa tridactyla	Black-legged Kittiwake	9	19	17	63	**108**
6049	Larus spec.	unidentified gull				70	**70**
6340	Uria aalge	Guillemot	59	68	267	94	**488**
6345	Alca torda / Uria aalge	Guillemot / Razorbill		5		37	**42**
6360	Alca torda	Razorbill	16	20	45	9	**90**
6540	Fratercula arctica	Atlantic Puffin				1	**1**
9760	Alauda arvensis	Skylark		2	1	1	**4**
10110	Anthus pratensis	Meadow Pipit		3			**3**
15820	Sturnus vulgaris	Starling		4	1	13	**18**
23510	Phocoena phocoena	Harbour Porpoise	130	22	53	6	**211**
24330	Phoca vitulina	Common Seal	3				**3**

Appendix 5 (continued). All birds seen during the April (2003) survey, split-up into birds seen along the nearshore (depths < 20 m) and offshore (> 20 m) components of the study area.

			NEARSHORE		OFFSHORE		
Euring	**Scientific name**	**English name**	**Total-in**	**Total out**	**Total in**	**Total out**	**Grand Total**
20	Gavia stellata	Red-throated Diver	29	49	101	53	**232**
30	Gavia arctica	Black-throated Diver		4	2	1	**7**
59	Gavia spec.	unidentified diver	4	19	4	30	**57**
90	Podiceps cristatus	Great Crested Grebe	3	4			**7**
100	Podiceps griseigena	Red-necked Grebe	2	2			**4**
220	Fulmarus glacialis	Northern Fulmar		3	35	54	**92**
710	Sula bassana	Northern Gannet	6	17	71	162	**256**
720	Phalacrocorax carbo	Great Cormorant	54	93	1	2	**150**
1570	Anser fabalis	Bean Goose		2			**2**
1680	Branta bernicla	Brent Goose		5		4	**9**
1700	Alopochen aegyptiacus	Egyptian Goose		2			**2**
1730	Tadorna tadorna	Shelduck		3			**3**
1790	Anas penelope	Wigeon		22			**22**
1820	Anas strepera	Gadwall		16			**16**
1840	Anas crecca	Common Teal		157			**157**
1860	Anas platyrhynchos	Mallard		2			**2**
1890	Anas acuta	Northern Pintail		74			**74**
1910	Anas querquedula	Garganey		2			**2**
1940	Anas clypeata	Northern Shoveler		80			**80**
2040	Aythya marila	Greater Scaup		2			**2**
2060	Somateria mollissima	Common Eider		66			**66**
2130	Melanitta nigra	Common Scoter	47	1030		37	**1114**
2150	Melanitta fusca	Velvet Scoter		8			**8**
2180	Bucephala clangula	Common Goldeneye		3			**3**
2210	Mergus serrator	Red-breasted Merganser		45			**45**
4700	Charadrius hiaticula	Ringed Plover				1	**1**
4860	Pluvialis squatarola	Grey Plover		16			**16**
4960	Calidris canutus	Knot		20			**20**
5670	Stercorarius parasiticus	Arctic Skua		1			**1**
5690	Stercorarius skua	Great Skua			1	1	**2**
5780	Larus minutus	Little Gull	261	339	525	840	**1965**
5820	Larus ridibundus	Black-headed Gull	15	39	4	1	**59**
5900	Larus canus	Common Gull	615	571	78	108	**1372**
5910	Larus fuscus	Lesser Black-backed Gull	300	683	4070	5056	**10109**
5919	L. fuscus / L. argentatus	Herring / LBB gull				60	**60**
5920	Larus argentatus	Herring Gull	1243	1666	415		**3324**
5929	L. canus / L. argentatus	Common / Herring Gull		1		400	**401**
6000	Larus marinus	Great Black-backed Gull	37	16	189	121	**363**
6020	Rissa tridactyla	Black-legged Kittiwake	9	16	54	115	**194**
6049	Larus spec.	unidentified gull		200		400	**600**
6110	Sterna sandvicensis	Sandwich Tern	14	118	35	93	**260**
6150	Sterna hirundo	Common Tern	15	20	4	8	**47**
6169	S. hirundo / S. paradisaea	Common / Arctic tern		8	4	6	**18**
6340	Uria aalge	Guillemot	8	5	48	10	**71**
6360	Alca torda	Razorbill	3	2	12	6	**23**
7670	Asio otus	Long-eared Owl				1	**1**
10110	Anthus pratensis	Meadow Pipit				3	**3**
10202	Motacilla alba yarrellii	Pied Wagtail		2			**2**
15630	Corvus frugilegus	Rook				2	**2**
23510	Phocoena phocoena	Harbour Porpoise	12	4	27	5	**48**
24320	Halichoerus grypus	Grey Seal	1				**1**

Appendix 5 (continued). All birds seen during the May (2003) survey, split-up into birds seen along the nearshore (depths < 20 m) and offshore (> 20 m) components of the study area.

			NEARSHORE		**OFFSHORE**		
Euring	**Scientific name**	**English name**	**Total-in**	**Total out**	**Total in**	**Total out**	**Grand Total**
20	Gavia stellata	Red-throated Diver		2			**2**
30	Gavia arctica	Black-throated Diver		1			**1**
90	Podiceps cristatus	Great Crested Grebe	1				**1**
220	Fulmarus glacialis	Northern Fulmar	5	11	37	74	**127**
460	Puffinus puffinus	Manx Shearwater		11			**11**
710	Sula bassana	Northern Gannet	2	11	30	46	**89**
720	Phalacrocorax carbo	Great Cormorant	236	415	1	14	**666**
1680	Branta bernicla	Brent Goose	11				**11**
1730	Tadorna tadorna	Shelduck		1			**1**
1840	Anas crecca	Common Teal		2			**2**
1860	Anas platyrhynchos	Mallard		5			**5**
2060	Somateria mollissima	Common Eider		2			**2**
2130	Melanitta nigra	Common Scoter	13	65			**78**
2210	Mergus serrator	Red-breasted Merganser		1			**1**
4500	Haematopus ostralegus	Eurasian Oystercatcher		1			**1**
5690	Stercorarius skua	Great Skua	3	3	3	5	**14**
5820	Larus ridibundus	Black-headed Gull	1	2		2	**5**
5900	Larus canus	Common Gull		13		1	**14**
5910	Larus fuscus	Lesser Black-backed Gull	736	2353	2162	1698	**6949**
5920	Larus argentatus	Herring Gull	630	1166	447	238	**2481**
6000	Larus marinus	Great Black-backed Gull	16	36	68	26	**146**
6005	Larus spec.	unidentified large gull		185		3920	**4105**
6020	Rissa tridactyla	Black-legged Kittiwake	1		20	27	**48**
6110	Sterna sandvicensis	Sandwich Tern	24	45	3	3	**75**
6150	Sterna hirundo	Common Tern	3	7	16	7	**33**
6160	Sterna paradisaea	Arctic Tern	19				**19**
6169	S. hirundo / S. paradisaea	Common / Arctic tern	2	44		52	**98**
6340	Uria aalge	Guillemot	1				**1**
6360	Alca torda	Razorbill		1			**1**
6655	Columba 'domestica'	Feral Pigeon				1	**1**
9920	Hirundo rustica	Swallow		2		1	**3**
10110	Anthus pratensis	Meadow Pipit		1			**1**
10170	Motacilla flava	Blue-headed Wagtail		1			**1**
23510	Phocoena phocoena	Harbour Porpoise	2		7		**9**

Appendix 5 (continued). All birds seen during the June (2003) survey, split-up into birds seen along the nearshore (depths < 20 m) and offshore (> 20 m) components of the study area.

			NEARSHORE		**OFFSHORE**		
Euring	**Scientific name**	**English name**	**Total-in**	**Total out**	**Total in**	**Total out**	**Grand Total**
220	Fulmarus glacialis	Northern Fulmar	1	1	3	7	**12**
710	Sula bassana	Northern Gannet	1	10	5	15	**31**
720	Phalacrocorax carbo	Great Cormorant	174	302	2	18	**496**
1730	Tadorna tadorna	Shelduck		52			**52**
2130	Melanitta nigra	Common Scoter	5	191			**196**
5410	Numenius arquata	Curlew				3	**3**
5460	Tringa totanus	Redshank		1			**1**
5690	Stercorarius skua	Great Skua				1	**1**
5820	Larus ridibundus	Black-headed Gull	1	18		1	**20**
5900	Larus canus	Common Gull	189	203			**392**
5910	Larus fuscus	Lesser Black-backed Gull	753	2956	424	657	**4790**
5920	Larus argentatus	Herring Gull	608	1572	124	130	**2434**
6000	Larus marinus	Great Black-backed Gull		2	2	5	**9**
6005	Larus spec.	unidentified large gull		441		205	**646**
6049	Larus spec.	unidentified gull		625		460	**1085**
6110	Sterna sandvicensis	Sandwich Tern	16	57		1	**74**
6150	Sterna hirundo	Common Tern	12	17			**29**
6169	S. hirundo / S. paradisaea	Common / Arctic tern	12	15		3	**30**
6655	Columba 'domestica'	Feral Pigeon		23			**23**
7950	Apus apus	Swift	4	8		3	**15**
11210	Phoenicurus ochruros	Black Redstart		1			**1**
15820	Sturnus vulgaris	Starling		1		2	**3**

Appendix 5 (continued). All birds seen during the August (2003) survey, split-up into birds seen along the nearshore (depths < 20 m) and offshore (> 20 m) components of the study area.

			NEARSHORE		OFFSHORE		
Euring	Scientific name	English name	Total-in	Total out	Total in	Total out	Grand Total
220	Fulmarus glacialis	Northern Fulmar		1	1	9	**11**
710	Sula bassana	Northern Gannet	97	281	52	186	**616**
720	Phalacrocorax carbo	Great Cormorant	106	182	2	2	**292**
1440	Platalea leucorodia	European Spoonbill		7			**7**
1730	Tadorna tadorna	Shelduck		20		3	**23**
1860	Anas platyrhynchos	Mallard		2			**2**
2060	Somateria mollissima	Common Eider		9			**9**
2130	Melanitta nigra	Common Scoter	8	55	1	3	**67**
4500	Haematopus ostralegus	Eurasian Oystercatcher				1	**1**
4700	Charadrius hiaticula	Ringed Plover		4			**4**
4770	Charadrius alexandrinus	Kentish Plover	1				**1**
4860	Pluvialis squatarola	Grey Plover		3			**3**
4960	Calidris canutus	Knot		9			**9**
5120	Calidris alpina	Dunlin		1			**1**
5170	Philomachus pugnax	Ruff		1			**1**
5340	Limosa lapponica	Bar-tailed Godwit		2		2	**4**
5380	Numenius phaeopus	Whimbrel		1			**1**
5410	Numenius arquata	Curlew		18			**18**
5460	Tringa totanus	Redshank		4			**4**
5610	Arenaria interpres	Turnstone	6	6		1	**13**
5670	Stercorarius parasiticus	Arctic Skua		1		1	**2**
5690	Stercorarius skua	Great Skua		1		4	**5**
5820	Larus ridibundus	Black-headed Gull	5	23	7	15	**50**
5900	Larus canus	Common Gull	6	22	1	2	**31**
5910	Larus fuscus	Lesser Black-backed Gull	1146	2845	1094	2025	**7110**
5920	Larus argentatus	Herring Gull	120	119	1	7	**247**
5927	Larus cachinnans	Yellow-legged Gull	1				**1**
6000	Larus marinus	Great Black-backed Gull	85	67	81	51	**284**
6005	Larus spec.	unidentified large gull	10	580		83	**673**
6020	Rissa tridactyla	Black-legged Kittiwake		1	1	5	**7**
6110	Sterna sandvicensis	Sandwich Tern	91	181	1	4	**277**
6150	Sterna hirundo	Common Tern	383	632	1	25	**1041**
6160	Sterna paradisaea	Arctic Tern	4	22		6	**32**
6169	S. hirundo / S. paradisaea	Common / Arctic tern		123		19	**142**
6240	Sterna albifrons	Little Tern		1			**1**
6270	Chlidonias niger	Black Tern	4	5	2		**11**
6655	Columba 'domestica'	Feral Pigeon		1		1	**2**
7950	Apus apus	Swift				2	**2**
10200	Motacilla alba	White Wagtail		1			**1**
13490	Ficedula hypoleuca	Pied Flycatcher		1			**1**
23510	Phocoena phocoena	Harbour Porpoise	8	1	3		**12**

Appendix 5 (continued). All birds seen during the September(2002) survey, split-up into birds seen along the nearshore (depths < 20 m) and offshore (> 20 m) components of the study area.

			NEARSHORE		OFFSHORE		
Euring	**Scientific name**	**English name**	**Total-in**	**Total out**	**Total in**	**Total out**	**Grand Total**
20	Gavia stellata	Red-throated Diver		2			**2**
59	Gavia spec.	unidentified diver		2			**2**
90	Podiceps cristatus	Great Crested Grebe		1			**1**
100	Podiceps griseigena	Red-necked Grebe		1			**1**
220	Fulmarus glacialis	Northern Fulmar	2	5	25	19	**51**
430	Puffinus griseus	Sooty Shearwater	1	3			**4**
710	Sula bassana	Northern Gannet	17	91	33	220	**361**
720	Phalacrocorax carbo	Great Cormorant	82	189	4	9	**284**
1680	Branta bernicla	Brent Goose		156		164	**320**
1730	Tadorna tadorna	Shelduck		6			**6**
1790	Anas penelope	Wigeon	5	2			**7**
1840	Anas crecca	Common Teal		2			**2**
2060	Somateria mollissima	Common Eider		24			**24**
2130	Melanitta nigra	Common Scoter	51	385		106	**542**
4850	Pluvialis apricaria	Golden Plover		10		2	**12**
4860	Pluvialis squatarola	Grey Plover		1			**1**
5120	Calidris alpina	Dunlin			1		**1**
5650	Phalaropus fulicaria	Grey Phalarope			1		**1**
5670	Stercorarius parasiticus	Arctic Skua	1	1		1	**3**
5690	Stercorarius skua	Great Skua				3	**3**
5780	Larus minutus	Little Gull	8	20	4	25	**57**
5820	Larus ridibundus	Black-headed Gull	1	3	2		**6**
5900	Larus canus	Common Gull	3	12	3	7	**25**
5910	Larus fuscus	Lesser Black-backed Gull	276	332	976	168	**1752**
5920	Larus argentatus	Herring Gull	401	1300	329	106	**2136**
5927	Larus cachinnans	Yellow-legged Gull	1				**1**
6000	Larus marinus	Great Black-backed Gull	208	343	2022	653	**3226**
6005	Larus spec.	unidentified large gull		3	200	1181	**1384**
6020	Rissa tridactyla	Black-legged Kittiwake	1	2	3	9	**15**
6110	Sterna sandvicensis	Sandwich Tern	9	22	1		**32**
6150	Sterna hirundo	Common Tern	3	19			**22**
6340	Uria aalge	Guillemot		4		7	**11**
6655	Columba 'domestica'	Feral Pigeon		1			**1**
9760	Alauda arvensis	Skylark				4	**4**
10110	Anthus pratensis	Meadow Pipit	1	65		23	**89**
10142	Anthus spinoletta petrosus	Rock Pipit		1			**1**
10200	Motacilla alba	White Wagtail		3			**3**
10990	Erithacus rubecula	Robin				1	**1**
13115	P. collybita / P. trochilus	Chiffchaff / Willow Warbler		1			**1**
13140	Regulus regulus	Goldcrest				1	**1**
19999	unidentified passerine	unidentified passerine		2			**2**
23510	Phocoena phocoena	Harbour Porpoise	1	3	4	4	**12**
24330	Phoca vitulina	Common Seal		1			**1**

Appendix 5 (continued). All birds seen during the October (2002) survey, split-up into birds seen along the nearshore (depths < 20 m) and offshore (> 20 m) components of the study area.

			NEARSHORE		OFFSHORE		
Euring	Scientific name	English name	Total-in	Total out	Total in	Total out	Grand Total
20	Gavia stellata	Red-throated Diver	8	9			**17**
59	Gavia spec.	unidentified diver		2			**2**
220	Fulmarus glacialis	Northern Fulmar	1	1	3	19	**24**
710	Sula bassana	Northern Gannet	3	9	6	49	**67**
720	Phalacrocorax carbo	Great Cormorant	13	73			**86**
1680	Branta bernicla	Brent Goose		8			**8**
1790	Anas penelope	Wigeon		1		63	**64**
1840	Anas crecca	Common Teal		9			**9**
1860	Anas platyrhynchos	Mallard			5	5	**10**
2060	Somateria mollissima	Common Eider	10	42			**52**
2130	Melanitta nigra	Common Scoter		165		3	**168**
2150	Melanitta fusca	Velvet Scoter		1			**1**
2180	Bucephala clangula	Common Goldeneye		3			**3**
4850	Pluvialis apricaria	Golden Plover				6	**6**
5650	Phalaropus fulicaria	Grey Phalarope			1		**1**
5690	Stercorarius skua	Great Skua		1	2	1	**4**
5780	Larus minutus	Little Gull	12	26	2		**40**
5820	Larus ridibundus	Black-headed Gull	15	31	4	5	**55**
5900	Larus canus	Common Gull	15	39	1	4	**59**
5910	Larus fuscus	Lesser Black-backed Gull	27	32	9	13	**81**
5920	Larus argentatus	Herring Gull	267	226	5	10	**508**
5927	Larus cachinnans	Yellow-legged Gull		1			**1**
6000	Larus marinus	Great Black-backed Gull	87	107	51	72	**317**
6005	Larus spec.	unidentified large gull		5		12	**17**
6020	Rissa tridactyla	Black-legged Kittiwake	20	38	23	108	**189**
6340	Uria aalge	Guillemot	72	96	29	49	**246**
6345	Alca torda / Uria aalge	Guillemot / Razorbill		5		1	**6**
6360	Alca torda	Razorbill	9		4	1	**14**
6540	Fratercula arctica	Atlantic Puffin		2			**2**
9760	Alauda arvensis	Skylark	2	20			**22**
10110	Anthus pratensis	Meadow Pipit	4	5			**9**
11870	Turdus merula	Blackbird		10		6	**16**
11980	Turdus pilaris	Fieldfare				9	**9**
12000	Turdus philomelos	Song Thrush		2	1	4	**7**
12010	Turdus iliacus	Redwing		11	1	45	**57**
15820	Sturnus vulgaris	Starling	35	1090	75	218	**1418**
16360	Fringilla coelebs	Chaffinch		5			**5**
16380	Fringilla montifringilla	Brambling		2			**2**
23510	Phocoena phocoena	Harbour Porpoise	7				**7**
24310	unidentified pinniped	unidentified seal	1				**1**

Appendix 5 (continued). All birds seen during the November (2003) survey, split-up into birds seen along the nearshore (depths < 20 m) and offshore (> 20 m) components of the study area.

