Iteration cycle: Dealing with peaks in counts of birds following active fishing vessels when assessing cumulative effects of offshore wind farms and other human activities in the Southern North Sea

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Contents

1 Summary

This report is an addition to the report of Leopold *et al*. (2014) that evaluates the effects of offshore wind farm development in the southern North Sea, on birds and birds. In that report, unacceptably high mortalities were predicted for several large gull species. However, it was felt that this might be an effect of local, short-lived concentrations of these birds, e.g. around fishing vessels. If this were the case, such concentrations of gulls in the vicinity of future offshore wind farms would unduly increase the estimated number of victims at these locations. Here, we explore a method to decrease the impact of high peaks in gull densities recorded in the past, by redistributing the gulls attracted to a temporal feeding hotspot over the supposed area from which they were attacted. This results in a marked (ca 37-41%) reduction of estimated numbers of victims among the bird species supposedly most impacted, the Lesser Black-backed Gull. The reduction of predicted numbers of victims among Great Black-backed Gulls was lower (14-21%), while predicted numbers of victims among Herring Gulls increased by 32-42%). The latter is probably an artifact of the coastal habits of Herring Gulls and a redistribution extending too far into offshore waters.

2 Introduction

The cumulative effects of some 100 offshore wind farms in the southern North Sea, both already operational and planned (to be operational before 2013), have been explored in IMARES Report 166/14 'A first approach to deal with cumulative effects on birds and bats of offshore wind farms and other human activities in the Southern North Sea' (Leopold *et al*. 2014). Each wind farm is likely to make some victims among seabirds, migratory birds and bats. On the population level, total numbers of victims across all projected wind farms were estimated to remain below the level of Potential Biological Removal (PBR) in most species, i.e. these species should be able to compensate the losses through producing sufficient offspring to take the places of the individuals killed. However, in three gull species the PBR was calculated to be exceeded or closely approached: European Herring Gull, Lesser Black-backed Gull and Great Black-backed Gull. A closer inspection of the data that were available to Leopold *et al*. (2014) showed that this was probably due to some steep spikes in gull densities, in areas of projected wind farms. Gulls are known to concentrate at sea, particularly around fishing vessels. Every now and then such fisheries-related gull swarms are encountered during seabirds at sea counts and are then entered into the database. Flocks usually number hundreds to thousands of birds and, when entered into a seabirds at sea count, will result in very high local gull densities, which are unlikely to 'disappear', no matter how many earlier or later counts are made in the same area. Should such a spike be registered on a location where a wind farm is planned, this wind farm will thus come forward as being located in a high density area - at least according to the calculation rules applied – and will consequently be associated with a large number of casualties. Given that fishing will be banned from offshore wind farms, and that the exact location of gull flocks registered in the past mean little when compared to the exact locations of future wind farms, ways and means were explored to better deal with this phenomenon when assessing the expected effects of future wind farms.

This additional note to IMARES Report 166/14 'A first approach to deal with cumulative effects on birds and bats of offshore wind farms and other human activities in the Southern North Sea' (Leopold *et al*. 2014), describes a first iteration cycle to deal with this problem. Here, we specifically look at Herring Gull, Lesser Black-backed Gull and greater black-backed gull, as these species were most prominently flagged up in the study of Leopold *et al*. (2014). In a worst-case scenario, significant impacts due to the risk of collision with a wind turbine could not be ruled out for Lesser Black-backed Gull and Great Black-backed Gull, while for Herring Gull a 'near-significant' impact was predicted. The aim of the iteration is to arrive at a more realistic assessment of the collision risk for the three gull species by using (GIS) techniques in which the density peaks related to the presence of actively fishing vessels are spread evenly across the attraction area: the area from where these gulls were attracted from while visiting the trawler. Based on the thus obtained new density values, the research results of Leopold *et al*. (2014) related to these three species are re-assessed with the same methods as before (extended-Bradbury, Band; Leopold *et al*. 2014).

3 Assignment

Since the definition of the term ‘peak’ determines the amount of data to be treated in this iteration cycle, an interaction meeting with the commissioner was held on 22 January 2015. In that meeting it was decided to treat gull densities of 10 birds / km^2 (per species) as ‘peaks’. These densities are about three times the average density and may thus be seen as outliers. In many cases, but not all, the data responsible for such densities were marked as ‘fisheries related gulls’. Note that gulls often settle on the water after a feeding frenzy. Such fishery related gull flocks on the water cannot always be attributed to fishing vessels by the bird observers, so any concentration of ship following birds could potentially be fishieries-related.