			NEARSHORE		OFFSHORE		
Euring	Scientific name	English name	Total-in	Total out	Total in	Total out	Grand Total
20	Gavia stellata	Red-throated Diver	27	32	3	5	67
30	Gavia arctica	Black-throated Diver		1	1		2
40	Gavia immer	Great Northern Diver		1			1
59	Gavia spec.	unidentified diver		9		1	10
90	Podiceps cristatus	Great Crested Grebe	3	7			10
220	Fulmarus glacialis	Northern Fulmar		1	3	1	5
710	Sula bassana	Northern Gannet	2	25	17	59	103
720	Phalacrocorax carbo	Great Cormorant	4	59	1	11	75
1220	Ardea cinerea	Grey Heron		1			1
1530	Cygnus columbianus	Bewick's Swan				6	6
1790	Anas penelope	Wigeon		4			4
1820	Anas strepera	Gadwall		4			4
1840	Anas crecca	Common Teal		2			2
1865	Anas domesticus	domestic duck		1			1
1940	Anas clypeata	Northern Shoveler		1			1
2060	Somateria mollissima	Common Eider	22	13			35
2130	Melanitta nigra	Common Scoter	26	336	18	6	386
2150	Melanitta fusca	Velvet Scoter		12			12
2210	Mergus serrator	Red-breasted Merganser		2		4	6
2610	Circus cyaneus	Hen Harrier				1	1
3200	Falco peregrinus	Pergrine Falcon		1			1
4290	Fulica atra	Common Coot	1				1
4960	Calidris canutus	Knot				8	8
4970	Calidris alba	Sanderling				1	1
5100	Calidris maritima	Purple Sandpiper				1	1
5120	Calidris alpina	Dunlin		1			1
5180	Lymnocryptes minimus	Jacksnipe				1	1
5190	Gallinago gallinago	Snipe		1		8	9
5410	Numenius arquata	Curlew		7			7
5460	Tringa totanus	Redshank		1			1
5659	unidentified wader	unidentified wader		14			14
5670	Stercorarius parasiticus	Arctic Skua		2			2
5690	Stercorarius skua	Great Skua	1		1		2
5780	Larus minutus	Little Gull	86	139	5	12	242
5820	Larus ridibundus	Black-headed Gull	93	348		13	454
5900	Larus canus	Common Gull	1328	2313	31	47	3719
5910	Larus fuscus	Lesser Black-backed Gull	24	49	23	3	99
5920	Larus argentatus	Herring Gull	4000	6957	9	18	10984
6000	Larus marinus	Great Black-backed Gull	1021	1199	21	44	2285
6005	Larus spec.	unidentified large gull		50			50
6020	Rissa tridactyla	Black-legged Kittiwake	376	467	131	310	1284
6049	Larus spec.	unidentified gull		1720			1720
6150	Sterna hirundo	Common Tern	1				1
6340	Uria aalge	Guillemot	150	73	880	210	1313
6345	Alca torda / Uria aalge	Guillemot / Razorbill		4		3	7
6360	Alca torda	Razorbill	11	3	14	7	35
6655	Columba 'domestica'	Feral Pigeon		2			2
9740	Lullula arborea	Woodlark		1		2	3
9760	Alauda arvensis	Skylark	29	187	4	93	313
10110	Anthus pratensis	Meadow Pipit		10		26	36
11870	Turdus merula	Blackbird	3	5	2	1	11
11980	Turdus pilaris	Fieldfare		2	2	2	6
12000	Turdus philomelos	Song Thrush		2		4	6
12010	Turdus iliacus	Redwing	13	9	1	19	42
15820	Sturnus vulgaris	Starling	81	2565	80	1164	3890
16360	Fringilla coelebs	Chaffinch		3		6	9
19999	unidentified passerine	unidentified passerine		1			1
23510	Phocoena phocoena	Harbour Porpoise	8		13		21
24330	Phoca vitulina	Common Seal			1		1

Appendix 6 Poisson loglinear regression of number (with offset logArea) on Spline(Distance)+ Spline(Yfield) + park with park = NSW or Q7, accounting for overdispersion (estimated from the Pearson statistic)

Euring	Species	month	npos	dispersion	P_Dist	P_YField	P_NSW	P_Q7
59	divers	2	41	1.5	0	0.011	0.172	0.720
59	divers	4	56	2.8	0	0.015	0.679	**0.000**
220	Fulmar	2	22	0.5	0	0	0.769	**0.004**
220	Fulmar	5	28	1.2	0	0.001	0.446	0.524
710	Gannet	4	37	1.7	0	0.017	0.506	0.168
710	Gannet	8	70	3	0.162	0	0.554	0.551
710	Gannet	9	39	1.1	0	0.343	0.187	0.417
720	Cormorant	5	62	1.7	0	0	0.347	0.826
720	Cormorant	6	43	2.5	0	0	0.566	0.882
720	Cormorant	8	30	3.5	0	0	0.677	**0.027**
720	Cormorant	9	38	1.1	0	0	0.065	0.577
5780	Little Gull	4	94	17.4	0	0.013	0.617	0.867
5780	Little Gull	11	47	1.4	0	0.022	0.120	0.190
5820	Black-headed Gull	11	25	1.8	0	0	0.050	0.908
5900	Common Gull	2	48	8.1	0.004	0.011	0.161	0.083
5900	Common Gull	4	95	27.7	0	0.034	0.646	0.482
5900	Common Gull	11	91	35	0	0	0.171	0.725
5910	LBB Gull	4	110	160.6	0	0	0.772	0.533
5910	LBB Gull	5	177	85.1	0	0	0.188	0.208
5910	LBB Gull	6	144	39.3	0.008	0.001	0.209	1.000
5910	LBB Gull	8	230	55	0.008	0.207	0.250	**0.000**
5910	LBB Gull	9	120	38.5	0	0	0.480	0.059
5920	Herring Gull	2	28	8.7	0	0	0.315	**0.025**
5920	Herring Gull	4	81	96.4	0.003	0.56	0.480	0.774
5920	Herring Gull	5	93	26.5	0	0	0.108	0.203
5920	Herring Gull	6	78	20.2	0	0	0.224	0.155
5920	Herring Gull	8	47	1.2	0	0	0.475	0.879
5920	Herring Gull	9	109	22.7	0	0.001	0.628	0.123
5920	Herring Gull	10	42	10.5	0	0	0.425	0.576
5920	Herring Gull	11	64	147.2	0	0	0.291	0.938
6000	GBB Gull	4	23	19.1	0.005	0.01	0.795	0.528
6000	GBB Gull	8	47	6.4	0.093	0.183	0.511	**0.000**
6000	GBB Gull	9	79	114.9	0	0.002	1.000	0.127
6000	GBB Gull	10	44	5.3	0.135	0.103	0.285	0.238
6000	GBB Gull	11	80	35	0	0	0.126	0.912
6020	Kittiwake	4	29	1.9	0	0.211	0.379	0.058
6020	Kittiwake	10	24	1.4	0	0	**0.011**	**0.046**
6020	Kittiwake	11	91	18	0.073	0.005	0.136	0.822
6110	Sandwich Tern	4	26	1.6	0.041	0.001	0.282	0.673
6169	Commic Tern	8	24	219.1	0.107	0.319	0.978	0.969
6340	Guillemot	2	160	1.6	0	0.044	**0.038**	0.367
6340	Guillemot	4	44	0.9	0	0.006	0.930	0.297
6340	Guillemot	10	59	1.7	0.001	0.18	0.551	0.060
6340	Guillemot	11	195	5.2	0	0.051	0.265	0.398
6360	Razorbill	2	27	2.4	0	0.006	1.000	0.232

Appendix 7 Desk study on seawatching results from Meetpost Noordwijk: variability in offshore observations

Offshore surveys are typically conducted in 'good' weather conditions. Good weather means favourable conditions to observe, safe for the observers, reliable abundance estimates can be made. Light conditions, weather and wind are vital parameters when the decision needs to be made to conduct a survey or rather to postpone one. Visits to anyone area are brief, but the surveys are presumed to provide data that are needed to describe the 'typical' avifauna in a sense that the results should characterise the species composition and relative abundance of the birds and marine mammals in an offshore area. One may wonder if that is true. The contractors in this project have proposed to use ship-based surveys rather than aerial surveys for several reasons, but one reason was that vessels spend considerably more time in and area, so that factors like diurnal rhythms and day-to-day variability are taken into account as good as possible. Rather than visiting a small area during a couple of hours were at least a couple of days work scheduled in each and every season, so that small-scale variability (both spatial and temporal) would have been compensated for. But what would such variability be like? Coastal seawatchers reported major shifts in abundance of coastal migrants from day to day (Camphuysen & Van Dijk 1983; Camphuysen 1985; Platteeuw *et al.* 1994). Substantial weather effects have been described by the same observers and elsewhere (Temme 1974; De Miranda & Platteeuw 1983; Blomqvist & Peterz 1984; Den Ouden & Stougie 1987; Wheeler 1990; Platteeuw 1991), severe winters or substantial prey supplies lead to remarkable changes in the abundance of some species, often from one day to the other (Leopold & Platteeuw 1987; Platteeuw 1987; Camphuysen & Derks 1989). But what about the variability offshore? Only few studies have been conducted and some were available, but not readily at hand. Between 1978 and 1984, the same seawatchers have conducted systematic observations at Meetpost Noordwijk, a small offshore platform some 9 km off the coast of Noordwijk at sea (Camphuysen 1979; Camphuysen *et al.* 1982; Den Ouden & Camphuysen 1983; Den Ouden & Van der Ham 1988; Van der Ham 1988). The data had been collected in a period when computers were not readily available, while the data could provide the necessary insight in offshore natural variability in bird numbers: the effects of weather, time of day, time of year, and combinations of all three parameters. For this project, a windfarm study off the mainland coast of Noord-Holland, but also for other, similar studies (Camphuysen 1998), the results seemed of considerable interest. Therefore, the data were computer-processed and made available in a digital format for the first time. This appendix oversees the material and presents some important results, underpinning the need to appreciate short-term temporal variability in offshore bird numbers.

Seabird observations Meetpost Noordwijk

Approximately 9 km off the mainland coast of Zuid-Holland, at 52°16'26"N, 4°17'46"E, has a platform been built as an experiment to test if offshore constructions would be strong enough to withstand wind and weather offshore. In the late 1970s, the platform, 'Meetpost Noordwijk' was owned by the Ministry of Transport, Public Works and Waterways and it was used to test and develop all sorts of instruments and techniques, such as remote sensing techniques to detect illegal oil spills. The 'Club van Zeetrekwaarnemers' frequently manned a seawatching site, systematically recording the passage of birds along the coast, just opposite to the site. Under exceptionally good conditions, high-powered binoculars mounted on tripods enabled the observers to see the largest of seabirds and flocks of waders and waterfowl pass by just behind the platform, i.e. at 10 km from the coast or more. The wish to be able to man a site offshore, to investigate seabird migration in the area just out of reach, was fulfilled when permission was granted to set-up systematic observations 'if there was sufficient space in the helicopter flying to and from the island to transport personnel'. Top-seawatchers have been recruited to man the site in spring and autumn between 1978 and 1984 during 1524 hours of observation (189 observation days; Table 1; Appendix 1).

The species accounts report the numbers of birds observed per month, per species, for the groups discussed earlier in this report, and highlight relevant details of the variability in numbers observed. A standard table for each group of birds provides an idea of relative abundance in each month (see Table 1 for observer effort), as the number of individuals heading south (→ S), north (→ N), present on the spot, heading east (→ E), heading west (→ W) and the total number.

Table 1. Observation hours at Meetpost Noordwijk per 10-day period, 1978-1984

Decade	1978	1979	1980	1981	1982	1984	Totals
21 - 31 jan						19.5	20
1 - 10 mrt			42.5			38.6	81
11 - 20 mrt			29				29
21 - 31 mrt				15.2		37.5	53
1 - 10 apr				63		14.9	78
11 - 20 apr	58			23		11.5	93
21 - 30 apr	69			54.5			124
1 - 10 mei	41.5	37		40			119
11 - 20 mei	15.5						16
21 - 31 mei	12.5	30.5					43
21 - 31 aug					33.3		33
1 - 10 sep		42.5			48		91
11 - 20 sep		27			45.5		73
21 - 30 sep				72.8	37		110
1 - 10 okt	38			63.2	28		129
11 - 20 okt	40.5			25.5	71		137
21 - 31 okt		20.5			16		37
1 - 10 nov		12		49.5			62
11 - 20 nov	41	41.5		49			132
21 - 30 nov	54						54
1 - 10 dec	2						2
11 - 20 dec						13	13
	372	211	71.5	456	279	135	1524

Table 2. Observation hours at the mainland coast of Zuid-Holland and Noord-Holland (Scheveningen – IJmuiden) when Meetpost Noordwijk was manned per 10-day period, 1978-1984, NZG/CvZ unpubl. data

Decade	1978	1979	1980	1981	1982	1984	Totals
21 – 31 Jan						20	20
1 - 10 Mar			38			30	68
11 – 20 Mar			27				27
21 – 31 Mar				36		33	69
1 - 10 Apr				32		27	59
11 – 20 Apr	54			48		36	138
21 – 30 Apr	117			49			166
1 - 10 May	112	47		40			199
11 – 20 May	104						104
21 – 31 May	102	52					154
21 – 31 Aug					82		82
1 - 10 Sep		51			45		96
11 – 20 Sep		97			37		134
21 – 30 Sep				49	36		85
1 - 10 Oct	66			59	32		157
11 – 20 Oct	42			38	40		120
21 – 31 Oct		68			29		97
1 - 10 Nov		57		25			82
11 - 20 Nov	42	38		15			95
21 - 30 Nov	22						22
1 - 10 Dec	19						19
11 – 20 Dec						9	9
	680	410	65	391	301	155	2002

A brief comparison is made with numbers passing by closer to the coast. To do that, exactly the same periods were selected as highlighted in Table 1, and the Club van Zeetrekwaarnemers database was consulted using data collected at mainland coast sites Scheveningen, Katwijk, Noordwijk, Bloemendaal, and IJmuiden (2002 hours of observation in total; Table 2).

Results are reported only when significant findings or patterns could be reported. No attempt has been made to present all findings for every group or species based on the material now available. As an important delivery of this project, a relational database has been provided, ready for consultation and for specific questions in the (near) future.

Divers

Table 3. Total numbers of divers seen at Meetpost Noordwijk per month, including the species, numbers heading south, north, east and west, total numbers and the number occurring 'on the spot' (i.e. without direction of flight, on the island, or swimming nearby).

Month	Species	'-> S	'-> N	on the spot	'-> E	'->W	Totals
1	Red-throated Diver	2					2
3	Red-throated Diver	3	18				21
4	Red-throated Diver		20			1	21
5	Red-throated Diver	1			1		2
9	Red-throated Diver	2	2				4
10	Red-throated Diver	8	3	1			12
11	Red-throated Diver	19	4	3			26
12	Red-throated Diver	2					2
4	Black-throated Diver		7				7
5	Black-throated Diver		2				2
10	Black-throated Diver	2		5			7
11	Black-throated Diver	6	6	2			14
1	unidentified diver	70	10	2			82
3	unidentified diver	23	157	3			183
4	unidentified diver	3	152	5			160
5	unidentified diver		15				15
9	unidentified diver	13					13
10	unidentified diver	31	13				44
11	unidentified diver	371	32	9			412
12	unidentified diver	84	1	1			86

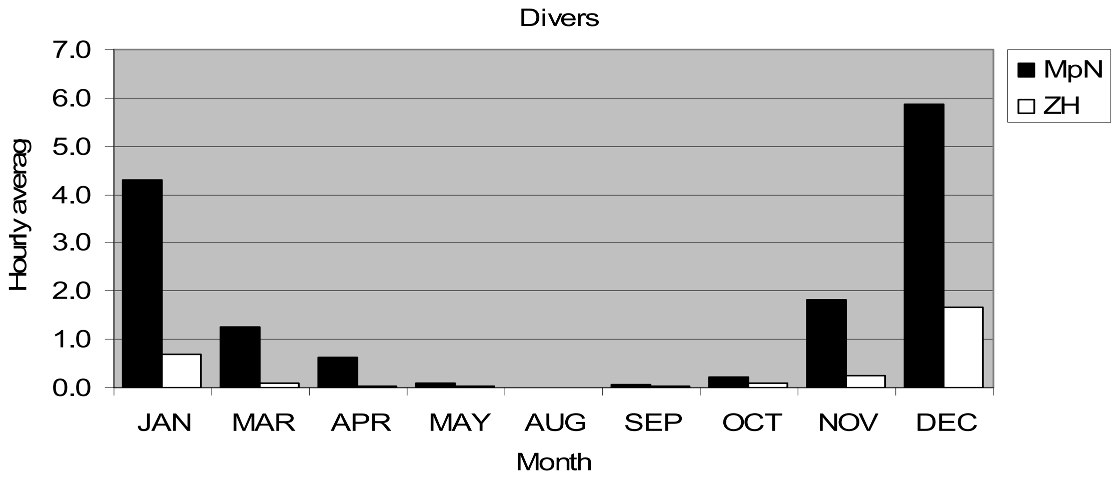


Figure 1. Relative abundance (n per hour) of divers along the mainland coast of Zuid-Holland (white bars) and to the west of Meetpost Noordwijk (black bars). See Tables 1-2 for observer effort.

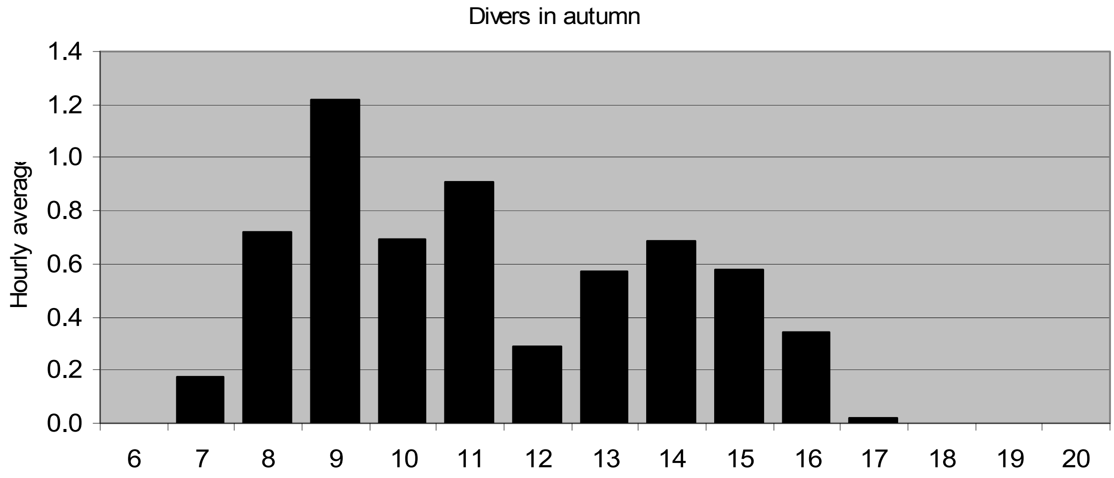


Figure 2. Diurnal pattern (n per hour) of divers at Meetpost Noordwijk in autumn.

Divers are strictly coastal species that occur mainly within 10km from the coast, utilising shallow, turbid waters in the German and Southern Bights (Camphuysen & Leopold 1994; Skov *et al.* 1995; Stone *et al.* 1995). Remarkably, considering their status as coastal birds, diver passage at Meetpost Noordwijk was considerably more substantial than along the mainland coast nearby (Fig. 1). As along the coast, divers were primarily winter birds and very few were seen to stage in the offshore waters around Meetpost Noordwijk. Black-throated Divers *Gavia arctica*, the scarcer species of the two smaller divers in The Netherlands, were rather common in autumn, whereas along the coast this species is more commonly reported during spring migration, when adult birds pass by in nuptial plumage (Stegeman & Den Ouden 1995).

Few divers have been seen staging in the Meetpost area, roughly in accordance with offshore observations at that distance from the coast anywhere in Dutch waters. Of great significance to windfarm developments, however, was the fact that migration was stronger than coastal migration between Scheveningen and IJmuiden. Migrating divers are divers in flight, flying divers are considered particularly vulnerable to windfarms (Garthe & Hüppop 2004). It is not completely clear as to how the numbers in flight at Meetpost Noordwijk relate to numbers migrating at exactly the same distance off Egmond aan Zee (Noord-Holland). Simultaneous observations at scattered sites along the Dutch coast demonstrated that many spring migrants take a short-cut off the 'hollow' mainland coast of Zuid-Holland, on their way from the Delta area to the Wadden Sea coast and beyond (Ruinaard 1977; Van Dijk 1979; Maas & Den Ouden 1983; Maas 1987). This is certainly true for scoters (seaduck), and probably so for divers, giving structural differences in migration strength for example between Scheveningen (Zuid-Holland) and Camperduin (Noord-Holland) (Camphuysen & Van Dijk 1983).

Divers (in autumn depicted in Fig. 2) had a strikingly clear diurnal pattern, with gradually increasing numbers during a morning, a noon-dip, followed by a second wave of passage migrants. This pattern may have been caused by distant staging areas (e.g. the Delta area), abandoned at first light by a first group of birds and abandoned after a first feeding bout by a second bout of individuals. The results suggest that the birds may settle well before darkness and do not continue migration at night around the Meetpost area. Radar data will need to confirm this.

Grebes

Grebes are winter visitors and passage migrants. Numbers of grebes observed at Meetpost Noordwijk were completely insignificant in comparison with numbers observed closer to the coast (Fig. 2). One exception is the relatively large numbers of Red-necked Grebes *Podiceps grisegena* observed offshore, but overall numbers were still small. As with divers, most grebes were migrants, with rather low numbers staging on the spot. Grebes fly usually very low over the sea, are less at risk for windfarms than divers is the general present consensus (Garthe & Hüppop 2004). Neither the seawatching data at Meetpost Noordwijk, nor the offshore data collected within this project or prior to this work (Camphuysen & Leopold 1994), suggest that special attention need to be paid at grebes at large distances from the coast. The situation may be different in severe winter conditions, however, when thousands of Great Crested Grebes *Podiceps cristatus* arrive at least in nearshore waters (Camphuysen & Derks 1989), but there are currently no data available to evaluate that situation.

Table 4. Total numbers of grebes seen at Meetpost Noordwijk per month, including the species, numbers heading south, north, east and west, total numbers and the number occurring 'on the spot' (i.e. without direction of flight, on the island, or swimming nearby).

Month	Species	'-> S	'-> N	on the spot	'-> E	'->W	Totals
10	Little Grebe			1			1
1	Great Crested Grebe	151	21	31	1		204
3	Great Crested Grebe	1	10				11
4	Great Crested Grebe		1	1			2
9	Great Crested Grebe	11					11
10	Great Crested Grebe	17	7				24
11	Great Crested Grebe	14	15				29
3	Red-necked Grebe		3				3
4	Red-necked Grebe		26				26
8	Red-necked Grebe			1			1
9	Red-necked Grebe		1	1			2
10	Red-necked Grebe	2	1				3
11	Red-necked Grebe	5	4				9
4	Slavonian Grebe	1		1			2
11	Black-necked Grebe		1				1
4	Slavonian/Black-necked Grebe		11				11
10	Slavonian/Black-necked Grebe	2					2
12	Slavonian/Black-necked Grebe	1	1				2
5	unidentified grebe	1					1
10	unidentified grebe	3					3
11	unidentified grebe	5	1				6

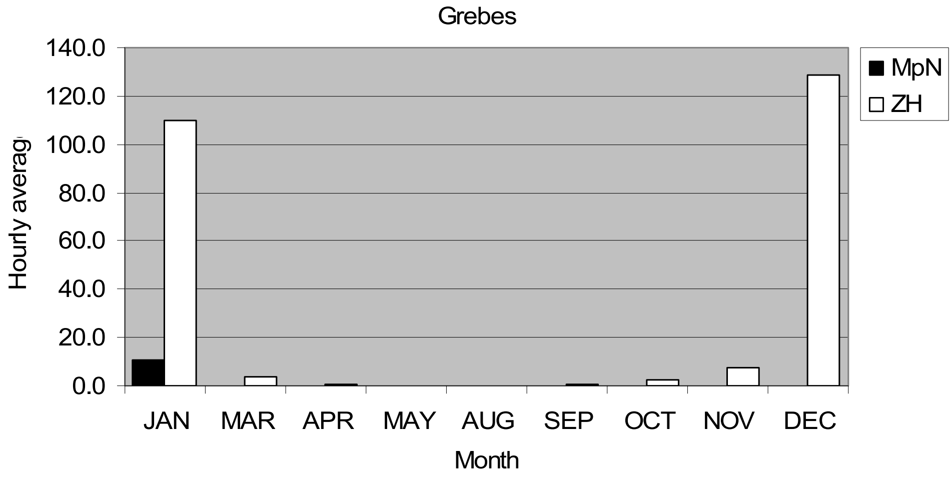


Figure 3. Relative abundance (n per hour) of grebes along the mainland coast of Zuid-Holland (white bars) and to the west of Meetpost Noordwijk (black bars). See Tables 1-2 for observer effort.

Tube-noses (Northern Fulmar, shearwaters and storm-petrels)

Procellariiforms, or tube-noses (Northern Fulmars *Fulmarus glacialis*, shearwaters and storm-petrels) form a particular group of seabirds that are notoriously variable in overall abundance in the Southern Bight. For ship-based and aerial surveys alike, the likelihood that storm-petrels or shearwaters are encountered in Dutch coastal waters are exceptionally small, because these birds frequent Dutch coastal waters usually in more violent conditions (northwesterly or westery gale), widely dispersed, and in low numbers. Northern Fulmars are different in being essentially offshore (pelagic) species, abundant residents in the Northern North Sea, that do utilise Dutch coastal waters at times and sometimes in substantial numbers[1]. Shearwaters and storm-petrels are autumn visitors that occur only very briefly in our waters, and typically in adverse weather. Seawatchers do observe shearwaters and storm-petrels in substantial numbers (hundreds a day at most), because the storm-driven birds flee away from the coast, preferably with head-winds (Camphuysen & Van Dijk 1983; De Miranda & Platteeuw 1983).

In autumn, winter and early spring, Northern Fulmars at Meetpost Noordwijk were clearly more abundant than closer to the coast, but in late spring, that picture became less clear (Fig. 4). All the other tube-noses were considerably more abundant at Meetpost Noordwijk than in Zuid-Holland (not illustrated). Of interest with regard to the variability issue are diurnal patterns and the meteorological conditions surrounding the presence of tube-noses in the offshore area around Meetpost Noordwijk. While Northern Fulmars in autumn typically occurred in the morning,

[1] but apparently less common in the late 1970s early 1980s than today; numbers observed at Meetpost Noordwijk and at the same time along the mainland coast in The Netherlands are disappointingly low compared to present day numbers. Note that the overall North Sea population has increased substantially since that time (Tasker 2004).

with declining numbers during the rest of the day (Fig. 5), was a gradual increase in numbers in the course of anyone day more characteristic for the other species (shearwaters and storm-petrels; Fig. 6). The cause of this difference is not at all clear, all species are wide-ranging and do not have (for as far as we know) localised staging areas from where or towards movements are directed in any way. The result underpin, however, the need to census an area during entire daylight periods to avoid the risk that one species is underestimated relative to another. First light as well as sunset are critical periods in terms of bird abundance for certain species.

Shearwaters and storm-petrels are virtually absent in spring, but Northern Fulmars again showed peak occurrences in the morning, with rather low numbers in the afternoon and a bit of a revival in the evening. Even if an explanation is beyond our current capacities, the fact that striking diurnal patterns occur offshore should be taken into account in the planning of offshore work. In case of our present project (with this knowledge not so much ready at hand, but certainly in the back of our head), the set-up of the surveys have indeed accommodated this problem.

Another crucial factor driving presences or absences of seabirds in certain areas are meteorological conditions. For aerial birds like tube-noses, strong winds are not so much of a problem, but certainly trigger displacements (whether voluntary or not). In fact, prolonged periods of still weather are a problem for these birds, because the energetic coast of flapping flight is considerable (Pennycuick 1960; Furness & Bryant 1996). Strong northwesterlies drive (or lead) tube-noses into the Southern Bight, so much so that hardly any are seen during other weather conditions. In fact, low-pressure areas moving over Scotland and forcing westerlies or northwesterlies at our latitudes are the circumstances under which the arrival of shearwaters and storm-petrels (and in autumn also Northern Fulmars and numerous other 'pelagic' species) may be anticipated. Westerlies caused by low-pressure areas travelling over southern England or northern France will not 'produce' much of interest in our areas (De Miranda & Platteeuw 1983; Blomqvist & Peterz 1984). The effect of westerly and northwesterly winds on the relative abundance of for example Sooty Shearwaters *Puffinus griseus* at Meetpost Noordwijk in autumn is striking (Fig. 8). Even more striking is the effect of northwesterlies on the relative abundance of Northern Fulmars in these waters (Fig. 9). Combining these wind directions with the fact that tube-noses typically arrive when winds are particularly strong (force 7 or more) explains the fact why hardly any of these birds are seen from ship-based or aerial surveys (Baptist & Wolf 1993; Camphuysen & Leopold 1994).

Table 5. Total numbers of tube-noses seen at Meetpost Noordwijk per month, including the species, numbers heading south, north, east and west, total numbers and the number occurring 'on the spot' (i.e. without direction of flight, on the island, or swimming nearby).

Month	Species	'-> S	'-> N	on the spot	'-> E	'->W	Totals
1	Northern Fulmar	2	3				5
3	Northern Fulmar	21	40				61
4	Northern Fulmar	4	38		1	1	44
5	Northern Fulmar	19	27	2	1		49
8	Northern Fulmar	1					1
9	Northern Fulmar	27	52	1			80
10	Northern Fulmar	197	216	4			417
11	Northern Fulmar	21	12	1			34
5	Great/Cory's Shearwater		2				2
9	Sooty Shearwater	33	6	1			40
10	Sooty Shearwater	90	35	7			132
11	Sooty Shearwater	51	6	1			58
5	Manx Shearwater		2				2
8	Manx Shearwater	1					1
9	Manx Shearwater	9	3				12
10	Manx Shearwater	8	1				9
11	Manx Shearwater	4					4
10	European Storm-petrel		1				1
8	Leach's Storm-petrel	1					1
9	Leach's Storm-petrel	1					1
10	Leach's Storm-petrel	9	7				16
11	Leach's Storm-petrel	2					2
10	storm-petrel	2					2

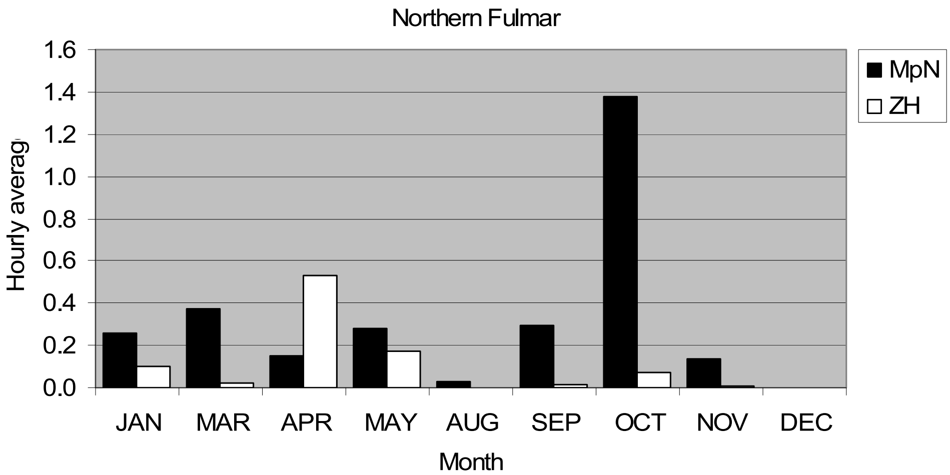


Figure 4. Relative abundance (n per hour) of Northern Fulmars along the mainland coast of Zuid-Holland (white bars) and to the west of Meetpost Noordwijk (black bars). See Tables 1-2 for observer effort.

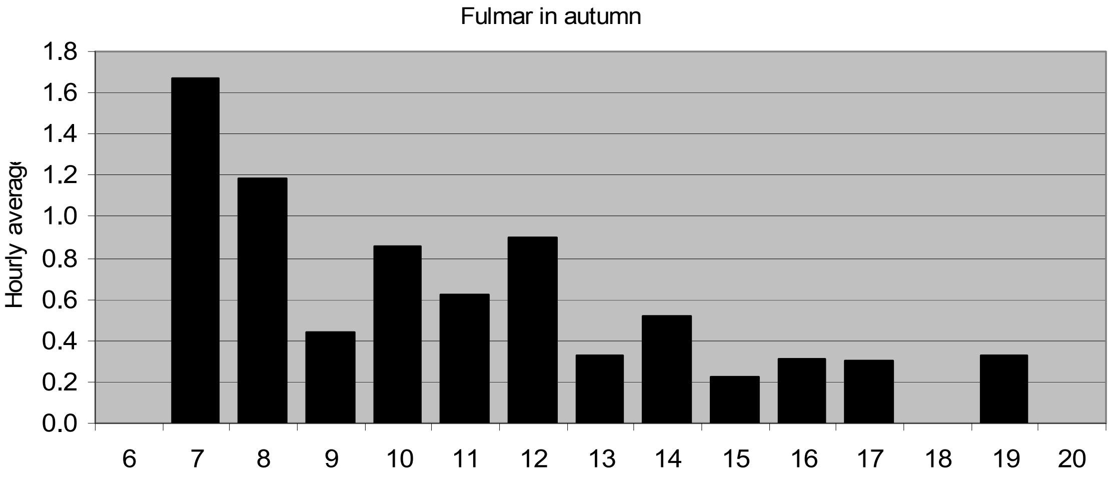


Figure 5. Diurnal pattern (n per hour) of Northern Fulmars at Meetpost Noordwijk in autumn.

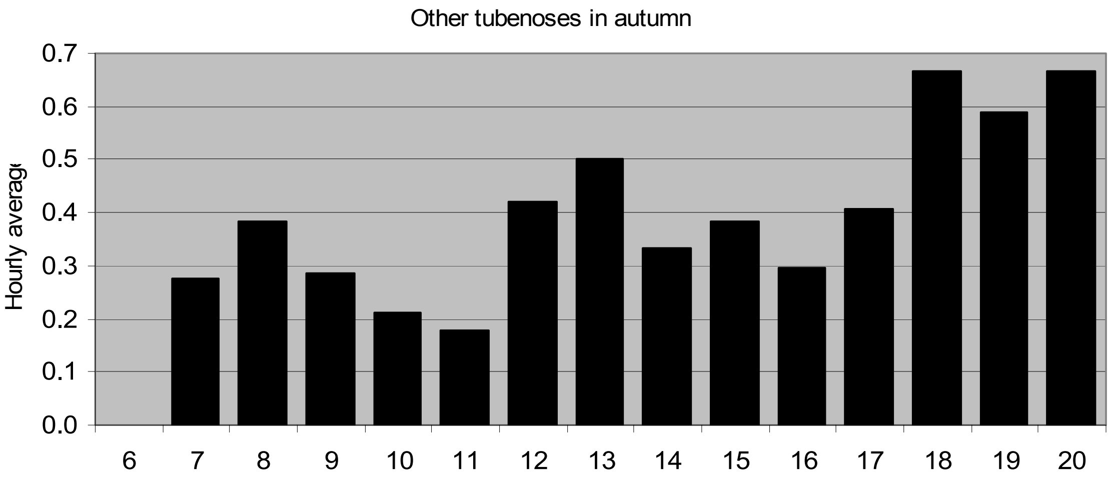


Figure 6. Diurnal pattern (n per hour) of shearwaters and storm-petrels at Meetpost Noordwijk in autumn.