The iteration process was started at the level of 5x5 km grid cells, in which the counting data had been amalgamated over the years (per season). Only squares with a specific density of 10 birds per km^2 and more were treated. This leaves about 80% of the data untreated (slightly more squares were treated for Lesser Black-backed Gull and slightly less for Great Black-backed Gull (Figure 1).

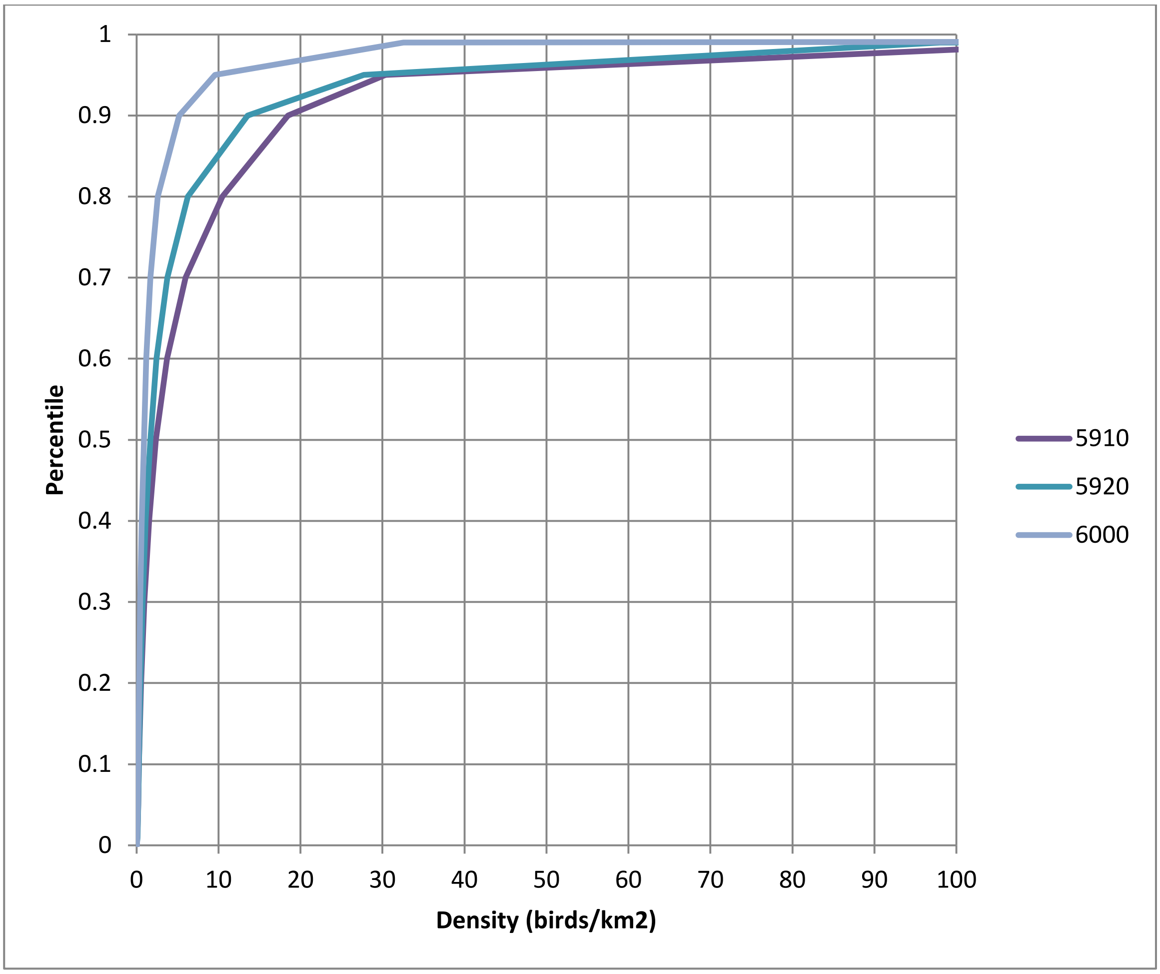

Figure 1. The cumulative number of squares (in percentiles), across all seasons, for three species, ranked for densitiy (birds/km2), for: Lesser Black-backed Gull (indicated by its Euring code, 5910), Herring Gull (5920) and Great Black-backed Gull (6000).