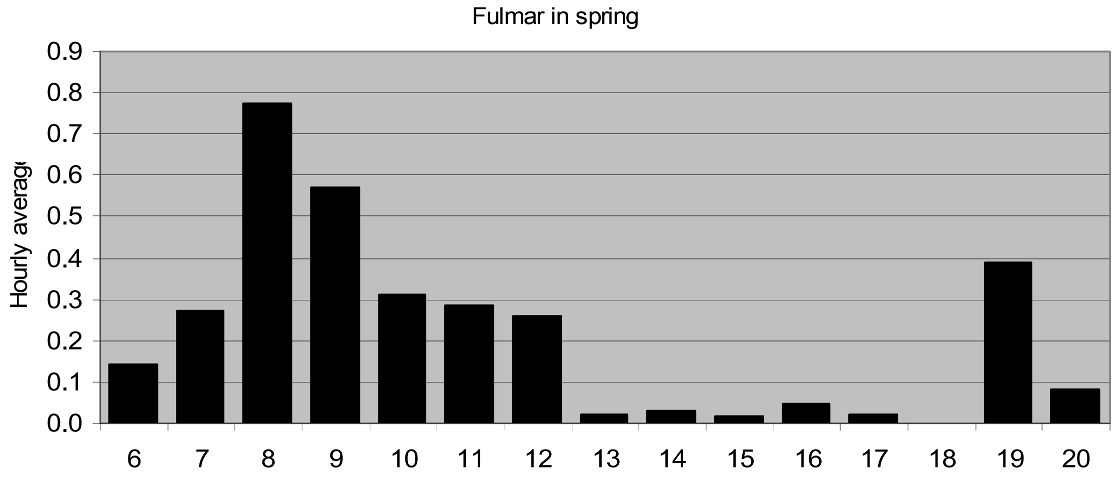


Figure 7. Diurnal pattern (n per hour) of Northern Fulmar at Meetpost Noordwijk in spring.

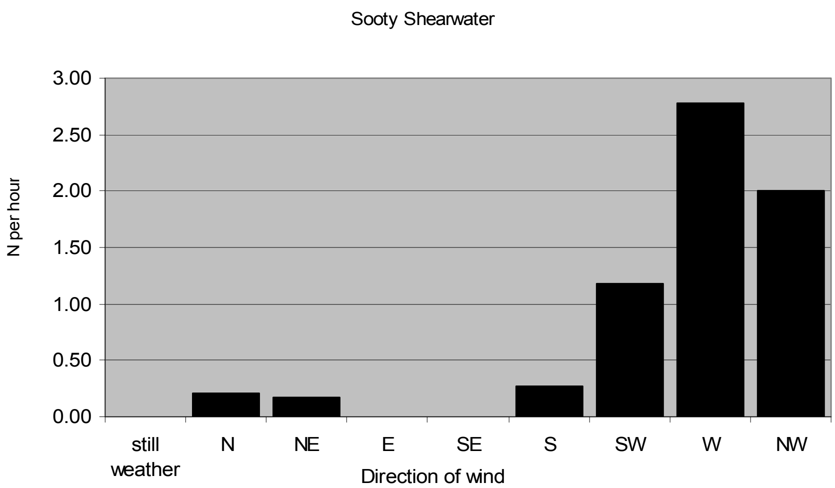


Figure 8. Relative abundance of Sooty Shearwaters at Meetpost Noordwijk in autumn relative to the direction of the wind.

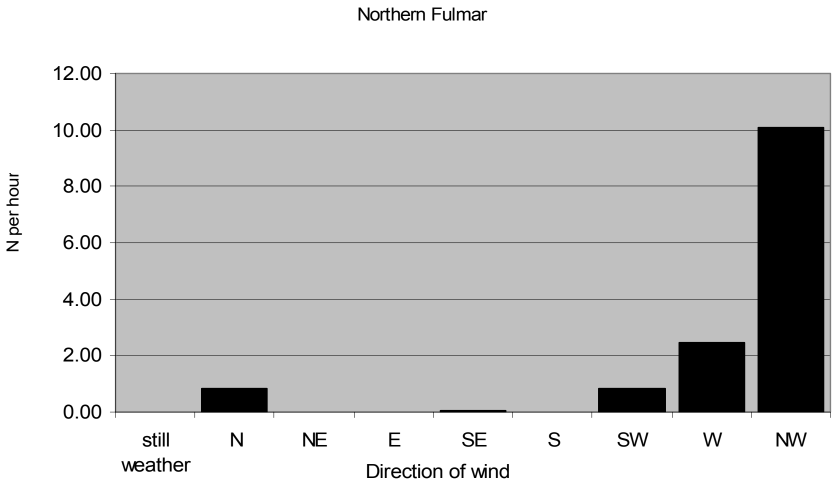


Figure 9. Relative abundance of Northern Fulmars at Meetpost Noordwijk in autumn relative to the direction of the wind.

Northern Gannet

Northern Gannets are passage migrants that are most numerous in autumn, but that can be seen throughout the year (Fig. 10). Note that the North Sea breeding population has more than tripled since the observations at Meetpost Noordwijk were carried out (Wanless & Harris 2004), so that the 'modest' relative abundances both along the coast (and probably at Meetpost Noordwijk) are currently outdated. There is little point in repeating much what has been stressed above for the other species, for the graphs are rather self-explanatory. Northern Gannets occurred in fairly equal numbers at Meetpost Noordwijk and closer to the coast, seasonal patterns were strikingly similar, so that the coastal surveys (with care) could be used as a proxy of offshore abundance. The diurnal pattern is striking, with early morning and late afternoon peaks and a rather substantial noon-dip (Fig. 11). As with the tube-noses would an explanation of this pattern be speculative rather than informative, but with a difference in relative abundance of the magnitude depicted here, it is clear that any survey should take the aspect serious and into account. Strong (north-) westerlies do bring larger numbers of Northern Gannets into the vicinity of Meetpost Noordwijk, but other conditions could be productive also (Fig. 12).

Not shown here, but found at Meetpost Noordwijk occasionally, observed incidentally along the coast (Leopold & Platteeuw 1987), as well as in the study area off Egmond during the present project (this report) were massive flocks of foraging Northern Gannets 'materialising out of the blue' and utilising a resource that was found apparently by accident by these birds. Such flocks may number thousands of gannets, diving and circling over particularly large fish shoals, and staying in a small area for hours or even days, to just as suddenly disappear again without leaving a trace.

Table 6. Total numbers of Northern Gannets seen at Meetpost Noordwijk per month, including the species, numbers heading south, north, east and west, total numbers and the number occurring 'on the spot' (i.e. without direction of flight, on the island, or swimming nearby).

Month	Species	'-> S	'-> N	on the spot	'-> E	'->W	Totals
1	Northern Gannet		30				30
3	Northern Gannet	23	36				59
4	Northern Gannet	34	42		1		77
5	Northern Gannet	10	38			1	49
8	Northern Gannet	2	6	2	1		11
9	Northern Gannet	611	252	194	5	1	1063
10	Northern Gannet	1172	1029	349	2	1	2553
11	Northern Gannet	262	165	2			429
12	Northern Gannet	3	7				10

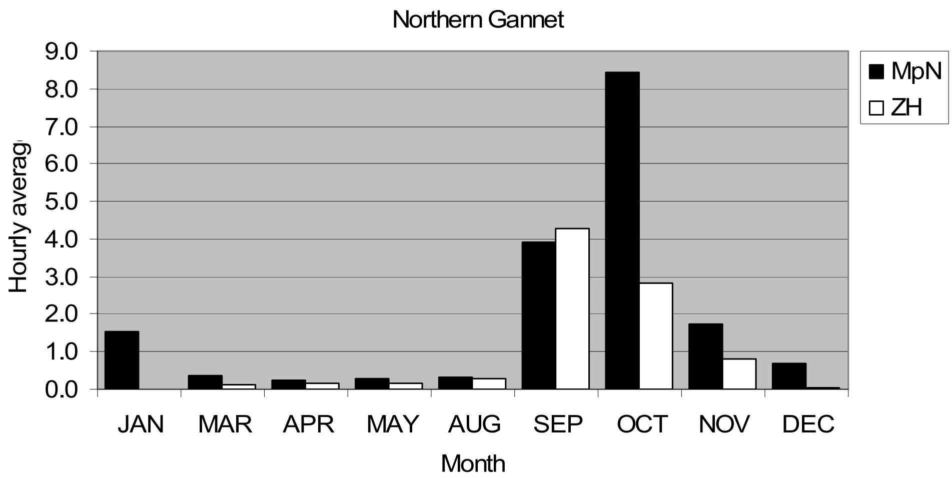


Figure 10. Relative abundance (n per hour) of Northern Gannets along the mainland coast of Zuid-Holland (white bars) and to the west of Meetpost Noordwijk (black bars). See Tables 1-2 for observer effort.

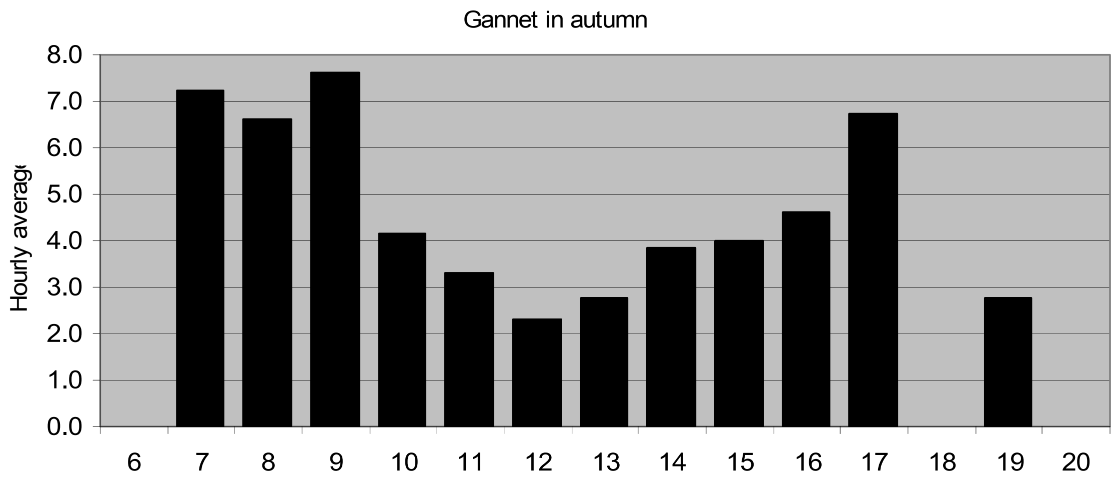


Figure 11. Diurnal pattern (n per hour) of Northern Gannets at Meetpost Noordwijk in autumn.

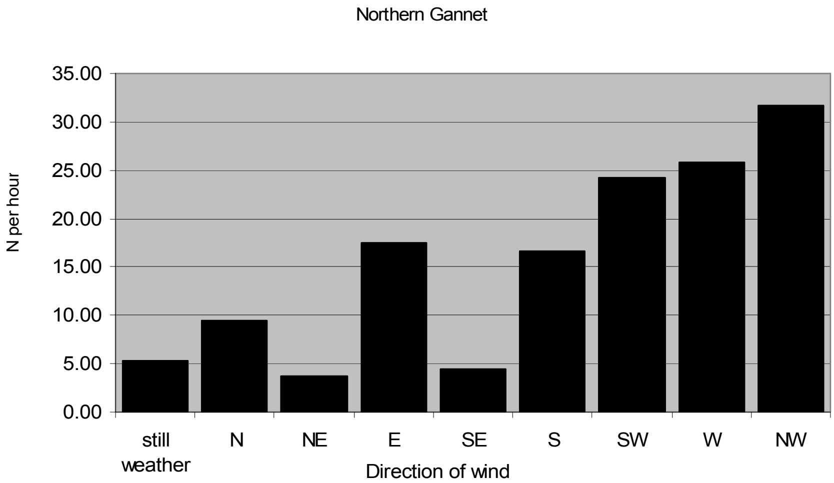


Figure 12. Relative abundance of Northern Gannets at Meetpost Noordwijk in autumn relative to the direction of the wind.

Great Cormorant

Table 7. Total numbers of Great Cormorants seen at Meetpost Noordwijk per month, including the species, numbers heading south, north, east and west, total numbers and the number occurring 'on the spot' (i.e. without direction of flight, on the island, or swimming nearby).

Month	Species	'-> S	'-> N	on the spot	'-> E	'->W	Totals
3	Great Cormorant	1	2				3
4	Great Cormorant	2	10			5	17
5	Great Cormorant		1				1
9	Great Cormorant	7			1		8
10	Great Cormorant	6					6

Great Cormorants *Phalacrocorax carbo* were virtually absent at sea in the late 1970s and early 1980s (Camphuysen & Van Dijk 1983; Camphuysen & Leopold 1994). This has changed dramatically in recent years (Bergman & Leopold 1992; Leopold & Van den Berg 1992; Costers 1993; Leopold 1999; Camphuysen & Leopold 2004), so much so, that we consider the Meetpost Noordwijk data as seriously outdated and of little significance for our present purposes.

seaduck (Common Eider, Common Scoter)

The results suggest that numbers of scoters *Melanitta* spp. and Eiders *Somateria mollissima* at Meetpost Noordwijk are similar as numbers migrating nearer the coast. An apparent discrepancy in December (Fig. 13) may be explained by the small number of observation hours at Meetpost Noordwijk in that month. There was no evidence for substantial numbers of staging seaduck in the vicinity of the Meetpost, whereas substantial numbers may occur closer to the coast when shellfish banks are rich (Leopold 1996).

Diurnal patterns are not very clear, with a very early morning peak in autumn and rather stable levels during the remainder of the day and a rather chaotic pattern in spring (see appendix table on diurnal pattern). Relative abundance vary a great deal with the direction of the wind, both in autumn as well as in spring, but without a clear pattern that could be used to forecast movements of seaduck in the area.

Table 8. Total numbers of seaduck seen at Meetpost Noordwijk per month, including the species, numbers heading south, north, east and west, total numbers and the number occurring 'on the spot' (i.e. without direction of flight, on the island, or swimming nearby).

Month	Species	'-> S	'-> N	on the spot	'-> E	'->W	Totals
1	Common Eider	2					2
3	Common Eider		59				59
4	Common Eider	6	130	20	5		161
5	Common Eider		4				4
10	Common Eider	1	68				69
11	Common Eider	48	83				131
12	Common Eider	12	2				14
1	Common Scoter	29	5				34
3	Common Scoter	322	3007	5	13		3347
4	Common Scoter	326	17766	453			18545
5	Common Scoter	19	471				490
8	Common Scoter	212	59				271
9	Common Scoter	2268	457	8	2		2735
10	Common Scoter	2751	596				3347
11	Common Scoter	1183	469	14			1666
12	Common Scoter	149	6				155
1	Velvet Scoter	3					3
3	Velvet Scoter		30				30
4	Velvet Scoter	4	2288	27			2319
5	Velvet Scoter	1	100				101
9	Velvet Scoter	4					4
10	Velvet Scoter	22	2	1			25
11	Velvet Scoter	63	6				69
12	Velvet Scoter	9	1				10

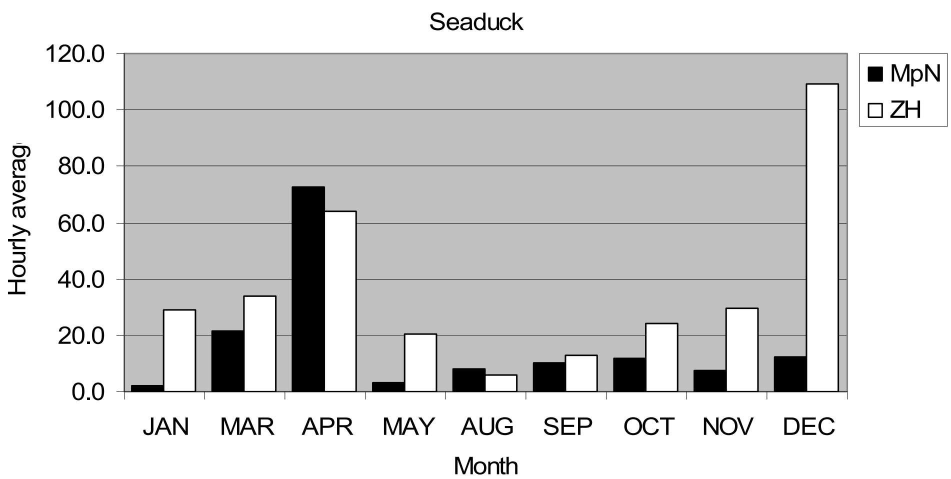


Figure 13. Relative abundance (n per hour) of seaduck (scoters and Eider) along the mainland coast of Zuid-Holland (white bars) and to the west of Meetpost Noordwijk (black bars). See Tables 1-2 for observer effort.

Little Gull

Little Gulls *Larus minutus* were common species at 10 km from the coast, occasionally occurring in even larger numbers than along the shore, but usually fewer. Foraging and feeding is common, underpinning the finding from the windfarm studies (this report) that offshore waters up to at least 20km from the coast may be of significance, at least during spring and autumn migration. Little Gulls in autumn peaked with northerly winds at Meetpost Noordwijk, whereas in spring, easterly winds would produce significantly higher numbers.

Table 9. Total numbers of Little Gulls seen at Meetpost Noordwijk per month, including the species, numbers heading south, north, east and west, total numbers and the number occurring 'on the spot' (i.e. without direction of flight, on the island, or swimming nearby).

Month	Species	'-> S	'-> N	on the spot	'-> E	'->W	Totals
1	Little Gull	5					5
3	Little Gull	39	38	13			90
4	Little Gull	198	968	31	3		1200
5	Little Gull	27	334	199			560
9	Little Gull	239	19	10	4	6	278
10	Little Gull	1313	201	104	1		1619
11	Little Gull	704	192	22			918
12	Little Gull	156	26				182

Black-headed Gull

Black-headed Gulls *Larus ridibundus* are more land-orientated than most other gulls discussed in offshore studies, but with the movements between the European continent and Britain, their occurrence at sea is frequent as a passage migrant and this includes offshore waters. Black-headed Gulls were frequently observed to feed around the Meetpost platform, at times attracted by the waste dumped into the sea, but otherwise attracted by more natural sources of food. Their appearance at sea was highly irregular, with rather low numbers associated with easterly winds in autumn, but with peak numbers with easterly winds in spring.

Table 10. Total numbers of Black-headed Gulls seen at Meetpost Noordwijk per month, including the species, numbers heading south, north, east and west, total numbers and the number occurring 'on the spot' (i.e. without direction of flight, on the island, or swimming nearby).

Month	Species	'-> S	'-> N	on the spot	'-> E	'->W	Totals
1	Black-headed Gull	2	1	2	6		11
3	Black-headed Gull	215	190	63	9	5	482
4	Black-headed Gull	192	174	53	61	4	484
5	Black-headed Gull	61	219	47	32		359
8	Black-headed Gull	1					1
9	Black-headed Gull	104	39	95	2	19	259
10	Black-headed Gull	707	232	174	3	1	1117
11	Black-headed Gull	687	106	66		1	860
12	Black-headed Gull	62		9			71

Common Gull

The Common Gull *Larus canus* is a species that has declined significantly as a breeding bird along the mainland coast since the observations at Meetpost Noordwijk have been conducted (Keijl & Arts 1998). Common Gulls appeared exceptionally numerous at Meetpost Noordwijk, but a direct comparison with coastal sites is hampered by the fact that most seawatchers there didn't take the labour to actually record a common species such as that (see also Herring Gull *Larus argentatus* and Lesser Black-backed Gull *Larus fuscus*). There are no circumstances, other than the occurrence of commercial trawlers, natural food sources, or the attraction of the platform itself (e.g. dumped waste) that clearly influenced the occurrence of Common Gulls at this offshore location and the gulls could be seen in any weather, any time of day, but still in highly fluctuating numbers. The platform itself was a major attraction for this species, to roost at night, or to simply stay around during daytime. Offshore constructions such as windmills may well have a similar effect, but we know nothing about that yet.

Table 11. Total numbers of Common Gulls seen at Meetpost Noordwijk per month, including the species, numbers heading south, north, east and west, total numbers and the number occurring 'on the spot' (i.e. without direction of flight, on the island, or swimming nearby).

Month	Species	'-> S	'-> N	on the spot	'-> E	'->W	Totals
1	Common Gull	438	319	785	115	41	1698
3	Common Gull	2252	2614	1082	41		5989
4	Common Gull	1030	2302	848	310	67	4557
5	Common Gull	637	373	128	27	1	1166
8	Common Gull	2					2
9	Common Gull	552	289	270	15	10	1136
10	Common Gull	2597	1973	2260	18	1	6849
11	Common Gull	4517	1711	3040			9268
12	Common Gull	625	130	564			1319

Lesser Black-backed Gull

Lesser Black-backed Gulls are increasing as breeding birds in The Netherlands (Spaans 1998a). In spring, migration was most obvious at Meetpost Noordwijk in westerly winds, with significantly lower numbers in other conditions. In autumn, that pattern is much less obvious. As with several other gulls, commercial trawlers, natural food sources, and the attraction of the platform itself (e.g. dumped waste) clearly influenced the occurrence at this offshore location. Lesser Black-backed Gulls were abundant particularly in autumn, when large numbers of juveniles and adults would concentrate around the island and set off for a southbound migration somewhere in September and October. Lesser Black-backed Gulls were largely "replaced" by Great Black-backed Gulls *Larus marinus* later in autumn.

Table 12. Total numbers of Lesser Black-backed Gulls seen at Meetpost Noordwijk per month, including the species, numbers heading south, north, east and west, total numbers and the number occurring 'on the spot' (i.e. without direction of flight, on the island, or swimming nearby).

Month	Species	'-> S	'-> N	on the spot	'-> E	'->W	Totals
1	Lesser Black-backed Gull		2		2		4
3	Lesser Black-backed Gull	131	168	40	1		340
4	Lesser Black-backed Gull	264	513	74	67	20	938
5	Lesser Black-backed Gull	501	359	50	12	1	923
8	Lesser Black-backed Gull	2701	646	376	1		3724
9	Lesser Black-backed Gull	8263	3632	11939	301	81	24216
10	Lesser Black-backed Gull	3384	1185	4895	38	7	9509
11	Lesser Black-backed Gull	196	84	81			361
12	Lesser Black-backed Gull	2		1			3
5	Herring / Lesser Black-backed gull	105					105
9	Herring / Lesser Black-backed gull			2698			2698
10	Herring / Lesser Black-backed gull		150	2600			2750

Herring Gull

Herring Gulls are declining as breeding birds in The Netherlands (Spaans 1998b). Unfortunately, coastal sites don't record Herring Gulls systematically, so that a direct comparison cannot be made. It would have shown, beyond doubt, that Lesser Black-backed Gulls are more numerous at Meetpost Noordwijk than along the coast, whereas the reverse is true in Herring Gulls. As with several other gulls, commercial trawlers, natural food sources, and the attraction of the platform itself (e.g. dumped waste) clearly influenced the occurrence at this offshore location.

Table 13. Total numbers of Herring Gulls seen at Meetpost Noordwijk per month, including the species, numbers heading south, north, east and west, total numbers and the number occurring 'on the spot' (i.e. without direction of flight, on the island, or swimming nearby).

Month	Species	'-> S	'-> N	on the spot	'-> E	'->W	Totals
1	Herring Gull	45	9	15	10	11	90
3	Herring Gull	872	2087	473	36	6	3474
4	Herring Gull	716	1053	360	164	8	2301
5	Herring Gull	640	498	175	28	3	1344
8	Herring Gull	47	8	60			115
9	Herring Gull	1386	545	1548	23	40	3542
10	Herring Gull	730	208	1629	22	2	2591
11	Herring Gull	1567	371	1410	20	10	3378
12	Herring Gull			0			0
5	Yellow-legged Gull			1			1

Great Black-backed Gull

Great Black-backed Gulls are the least numerous species of the common large gulls and these are typically winter (or late autumn, early spring) visitors in the area. In autumn, overall numerous are heavily influenced by westerly and northwesterly winds, in fact just as several pelagic seabirds. In spring, no such pattern could be found and Great Black-backed Gulls would linger around under any conditions at least in some numbers. As with several other gulls, commercial trawlers, natural food sources, and the attraction of the platform itself (e.g. dumped waste) clearly influenced the occurrence at this offshore location.

An interesting aspect in large gulls at Meetpost Noordwijk (not so much Great Black-backed Gulls in particular) were peak occurrences at sunrise and sunset in the vicinity of the platform. It should be realized that the platform functions as a roost, with gulls leaving in the morning, and assembling in the late evening. An undisturbed situation (i.e. an offshore zone with no platform) would not probably produce a diurnal rhythm such as this and indeed, 'sleep-migration' towards the coast, and morning flights towards the sea have been a typical phenomenon during the windfarm project off the coast of Egmond (this report).

Table 14. Total numbers of Great Black-backed Gulls seen at Meetpost Noordwijk per month, including the species, numbers heading south, north, east and west, total numbers and the number occurring 'on the spot' (i.e. without direction of flight, on the island, or swimming nearby).

Month	Species	'-> S	'-> N	on the spot	'-> E	'->W	Totals
1	Great Black-backed Gull	38	6	5	10	8	67
3	Great Black-backed Gull	133	192	56		1	382
4	Great Black-backed Gull	63	163	15	28	14	283
5	Great Black-backed Gull	34	49	12			95
8	Great Black-backed Gull	223	96	20			339
9	Great Black-backed Gull	381	103	161	5	4	654
10	Great Black-backed Gull	1144	771	660	10	3	2588
11	Great Black-backed Gull	1837	831	750	2	10	3430
12	Great Black-backed Gull	90	28	14			132

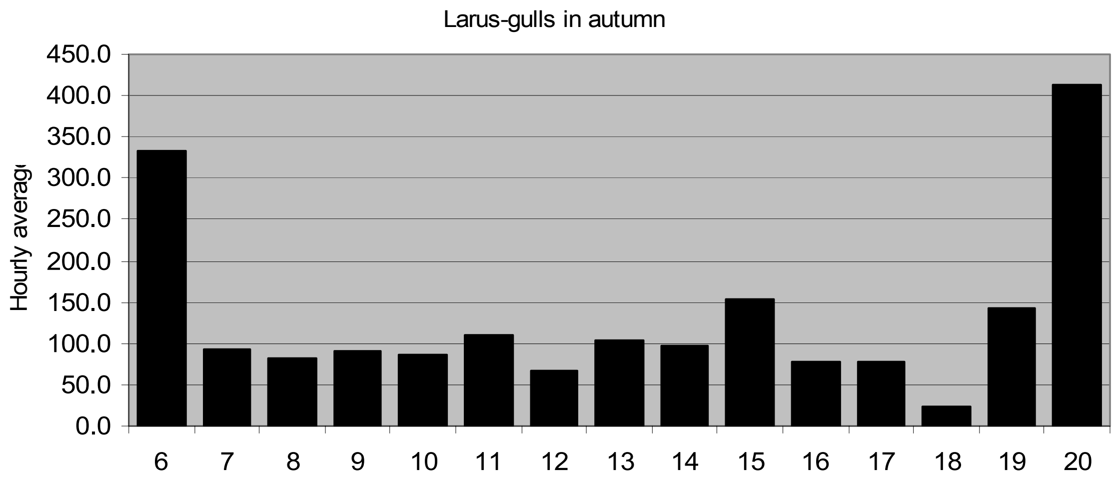


Figure 14. Diurnal pattern (n per hour) of Larus gulls at Meetpost Noordwijk in autumn.

Black-legged Kittiwake

Table 15. Total numbers of Black-legged Kittiwakes seen at Meetpost Noordwijk per month, including the species, numbers heading south, north, east and west, total numbers and the number occurring 'on the spot' (i.e. without direction of flight, on the island, or swimming nearby).

Month	Species	'-> S	'-> N	on the spot	'-> E	'->W	Totals
1	Black-legged Kittiwake	36	24	44	6	5	115
3	Black-legged Kittiwake	108	75	30	2		215
4	Black-legged Kittiwake	5	14	2			21
5	Black-legged Kittiwake	4	22	5	1	1	33
8	Black-legged Kittiwake	4	1	40			45
9	Black-legged Kittiwake	174	73	228	3	1	479
10	Black-legged Kittiwake	3607	1549	6665	2		11823
11	Black-legged Kittiwake	9222	2551	2154			13927
12	Black-legged Kittiwake	822	156	33			1011

Black-legged Kittiwakes *Rissa tridactyla*, as the most pelagic gull of them all, were about 9x more numerous at Meetpost Noordwijk than closer to the coast. It is a species that would arrive in even larger numbers during westerly and northwesterly winds, but apart from this, in autumn a persistent platform association was formed and the birds would roost on board. The presence of Black-legged Kittiwakes and other gulls in association with the Meetpost platform did attract kleptoparasites such as skuas to the island. The same is actually true with the beach, so that overall numbers of skuas at the island were not too different from the coastal situation.

Sandwich Tern

See Common and Arctic tern.

Table 16. Total numbers of Sandwich Terns seen at Meetpost Noordwijk per month, including the species, numbers heading south, north, east and west, total numbers and the number occurring 'on the spot' (i.e. without direction of flight, on the island, or swimming nearby).

Month	Species	'-> S	'-> N	on the spot	'-> E	'->W	Totals
3	Sandwich Tern	4	12				16
4	Sandwich Tern	194	945	12			1151
5	Sandwich Tern	297	746	18	4		1065
8	Sandwich Tern	1438	245	1316			2999
9	Sandwich Tern	924	89	3		5	1021
10	Sandwich Tern	118	41	3			162
11	Sandwich Tern	1					1

Common and Arctic Tern

Table 17. Total numbers of 'commic terns' seen at Meetpost Noordwijk per month, including the species, numbers heading south, north, east and west, total numbers and the number occurring 'on the spot' (i.e. without direction of flight, on the island, or swimming nearby).

Month	Species	'-> S	'-> N	on the spot	'-> E	'->W	Totals
4	Common Tern		26				26
5	Common Tern	12	286	4			302
8	Common Tern	458	60		1		519
9	Common Tern	617	107	51	2	1	778
10	Common Tern	27	12	8			47
4	Arctic Tern	13	191	7			211
5	Arctic Tern	11	273				284
8	Arctic Tern	101	11				112
9	Arctic Tern	183	9	1			193
10	Arctic Tern	2					2
3	Common / Arctic tern	1	3				4
4	Common / Arctic tern	79	1369	2	1		1451
5	Common / Arctic tern	96	4227	11			4334
8	Common / Arctic tern	1073	227	1911			3211
9	Common / Arctic tern	2505	256	53	3	1	2818
10	Common / Arctic tern	37	19	2			58
11	Common / Arctic tern	1					1

Terns are essentially coastal species, but substantial numbers of terns could be observed further offshore, such as at Meetpost Noordwijk (Fig. 15). Sandwich Tern *Sterna sandvicensis* and 'commic terns' *Sterna hirundo* and *Sterna paradisaea* (not normally identified to species level) were the most numerous species, but it has been suggested at least for late spring-migration, that Arctic Terns *S. paradisaea* occurred more frequently at Meetpost Noordwijk than closer to the coast (Den Ouden & Van der Ham 1988). Late autumn migration seemingly drove tern closer to the shore, but otherwise the relative abundance offshore and nearshore were rather similar. In autumn, terns were considerably more numerous offshore during westerly winds, whereas in spring no such pattern was found. The diurnal patterns found in terns were different in a sense that a sunset peak was found in autumn (Fig. 16), an early morning peak in spring (Fig. 17). It has to be noted that both peaks consisted rapidly passing flocks of birds rather than resident (feeding) flocks.

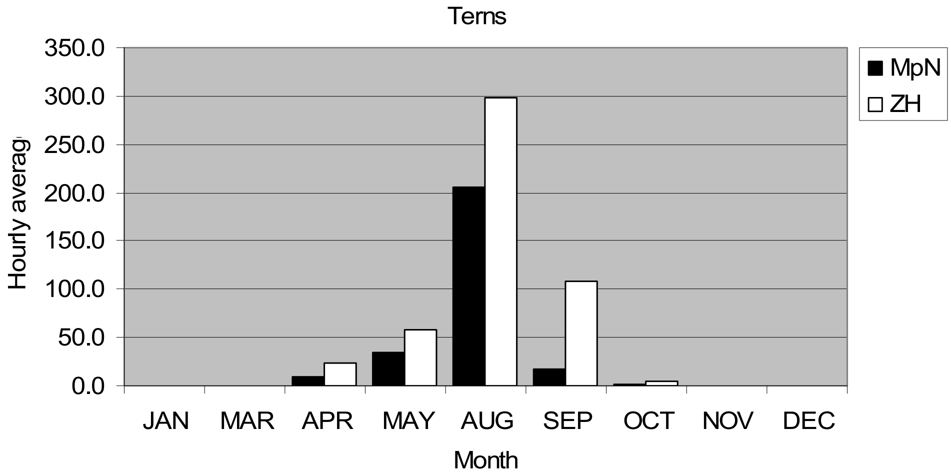


Figure 15. Relative abundance (n per hour) of terns along the mainland coast of Zuid-Holland (white bars) and to the west of Meetpost Noordwijk (black bars). See Tables 1-2 for observer effort.

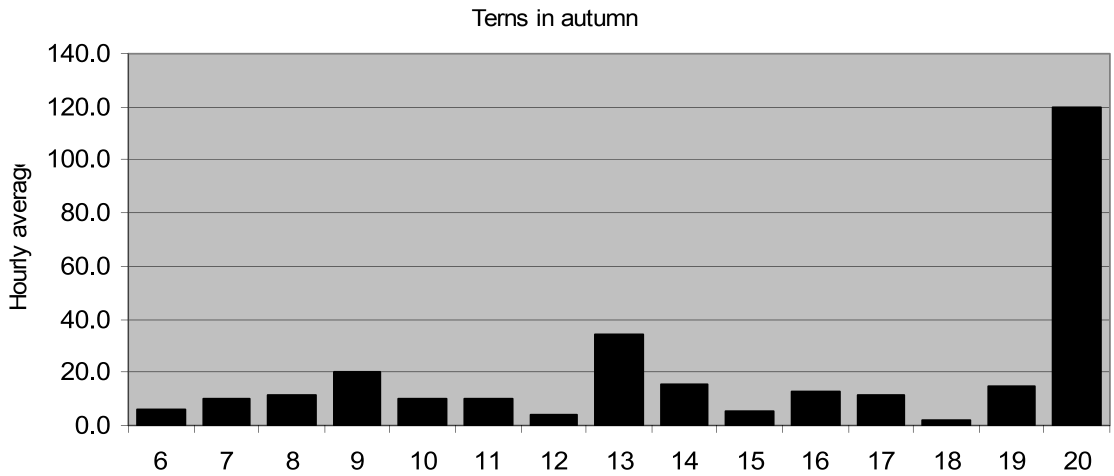


Figure 16. Diurnal pattern (n per hour) of terns at Meetpost Noordwijk in autumn.