It was decided to smooth out the peak densities over neighbouring grid cells. The next decision to be made, was to determine the number of neighbouring cells involved. This decision was based on the theoretical range from which gulls could be attracted to an active fishing vessel, based on a viewshed analysis. This analysis has been performed in GIS to determine over how large a distance a sea gull might be physically able to spot a fishing vessel, when flying at a given altitude. A schematic representation is provided in Figure 2. For the purpose of the analysis the assumed height of the fishing vessel has been fixed at 10 m. An object of this height remains visible over the sea surface for a distance of ca. 13.5 km; beyond this distance the objects disappears behind the horizon.

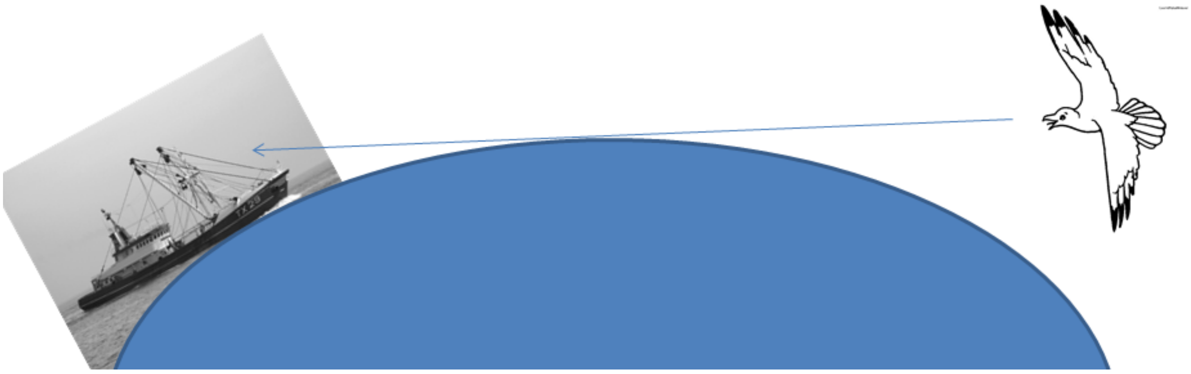

Figure 2. Schematic representation of a viewshed analysis, taking the curvature of the earth into account.

A gull flying at a 10m above sea level (asl) should just be able to make out the fishing vessel at a distance of ca. 27 km (2x13.5 km), given the curvature of the earth and perfect eye sight. At an increased flight level of 25 m the range of view for the gull is extended to ca. 32 km, which increases to ca. 40 km for a flight level of 50 m.

In reality, gulls probably do not only look for active fishing vessels, but also monitor the behaviour of other gulls. One gull that suddenly changes direction and starts flying into a certain direction may cause other gulls to follow, even if the latter are further removed from the potential target. This may increase the range over which gulls, searching for feeding opportunities, may find distant trawlers. On the other hand, flying too far for food may be avoided, as directional flight is energetically costly and the food source may have disappeared by the time the gull arrives at a distant trawler, if the flight time is too long. Another complication is that fishing vessels are not stationary but moving targets that may collect birds over a larger area than just a circular radius based on visibility around one static position.

Taking all considerations together, it was decided to ‘re-distribute’ concentrated birds over an area of 55x55 km, or over 11x11 squares. The area thus extends outward in all directions to a maximum distance of 25 km from the central square. Effectively, this means that peak densities found in any given square were smoothed over both the squares directly neighbouring this peak square and over the squares neighbouring these, or over 3025 square kilometers, the supposed attraction area.

4 Iteration

The data were treated in several steps: first squares with peak densities (>10 birds/km2) were identified, and then extracted from the database. These peak densities were evenly distributed over the 11x11 neighbouring squares and later combined (added) with the other data. With the remaining (non-peak) densities an IDW-interpolation of the data was performed, exactly like in the previous run (Leopold *et al*. 2014). To these IDW-densities the evenly distributed 11x11 densities were added. New distribution maps were plotted and the newly calculated gull densities at (future) wind farm sites were used in (new) Bradbury and Band estimations of wind farm victims (see Leopold *et al.* 2014).

5 Data exploration

As a first step in the data treatment, we explored the available data to detect the squares where peaks in gulls densities mostly occur and also if the data from ESAS (ship-based counts) and MWTL (aerial survey data) show a broadly similar picture. To this end, we plotted counts (note: not squares!) in which over 100 gulls per km^2 were observed (Figure 2). This map shows that flocks of Herring Gulls were mostly encountered very close to shore, as opposed to the two species of black-backed gulls; the picture from ship-based and aerial survey data show large overlaps; and dense flocks of these species were mostly encountered off the European mainland in German, Dutch, and Belgian waters.