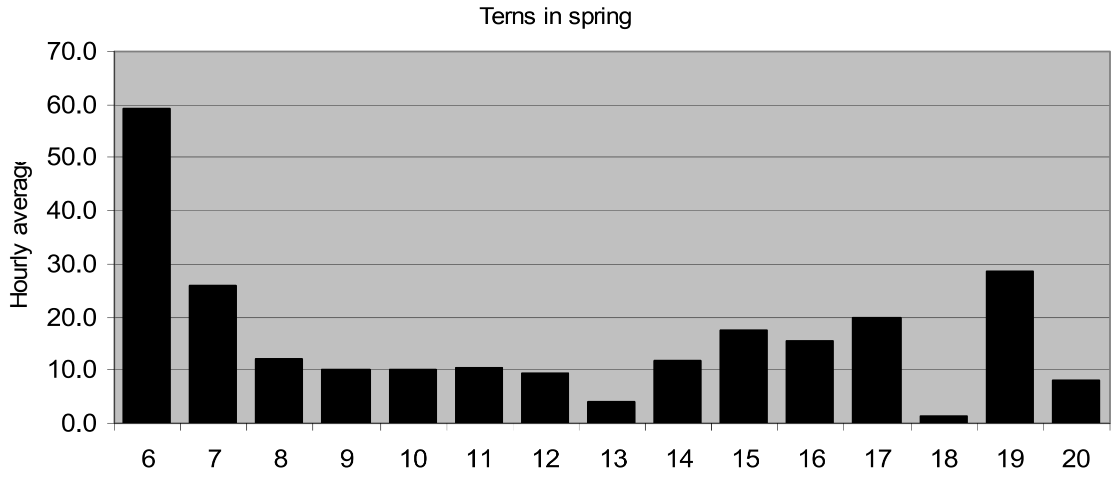


Figure 17. Diurnal pattern (n per hour) of terns at Meetpost Noordwijk in spring.

Auks (Common Guillemot, Razorbill and smaller auks)

Table 18. Total numbers of auks seen at Meetpost Noordwijk per month, including the species, numbers heading south, north, east and west, total numbers and the number occurring 'on the spot' (i.e. without direction of flight, on the island, or swimming nearby).

Month	Species	'-> S	'-> N	on the spot	'-> E	'->W	Totals
1	Common Guillemot	2	6	12			20
3	Common Guillemot	5	6	12			23
4	Common Guillemot	6	1	10			17
5	Common Guillemot		1	2			3
9	Common Guillemot	4	3	5			12
10	Common Guillemot	13	16	13			42
11	Common Guillemot	139	122	88			349
12	Common Guillemot	28	2	7			37
1	Common Guillemot / Razorbill	44	7	6	3	1	61
3	Common Guillemot / Razorbill	20	60	7			87
4	Common Guillemot / Razorbill	34	20	7			61
5	Common Guillemot / Razorbill	1	10				11
9	Common Guillemot / Razorbill	23	8	5			36
10	Common Guillemot / Razorbill	92	104	12			208
11	Common Guillemot / Razorbill	1399	469	44			1912
12	Common Guillemot / Razorbill	120	14	9			143
1	Razorbill		1				1
3	Razorbill			1			1
4	Razorbill	2	2				4
9	Razorbill	1		1			2
10	Razorbill	6	4	7			17
11	Razorbill	28	14	12	1		55
12	Razorbill	12	2				14
9	Little Auk	5					5
11	Little Auk	28					28
12	Little Auk	2					2
3	Atlantic Puffin	2		1			3
4	Atlantic Puffin	1	1				2
5	Atlantic Puffin	1					1
8	Atlantic Puffin	1					1
10	Atlantic Puffin	3	1				4
11	Atlantic Puffin	3					3
12	Atlantic Puffin	1	1				2

For auks, Meetpost Noordwijk turned out to be much better than any coastal site (Fig. 18) and the results yielded some interesting and highly relevant data. Species composition, nor overall abundance did surprise the observers, but a striking diurnal pattern was recorded (Fig. 19), that we are not able to explain without speculation. If tidal rhythms would have influenced the foraging distribution (and, hence, occurrence at Meetpost Noordwijk) of auks, the diurnal pattern would have flattened out to cover all of the daylight period, whereas a peak between 09:00 and 12:00 suggests an arrival and subsequent departure from the area on a daily basis. Camphuysen (1998) analysed the diurnal pattern of offshore auks at an even greater distance from the coast and found a pattern that looks more like the opposite as this, pointing at declining flying activity in the course of a day (in the morning), and an increase in the evening. This study, as well as the present analysis, suggests that at any one spot offshore, auks do not so much spend the day, but that a re-arrangement of birds takes places on a fairly regular, but apparently site-specific basis. This aspect does deserve more study if the presence or absence of auks in any given area is to be better understood.

Spring numbers of auks at Meetpost Noordwijk were rather low, but numbers clearly increased during northerly (NE-NW) winds. The same conditions would significantly elevate overall numbers in autumn (Fig. 20), when all species were most numerous. It should be noted that the peak-period for auks in Dutch offshore waters (December-February) has not adequately been covered in the Meetpost Noordwijk project.

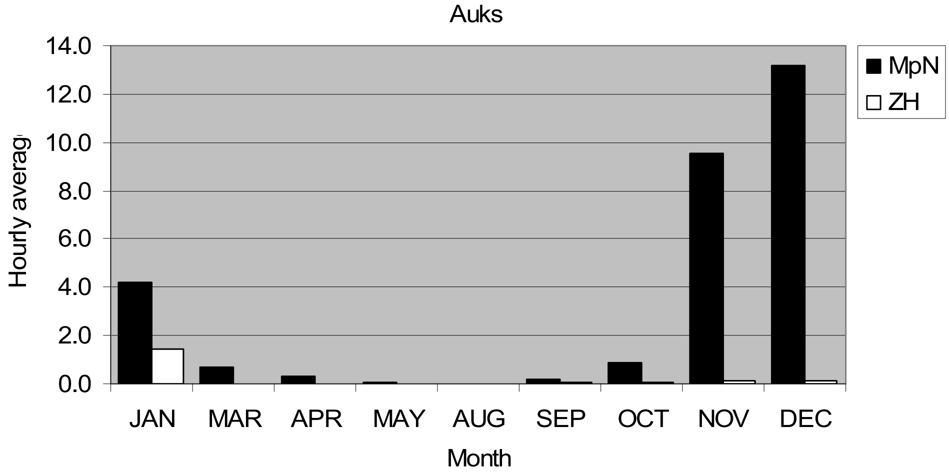


Figure 18. Relative abundance (n per hour) of auks along the mainland coast of Zuid-Holland (white bars) and to the west of Meetpost Noordwijk (black bars). See Tables 1-2 for observer effort.

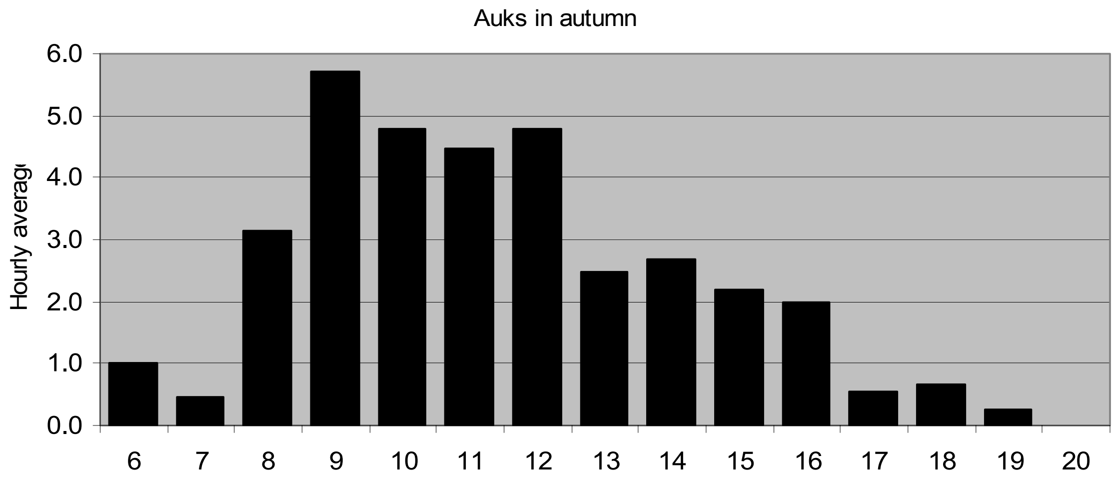


Figure 19. Diurnal pattern (n per hour) of auks at Meetpost Noordwijk in autumn.

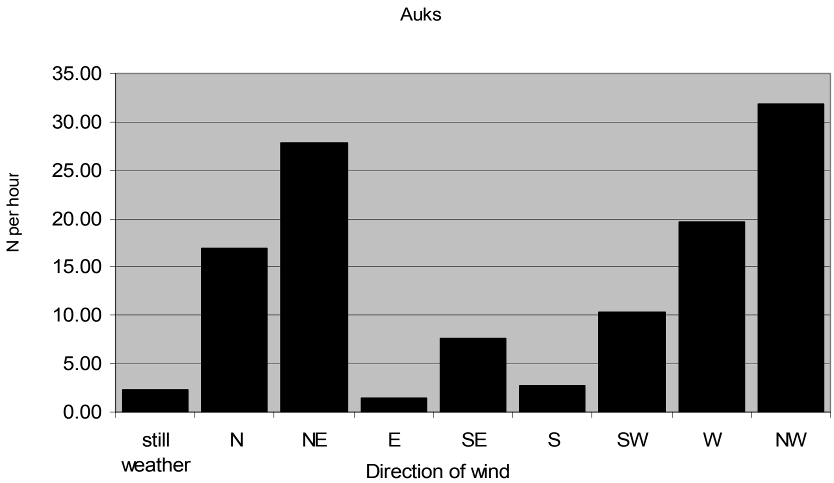


Figure 20. Relative abundance of auks at Meetpost Noordwijk in autumn relative to the direction of the wind.

General remarks (1): the attraction of fishing vessels

Fishing vessels do attract scavenging seabirds, that is beyond any doubt, and therefore have a great influence on the abundance of seabirds in any given area (Camphuysen *et al.* 1995). The data collected at Meetpost Noordwijk suggest that this is particularly true for large *Larus* gulls in the study area (Herring, Lesser and Great Black-backed Gull), but much less so for most other species. The attraction of fishing vessels is not a constant phenomenon also and for nearly every species, proteins obtained at trawlers are a secondary prey type, with standing preference for more natural prey such as fatty shoaling fish (Lesser Black-backed Gull, Northern Gannet, Black-legged Kittiwake), zooplankton (Northern Fulmar, Black-legged Kittiwake) or other prey in the species-specific natural habitats. In Table 19, the relative abundance (n per hour of observation) of the main groups of birds at fishing vessels has been listed, showing that some birds were never seen to profit from a fishing vessel, whereas substantial numbers were seen for others. Note that Great Cormorants have seldom been seen near fishing vessels in this analysis, but this has changed markedly in recent years (Camphuysen 1999) and underpins that Cormorant data are really outdated.

The relative importance of trawler presence is approximated in Table 20, where the number of fishing vessel associates is compared with the total number of birds recorded. It can be seen that for some species (notably the larger gulls again), the presence or absence of a fishing fleet does make a huge difference!

Table 19. Seabirds attracted by fishing vessels at Meetpost Noordwijk (n per hour per month). Since not all observers carefully recorded the attraction by trawlers, this is a minimum estimate.

Birds at trawlers	JAN	MAR	APR	MAY	AUG	SEP	OCT	NOV	DEC
Divers	0	0	0	0		0	0	0	0
Grebes	0	0	0	0	0	0	0	0	0
Fulmar	**0**	**0**	**0**	**0**	**0**	**2.5**	**0**	**0**	
Other tubenoses				0	0	0	0	0	0
Gannet	**0**	**1.7**	**0**	**0**	**0**	**0.1**	**0.8**	**0.7**	**0**
C/Shag		0.0	0	0		0.0	0.0		
Seaduck	0	0	0	0	0	0	0	0	0
Other wildfowl	0	0	0	0	0	0	0	0	0
Waders	0	0	0	0	0	0	0	0	0
Skuas		**0**	**0**	**0**	**0**	**0.4**	**1.4**	**0**	
Larus-gulls	**21.0**	**11.7**	**0**	**3.4**	**0.7**	**36.9**	**26.5**	**19.2**	**0**
Kittiwake	**0**	**1.4**	**0**	**0.0**	**0.0**	**0.4**	**5.2**	**4.7**	**0**
Terns		**0.0**	**0**	**0**	**1.2**	**0.5**	**0.0**	**0.0**	
Auks	0	0	0	0	0.0	0.0	0	0	0
Herons and rails			0		0	0	0	0	
Raptors			0	0		0	0	0	
Pigeons and owls		0	0	0		0	0	0	0
Passerines	0	0	0	0	0	0	0	0	0

Table 20. Seabirds attracted by fishing vessels at Meetpost Noordwijk. Since not all observers carefully recorded the attraction by trawlers, this is a minimum estimate. Shown are: species, number recorded at trawlers, total numbers observed, and proportion (%) recorded at trawlers.

Species	**Group**	**at trawlers**	**total recorded**	**% trawler**
Lesser Black-backed Gull / Herring Gull	Larus-gulls	5443	5553	98.0
unidentified large gulls	Larus-gulls	3220	4019	80.1
Lesser Black-backed Gull	Larus-gulls	10685	40018	26.7
Herring Gull	Larus-gulls	3987	16835	23.7
Great Black-backed Gull	Larus-gulls	1057	7970	13.3
total large *Larus* gulls		24392	74395	32.8
Black-legged Kittiwake	Kittiwake	1275	27669	4.6
Common Gull	Larus-gulls	1189	31984	3.7
Black-headed Gull	Larus-gulls	104	3644	2.9
Great Skua	Skuas	3	186	1.6
Common Tern	Terns	22	1672	1.3
Common Tern / Arctic Tern	Terns	80	11877	0.7
Northern Gannet	Gannet	25	4281	0.6
Arctic Skua	Skuas	3	579	0.5
Northern Fulmar	Fulmar	2	691	0.3

General remarks (2): birds and the direction of wind

Several birds have been discussed already in terms of wind direction, but some were missing in the list of major groups that was resulting from the windfarm studies off Egmond. Figures 21 and 22 show the rather clear-cut patterns found for wader and passerine migration observed in autumn at Meetpost Noordwijk. All data are summarised in Table 21.

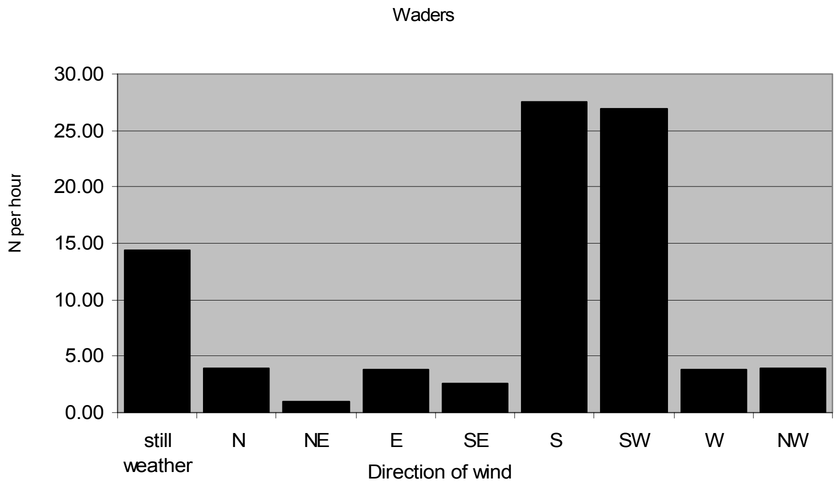


Figure 21. Relative abundance of waders at Meetpost Noordwijk in autumn relative to the direction of the wind.

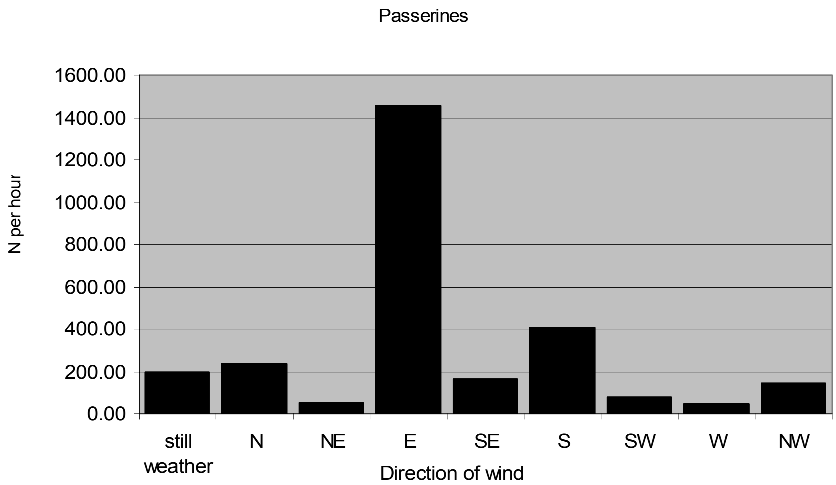


Figure 22. Relative abundance of passerins at Meetpost Noordwijk in autumn relative to the direction of the wind.

Table 21. Relative abundance of birds at Meetpost Noordwijk in autumn relative to the direction of the wind (summary of all results, including observer effort).

Observer effort and direction of wind (hours observed; 0 = still weather)

	0	N	NO	O	ZO	Z	ZW	W	NW
JAN					5.5		1.0	5.0	8.0
MAR	1.0	12.6	30.9	2.0	17.0	2.0	47.8	10.3	39.3
APR		16.9	88.0	3.0	65.5	4.0	33.0	13.0	70.5
MAY		29.5	7.5	9.5	30.0	4.0	31.5	6.0	59.0
AUG							23.0	3.3	7.0
SEP	6.0	14.0	6.0	10.5	26.5	28.8	111.1	26.9	43.0
OCT	1.0	6.0	6.0	5.0	30.5	46.5	116.7	19.5	71.5
NOV		4.0	15.0		13.5	4.0	106.5	35.0	69.0
DEC	1.0				1.5		5.0	0.5	7.0
	0	**N**	**NO**	**O**	**ZO**	**Z**	**ZW**	**W**	**NW**
SPRING	1.0	59.0	126.4	14.5	118.0	10.0	113.3	34.3	176.8
AUTUMN	8.0	24.0	27.0	15.5	72.0	79.3	362.3	85.3	197.5

Relative abundance (n per hour) and direction of wind (0 = still weather)

AUTUMN	0	N	NO	O	ZO	Z	ZW	W	NW
Divers	0.6	0.3	0.9	0.2	1.5	0.2	0.3	1.0	1.3
Grebes		0.5	0.5	0.3	0.2	0.2	0.1	0.1	0.1
Fulmar		0.2			0.0		0.2	0.5	2.1
Other tubenoses		0.1	0.0			0.1	0.3	0.7	0.5
Gannet	0.9	1.9	0.8	3.2	0.9	3.1	5.1	5.6	6.6
C/Shag						0.1	0.0	0.0	0.0
Seaduck	2.6	5.1	10.0	30.8	9.3	8.5	8.6	12.1	11.4
Other wildfowl	0.1	10.0	1.7	4.6	2.4	6.3	1.2	0.7	2.2
Waders	2.4	0.8	0.2	0.7	0.5	5.2	5.7	0.8	0.8
Skuas	1.1	0.8	0.3	0.7	0.2	0.9	0.8	1.0	1.5
Larus-gulls	118.8	200.6	72.1	82.2	56.9	131.5	100.3	87.4	99.6
Kittiwake	22.6	28.4	23.4	15.4	11.2	10.9	24.3	34.8	61.3
Terns	5.8	1.3	0.4	2.8	5.0	20.8	11.9	15.0	21.6
Auks	0.4	3.4	6.1	0.3	1.5	0.5	2.2	4.2	6.7
Herons and rails						0.1	0.0		
Raptors	0.1	0.0		0.1	0.1	0.1	0.0		0.0
Pigeons and owls	0.1	0.1	0.1	0.1	0.2	0.1	0.0	0.0	0.1
Passerines	32.1	47.5	10.8	269.7	33.7	76.9	17.0	9.9	30.5
SPRING	**0**	**N**	**NO**	**O**	**ZO**	**Z**	**ZW**	**W**	**NW**
Divers	4.0	0.8	0.6	0.1	0.2	0.1	0.4	1.1	1.5
Grebes		0.2	0.1		0.1		0.0	1.0	1.0
Fulmar			0.0	0.1	0.1		0.1	0.1	0.8
Other tubenoses							0.0		0.0
Gannet	1.0	0.3	0.3	0.2	0.2	0.1	0.4	0.1	0.5
C/Shag			0.0		0.1		0.0	0.0	0.0
Seaduck	7.0	14.6	47.1	1.9	20.5	3.8	30.5	26.3	66.5
Other wildfowl		6.6	2.5	0.6	0.9	0.1	2.3	1.3	2.1
Waders		4.1	5.6	0.6	9.3		2.1	1.0	7.5
Skuas			0.0	0.1	0.0		0.1		0.0
Larus-gulls	57.0	29.5	39.0	42.7	43.4	31.8	38.3	66.3	48.5
Kittiwake		0.1	0.2		0.6	0.3	0.8	0.8	0.9
Terns		17.5	6.7	20.4	7.4	3.1	22.6	6.2	17.8
Auks		0.5	0.9	0.3	0.0		0.1	0.2	0.7
Herons and rails		0.0	0.0		0.0				
Raptors		0.0	0.0		0.0		0.0		
Pigeons and owls		0.2	0.2	0.6	0.6	0.9	0.1	0.0	0.1
Passerines	30.0	4.6	3.4	10.5	12.3	6.5	11.7	4.7	4.6

General remarks (3): birds and the time of day

For most species, the diurnal patterns have been addressed in the species accounts, with or without a graph to show the pattern found. In Table 22 all results have been summarised for comparison.

Table 22. Diurnal patterns (relative abundance, n per hour of observation relative to time of day) of main groups of birds observed at Meetpost Noordwijk in autumn and spring

	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Divers in autumn		0.2	0.7	1.2	0.7	0.9	0.3	0.6	0.7	0.6	0.3	0.0			
Grebes in autumn		0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.0	0.1	0.0			
Fulmar in autumn		1.7	1.2	0.4	0.9	0.6	0.9	0.3	0.5	0.2	0.3	0.3		0.3	
Other tubenoses in autumn		0.3	0.4	0.3	0.2	0.2	0.4	0.5	0.3	0.4	0.3	0.4	0.7	0.6	0.7
Gannet in autumn		7.2	6.6	7.6	4.1	3.3	2.3	2.8	3.8	4.0	4.6	6.7		2.8	
C/Shag in autumn			0.0	0.1				0.0	0.0		0.0				
Seaduck in autumn	25.0	10.6	11.3	10.3	11.9	12.0	7.8	7.8	7.6	9.8	7.6	11.3	9.3	6.0	
Other wildfowl in autumn	1.5	2.0	2.5	4.1	1.8	2.8	1.8	1.5	0.7	4.3	0.9	1.0		0.3	
Waders in autumn	1.0	1.1	1.1	1.8	2.9	1.7	0.4	0.4	0.2	0.3	13.4	10.2		15.1	54.0
Skuas in autumn	3.0	2.2	1.1	1.1	0.8	0.8	0.7	0.7	0.6	0.7	1.1	1.1	0.7	1.3	1.3
Larus-gulls in autumn	333.0	94.0	83.1	91.5	86.9	109.6	67.1	104.7	96.5	154.2	78.5	78.5	24.7	141.9	413.3
Kittiwake in autumn		39.4	49.4	47.0	37.0	27.3	41.3	17.5	21.5	23.5	25.8	19.0		1.5	0.7
Terns in autumn	6.0	10.3	11.1	20.3	9.9	9.9	4.3	34.6	15.6	5.7	12.6	11.1	2.0	14.5	120.0
Auks in autumn	1.0	0.5	3.1	5.7	4.8	4.5	4.8	2.5	2.7	2.2	2.0	0.6	0.7	0.3	
Herons and rails in autumn		0.1	0.0	0.1	0.1		0.0		0.0	0.0					
Raptors in autumn	1.0	0.1		0.0	0.1	0.0		0.0	0.0	0.0		0.0			
Pigeons and owls in autumn		0.1	0.1	0.1	0.1	0.1	0.2	0.0	0.1	0.0	0.1	0.1	0.7	0.1	
Passerines in autumn	56.0	11.0	71.6	74.0	44.9	21.7	26.8	19.2	12.2	9.4	21.8	30.9		0.2	

	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Divers in spring	0.1	0.7	0.8	1.0	1.0	0.7	0.1	0.5	0.4	0.3	0.6	0.9		0.5	
Grebes in spring		0.0	0.1	0.1	0.1	0.0		0.3	0.1	0.1	0.0	0.2		0.1	
Fulmar in spring	0.1	0.3	0.8	0.6	0.3	0.3	0.3	0.0	0.0	0.0	0.0	0.0		0.4	0.1
Other tubenoses in spring				0.0	0.0					0.0					
Gannet in spring	0.1	0.2	0.7	0.5	0.4	0.4	0.1	0.2	0.2	0.1	0.2	0.2		0.0	
C/Shag in spring			0.2	0.0		0.0			0.0		0.0	0.1			
Seaduck in spring	8.0	51.7	35.7	34.8	33.6	84.6	7.5	59.0	34.6	35.8	26.9	29.9	86.7	15.3	4.5
Other wildfowl in spring	0.6	2.0	1.4	3.6	3.5	5.4		4.6	1.3	1.9	0.6	1.2		0.3	
Waders in spring	12.6	7.9	6.5	3.1	3.2	5.8	4.9	2.4	3.5	5.6	3.8	9.8	0.7	24.2	1.5
Skuas in spring			0.0	0.0	0.0	0.0	0.1	0.0		0.0		0.0		0.1	
Larus-gulls in spring	41.9	37.5	42.8	37.1	43.1	50.0	26.8	37.6	43.4	35.9	41.0	37.5	74.7	35.8	14.5
Kittiwake in spring	0.6	0.2	0.4	0.3	0.5	0.5	0.2	0.1	0.4	0.5	0.9	0.6		0.2	0.2
Terns in spring	59.1	26.0	12.0	10.1	10.2	10.3	9.4	4.0	11.6	17.3	15.4	19.9	1.3	28.5	8.2
Auks in spring		0.5	0.6	0.7	0.6	0.3		0.3	0.1	0.2	0.3	0.2		0.2	0.5
Herons and rails in spring		0.0	0.0		0.1			0.0	0.0						
Raptors in spring			0.0	0.0			0.1	0.0	0.0	0.0		0.0			
Pigeons and owls in spring		0.3	0.8	0.4	0.2	0.2	0.3	0.1	0.1	0.2	0.2	0.1		0.3	
Passerines in spring	1.3	4.7	6.7	7.1	13.7	7.4	1.0	9.6	8.1	7.1	3.8	1.6		0.5	0.7

General remarks (4): Meetpost versus coastal sites

The difference in relative abundance of birds between Meetpost Noordwijk and selected coastal sites (ZH) in identical periods (day/month/year) has been discussed for most species, but the results are summarised in Table 23.

Table 23. Relative abundance (n per hour of observation) of seabirds and other species at Meetpost Noordwijk and along the mainland coast between Scheveningen and IJmuiden

	JAN	MAR	APR	MAY	AUG	SEP	OCT	NOV	DEC		Mean	Max	Ratio MpN/ZH
Divers	4.3	1.3	0.6	0.1		0.1	0.2	1.8	5.9	MpN	1.8	5.9	5.5
Divers	0.7	0.1	0.0	0.0	0.0	0.0	0.1	0.2	1.7	ZH	0.3	1.7	
Grebes	10.5	0.1	0.1	0.0	0.0	0.0	0.1	0.2	0.1	MpN	1.2	10.5	0.0
Grebes	109.6	3.6	0.7	0.3	0.3	0.4	2.3	7.3	128.4	ZH	28.1	128.4	
Fulmar	0.3	0.4	0.1	0.3	0.0	0.3	1.4	0.1		MpN	0.4	1.4	2.8
Fulmar	0.1	0.0	0.5	0.2		0.0	0.1	0.0		ZH	0.1	0.5	
Other tubenoses				0.0	0.1	0.2	0.5	0.3	0.1	MpN	0.2	0.5	1.5
Other tubenoses					0.1	0.2	0.2	0.1		ZH	0.1	0.2	
Gannet	1.5	0.4	0.3	0.3	0.3	3.9	8.4	1.7	0.7	MpN	1.9	8.4	1.8
Gannet		0.1	0.2	0.1	0.3	4.3	2.8	0.8	0.0	ZH	1.1	4.3	
C/Shag		0.0	0.1	0.0		0.0	0.0			MpN	0.0	0.1	0.0
C/Shag	0.1	0.5	1.2	0.4	1.5	0.9	1.2	0.1	0.0	ZH	0.6	1.5	
Seaduck	2.1	21.4	72.5	3.4	8.1	10.1	11.7	7.7	12.5	MpN	16.6	72.5	0.5
Seaduck	29.0	34.1	64.1	20.6	5.9	13.0	24.4	29.7	109.3	ZH	36.7	109.3	
Other wildfowl	0.2	4.4	2.3	0.5	1.0	1.8	2.7	2.2	6.2	MpN	2.4	6.2	0.1
Other wildfowl	28.5	16.3	16.3	2.9	5.5	6.7	36.7	14.5	40.8	ZH	18.7	40.8	
Waders	0.6	2.2	7.5	6.1	53.9	1.2	1.6	0.4	5.5	MpN	8.8	53.9	0.2
Waders	98.1	44.9	64.6	82.8	38.5	17.0	26.8	12.0	92.8	ZH	53.0	98.1	
Skuas		0.0	0.0	0.1	3.3	1.0	1.2	0.3		MpN	0.8	3.3	1.1
Skuas	0.1	0.0	0.0	0.0	2.1	2.5	1.2	0.3		ZH	0.8	2.5	
Larus-gulls	132.1	67.9	33.2	25.8	125.5	127.0	89.8	77.8	113.9	MpN	88.1	132.1	2.7
Larus-gulls	1.8	66.6	43.6	28.5	26.8	24.3	37.3	50.2	11.3	ZH	32.3	66.6	
Kittiwake	5.9	1.3	0.1	0.2	1.4	1.8	39.1	56.4	67.4	MpN	19.3	67.4	8.9
Kittiwake	5.4	0.4	0.3	1.1	0.1	0.1	1.7	8.5	2.0	ZH	2.2	8.5	
Terns		0.1	9.7	34.6	206.2	17.7	0.9	0.0		MpN	38.5	206.2	0.5
Terns		0.5	22.9	58.4	297.9	108.8	4.0	0.0		ZH	70.4	297.9	
Auks	4.2	0.7	0.3	0.1	0.0	0.2	0.9	9.5	13.2	MpN	3.2	13.2	15.2
Auks	1.5	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	ZH	0.2	1.5	
Herons and rails			0.0		0.2	0.1	0.0	0.0		MpN			
Herons and rails	0.1	0.3	0.3	0.1	0.7	0.6	0.1	0.0	0.1	ZH			
Raptors			0.0	0.0		0.0	0.0	0.0		MpN			
Raptors		0.0	0.1	0.0		0.0	0.2	0.1	0.4	ZH			
Pigeons and owls		0.1	0.3	0.3		0.1	0.1	0.0	0.1	MpN			
Pigeons and owls			0.0	0.0			0.0	0.0		ZH			
Passerines	31.6	16.4	3.7	1.7	0.1	5.2	62.6	28.1	5.7	MpN			
Cetaceans				0.0			0.0			MpN			
Pinnipeds			0.0							MpN			

General remarks (5): day-to-day variability

A final aspect that deserves particular attention is the day-to-day variability of the material as this was now collected at an offshore site. Four images are shown, illustrating the relative abundance of the major groups of birds in a large number of consecutive hours observation and the changing wind (direction and velocity), as examples of day-to-day variability (Fig. 23-26). Keeping in mind that most surveys are conducted with 'favourable weather' (i.e. wind force 6 or less), choosing periods in which at least a series of days is forecasted with such conditions, it becomes clear that the results obtained may be heavily biased. It is not possible to work under adverse weather conditions and it is not safe. Any future T_1 survey, however, should preferably be conducted under similar conditions as the T_0 study. Alternatively, the difference caused by day-to-day variability (the sum of weather, seasonality, diurnal patterns and external influences of prey supply) should be kept firmly in mind during the analysis and comparisons of data. It is highly recommended that as much 'explanatory data' (external associations, weather, timing, and behaviour of the birds involved) are collected in any such project, to allow for a sensible explanation of patterns found.

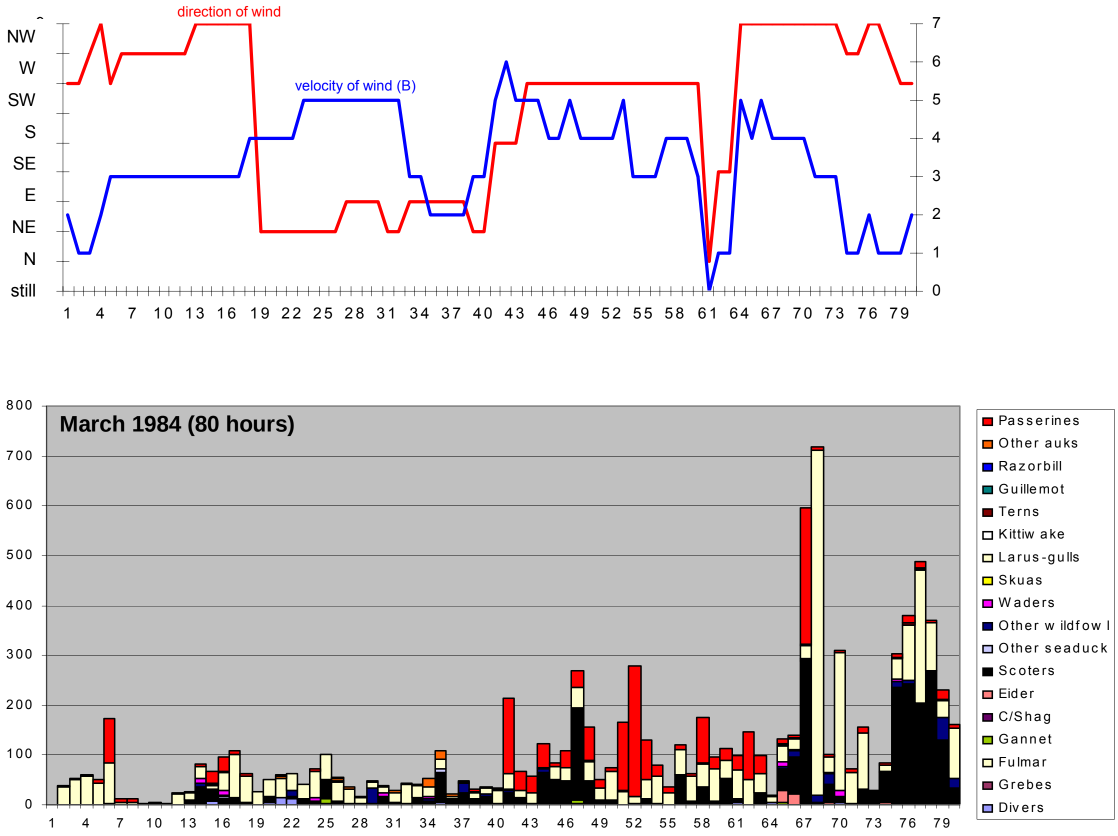


Figure 23. Species composition (bottom) and weather (top) during 80 hours of seawatching at Meetpost Noordwijk in March 1984.

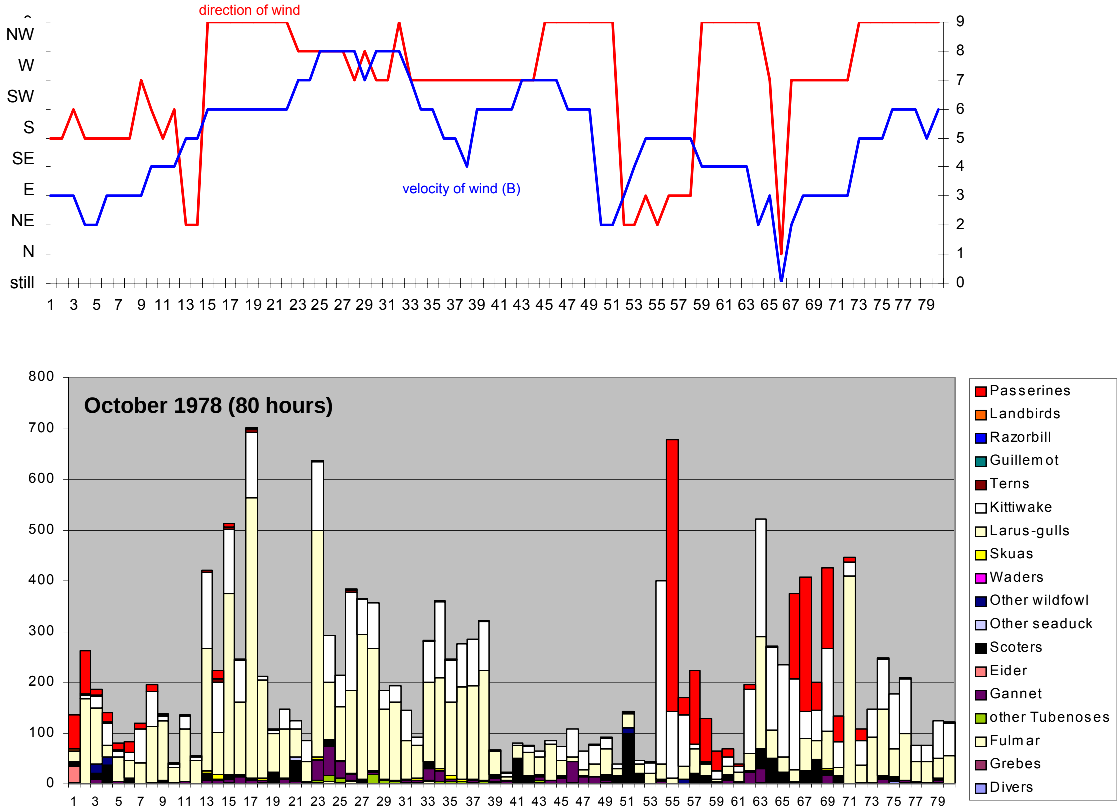
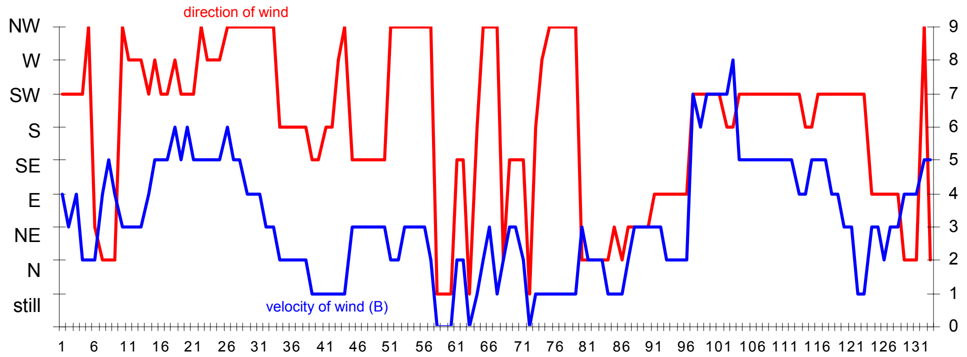


Figure 24. Species composition (bottom) and weather (top) during 80 hours of seawatching at Meetpost Noordwijk in October 1978.



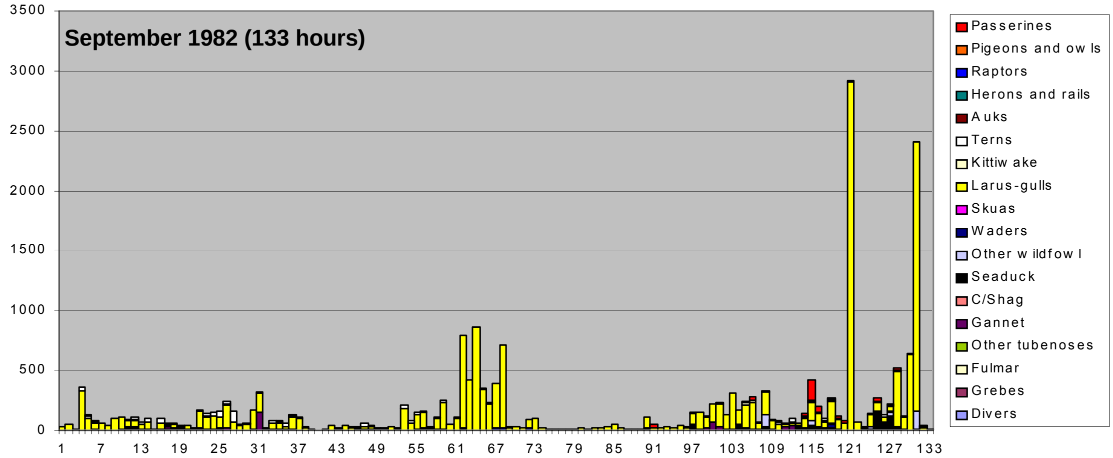


Figure 25. Species composition (bottom) and weather (top) during 133 hours of seawatching at Meetpost Noordwijk in September 1982.

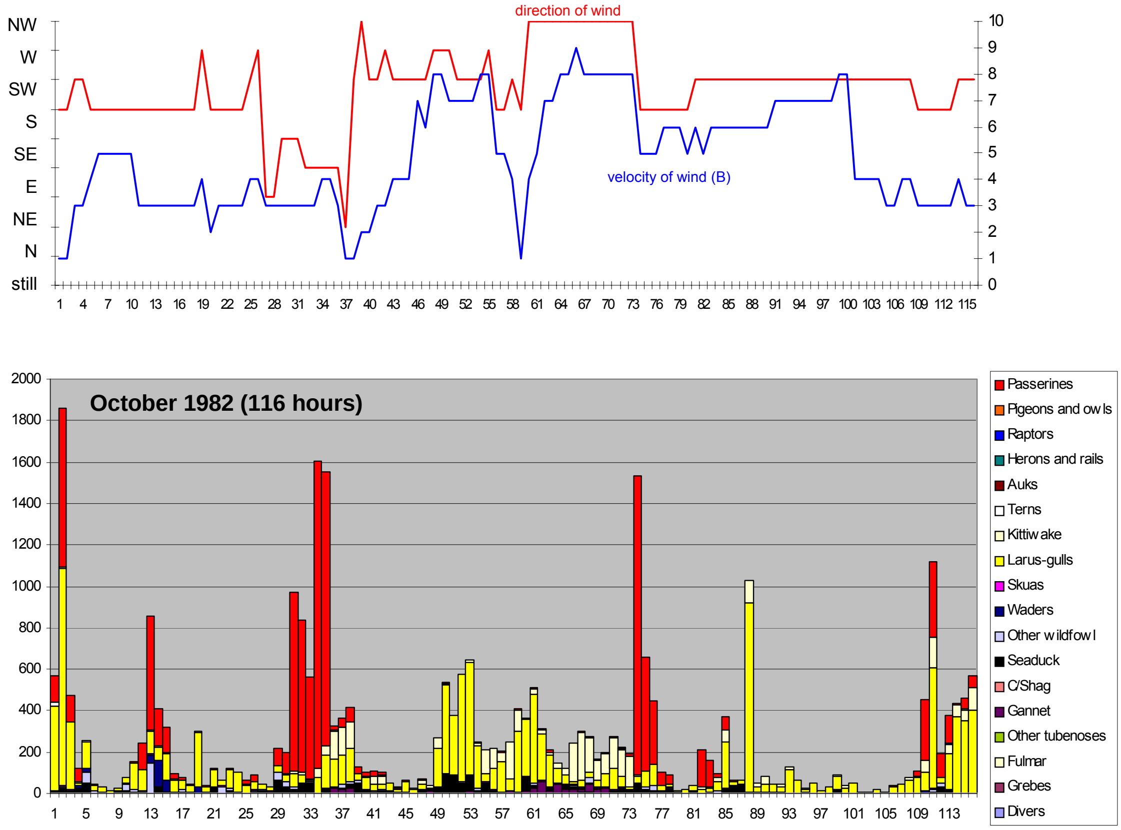


Figure 26. Species composition (bottom) and weather (top) during 116 hours of seawatching at Meetpost Noordwijk in October 1982.

References

Baptist H.J.M. & Wolf P.A. 1993. Atlas van de vogels van het Nederlands Continentaal Plat. Rapport DGW-93.013, Dienst Getijdewateren, Rijkswaterstaat, Middelburg, 168pp.

Bergman M.J.N. & Leopold M.F. 1992. De ecologie van de kustzone van Vlieland en Terschelling. NIOZ-Report 1992-2, Netherlands Institute for Sea Research, Texel.

Blomqvist S. & Peterz M. 1984. Cyclones and pelagic seabird movements. Mar. Ecol. Progr. Ser. 20: 85-92.

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

Camphuysen C.J. 1985. Zeetrektellingen. In: Hustings M.F.H., Kwak R.G.M., Opdam P.F.M. & Reijnen M.J.S.M. (eds). Vogelinventarisatie: 215-219. Pudoc, Wageningen.

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 1998-3, CSR Consultancy, Oosterend.

Camphuysen C.J. 1998. Diurnal activity patterns and nocturnal group formation of wintering Common Murres in the central North Sea. Colonial Waterbirds 21(3): 406-413.

Camphuysen C.J. 1999. New feeding technique of Great Cormorants *Phalacrocorax carbo sinensis* at beam trawlers. Atlantic Seabirds 1(2): 85-90.

Camphuysen C.J., Calvo B., Durinck J., Ensor K., Follestad A., Furness R.W., Garthe S., Leaper G., Skov H., Tasker M.L. & Winter C.J.N. 1995. Consumption of discards by seabirds in the North Sea. Final report to the European Comm., study contr. BIOECO/93/10, NIOZ-Report 1995-5, Netherlands Institute for Sea Research, Texel, 202+LVIIIpp.

Camphuysen C.J. & Derks P.J.T. 1989. Voorkomen en sterfte van de Fuut *Podiceps cristatus* voor de Nederlandse kust, 1974-86. Limosa 62: 57-62.
Camphuysen C.J. & Dijk J.van 1983. Zee- en kustvogels langs de Nederlandse kust, 1974-79. Limosa special issue 56(3): 81-230.
Camphuysen C.J., Keijl G.O. & Ouden J.E.den 1982. Meetpost Noordwijk 1978-1981, Report no. 1 Gaviidae-Ardeidae. CvZ MpN-verslag nr. 1, Amsterdam.
Camphuysen C.J. & Leopold M.F. 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. & M.F. Leopold 2004. Dutch Great Cormorants invade an offshore area. Poster presentation at the 8th International Conference, 2-4 April 2004, King's College Conference Centre, University of Aberdeen.
Costers R. 1993. De spectaculaire toename van de Aalscholver rond Petten. De Windbreker no. 58: 13-17.
Dijk J. van 1979. Kort verslag van de simultaantelling van 24 en 25 mei 1979. CvZ speciaal ongepubl. verslag: 1-4. CvZ, Noordwijk.
Furness R.W. & Bryant D.M. 1996. Field metabolic rate and flight characteristics of Fulmars *Fulmarus glacialis* in relation to wind speed. Ecology 77: 1181-1188.
Garthe S. & Hüppop O. 2004. Scaling possible adverse effects of marine wind farms on seabirds: suggestion of a vulnerability index and application to the southeastern North Sea. J. Appl. Ecol. 41: 724-734.
Ham N.F. van der 1988. Meetpost Noordwijk 1978-1982, verslag nr. 4, Columbidae - Emberizidae. Sula 2(3): 83-90.
Keijl G.O. & Arts F.A. 1998. Breeding Common Gulls *Larus canus* in The Netherlands, 1900-1996. Sula 12(4): 159-171.
Leopold M.F. 1996. *Spisula subtruncata* als voedselbron voor zee-eenden in Nederland. BEON Report 96-2, Programmabureau BEON, Rijksinstituut voor Kust en Zee, Den Haag, 58pp.
Leopold M.F. 1999. Van IJsselmeerpaling naar Noordzeeschol: ontwikkelingen bij de Aalscholver in Nederland. [Oral presentation IBN-DLO/NOU Symposium 'Vis-etende vogels', 3 October 1998, Wageningen] Limosa 72: 71-72.
Leopold M.F. & Berg J. van den 1992. Een zoutwater-kolonie Aalscholvers Phalacrocorax carbo in Groningen. Sula 6(3): 100-102.
Leopold M.F. & Platteeuw M. 1987. Talrijk voorkomen van Jan van Genten *Sula bassana* bij Texel in de herfst: reactie op lokale voedselsituatie. Limosa 60(3): 105-110.
Maas F.J. 1987. Kort verslag van de simultaan zeetrektelling van 30 april-3 mei 1987. Sula 1(4): 109-111.
Maas F.J. & Ouden J.E. den 1983. Verslag van de simultaantelling op 21, 22 en 23 oktober 1983. CvZ speciaal ongepubl. verslag: 1-10. CvZ, Amsterdam.
Miranda J.F. de & Platteeuw M. 1983. Invloed van bijzondere weersomstandigheden op het verschijnen van vogels voor de kust. In: Camphuysen C.J. & Van Dijk J. (eds). Zee- en kustvogels langs de Nederlandse kust, 1974-79. Limosa 56: 191-198.
Ouden J.E. den & Camphuysen C.J. 1983. Meetpost Noordwijk 1978-1981, Report no. 2 Anatidae-Scolopacidae. CvZ MpN-verslag nr. 2, Amsterdam.
Ouden J.E. den & Ham N.F. van der 1988. Meetpost Noordwijk 1978-1982, Report no. 3 Stercoraridae-Alcidae. CvZ MpN-verslag nr. 3, Alkmaar/Amsterdam.
Ouden J.E. den & Stougie L. 1987. Zeetrekgegevens nader bekeken. Sula 1(3): 57-65.
Pennycuick C.J. 1960. Gliding flight of the Fulmar Petrel. J. Exp. Biol. 37: 330-338.
Platteeuw M. 1987. Trekbewegingen van Kokmeeuwen *Larus ridibundus* langs de Noordzeekust: oorzaken en achtergronden. Sula 1(2): 29-37.
Platteeuw M. 1991. Zeevogels langs de Nederlandse kust: wanneer, welke soorten en onder wat voor omstandigheden. Sula 5(1): 2-15.
Platteeuw M., Ham N.F. van der & Ouden J.E. den 1994. Zeetrektellingen in Nederland in de jaren tachtig. Sula 8(1/2, special issue): 1-203.
Ruinaard J. 1977. Simultaanzeetrektellingen in het voorjaar van 1976. In: Dijk J.van (ed). De trek over zee gedurende de eerste helft van 1976. CvZ verslag Nr. 10: 29-31.
Skov H., Durinck J., Leopold M.F. & Tasker M.L. 1995. Important bird areas for seabirds in the North Sea, including the Channel and the Kattegat. Birdlife International, Cambridge, 156pp.
Spaans A.L. 1998a. Breeding Lesser Black-backed Gulls *Larus graellsii* in The Netherlands during the 20th century. Sula 12(4): 173-182.
Spaans A.L. 1998b. The Herring Gull *Larus argentatus* as a breeding bird in The Netherlands during the 20th century. Sula 12(4): 183-196.

Stone C.J., Webb A., Barton C., Ratcliffe N., Reed T.C., Tasker M.L., Camphuysen C.J. & Pienkowski M.W. 1995. An atlas of seabird distribution in north-west European waters. Joint Nature Conservation Committee, Peterborough, 326pp.
Stegeman L. & Ouden J.E. den 1995. Parelduikers *Gavia arctica* in de Nederlandse kustwateren. Sula 9(2): 65-74.
Tasker M.L. 2004. Northern Fulmar *Fulmarus glacialis*. In: Mitchell P.I., S.F. Newton, N. Ratcliffe & T.E. Dunn (eds) Seabird populations in Britain and Ireland: 49-62. T. & A.D. Poyser, London.
Temme M. 1974. Zugbewegungen der Eiderente (*Somateria mollissima*) vor der Insel Norderney unter besonderer Berücksichtigung der Wetterverhältnisse. Die Vogelwarte 27(4): 252-263.
Wanless S. & M.P. Harris 2004. Northern Gannet *Morus bassanus*. In: Mitchell P.I., S.F. Newton, N. Ratcliffe & T.E. Dunn (eds) Seabird populations in Britain and Ireland: 115-127. T. & A.D. Poyser, London.
Wheeler D.A. 1990. Factors influencing the large-scale displacement of Little Auks towards the Northumberland coast, November 1987. Trans. Nat. Soc. Northumbria 55(2): 136-143.

Observation time primary observers

		1978	**1979**	**1980**	**1981**	**1982**	**1984**	**Total**	%
C.J.	Camphuysen	239	101	72	61	87		559	36.7
A.H.V.	Eggenhuizen						13	13	0.9
F.P. van den	Ende				47		26	73	4.8
B.J.M.	Haase	13			36			48	3.1
G.O.	Keijl				40	33		73	4.8
E.V.	Koopman					43		43	2.8
M.H.	Laks					24		24	1.6
J.F. de	Miranda	28						28	1.8
D.J.	Moerbeek				46		20	65	4.3
A.M. van der	Niet				19			19	1.2
J.E. den	Ouden	64			96	44	39	242	15.9
M.	Platteeuw				79	48		127	8.3
H.T. van de	Pol	30						30	1.9
M.	Wiersema		12					12	0.8
W.J.R. de	Wijs		62		33		38	133	8.7
K.	Woutersen		37					37	2.4
		372	211	72	456	279	135	1524	