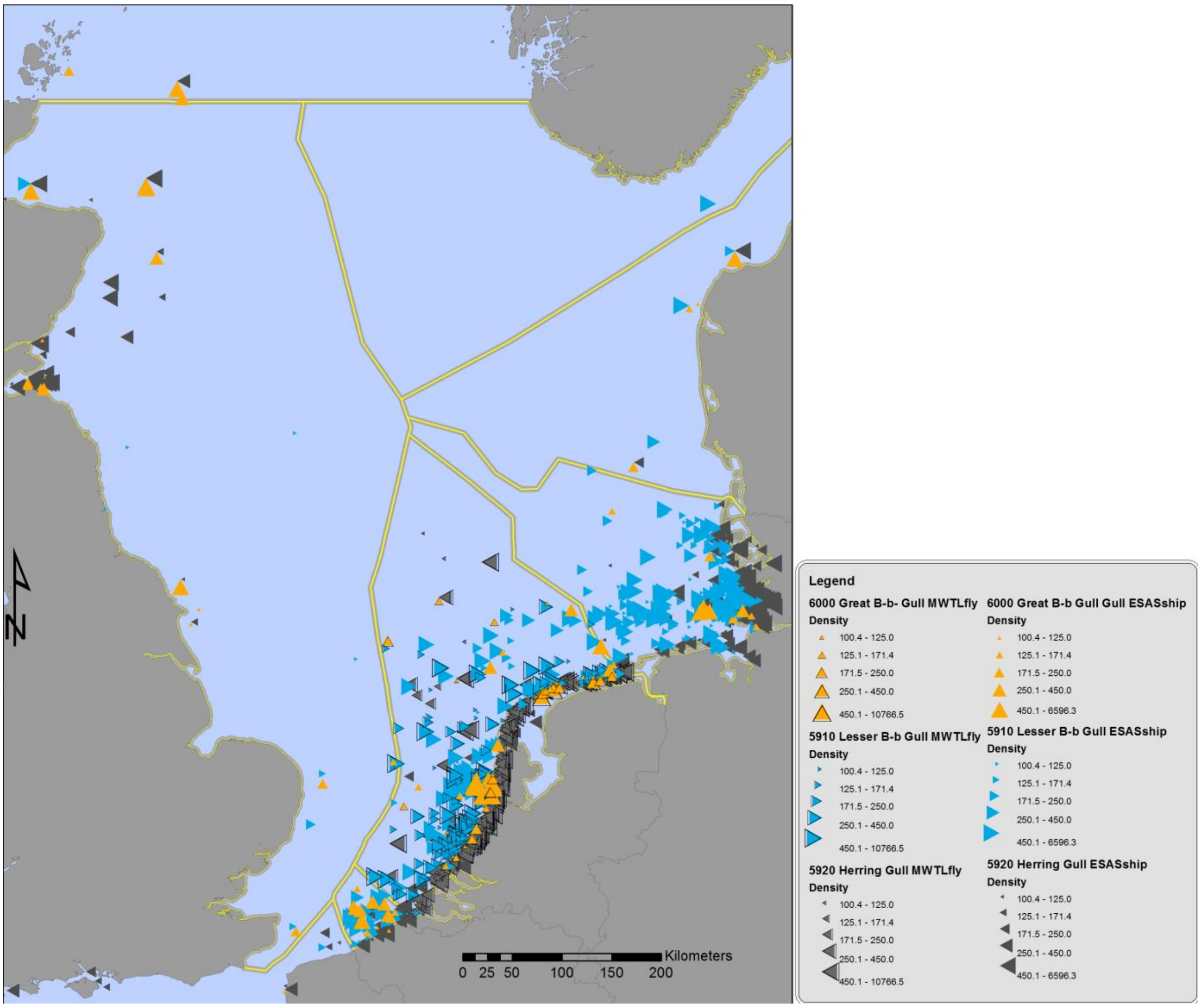

Figure 2. Individual bird counts with over 100 gulls (per species) registered per km2. Arrows (note arrow direction in legend) point to the exact location. Lean arrows: ship based count data. Arrows with black or white margin: aerial survey data.

To check if gull flocks were only seen by Dutch seabirds at sea observers, we drew a similar picture for species that are more abundant in UK waters: the northern fulmar, the northern gannet and the black-legged kittiwake (Figure 3). This clearly shows that the target species of this exercise, the large gulls, were mostly seen in large flocks at sea along the continental seaboard, and that this was not an artifact of poor survey effort further west.

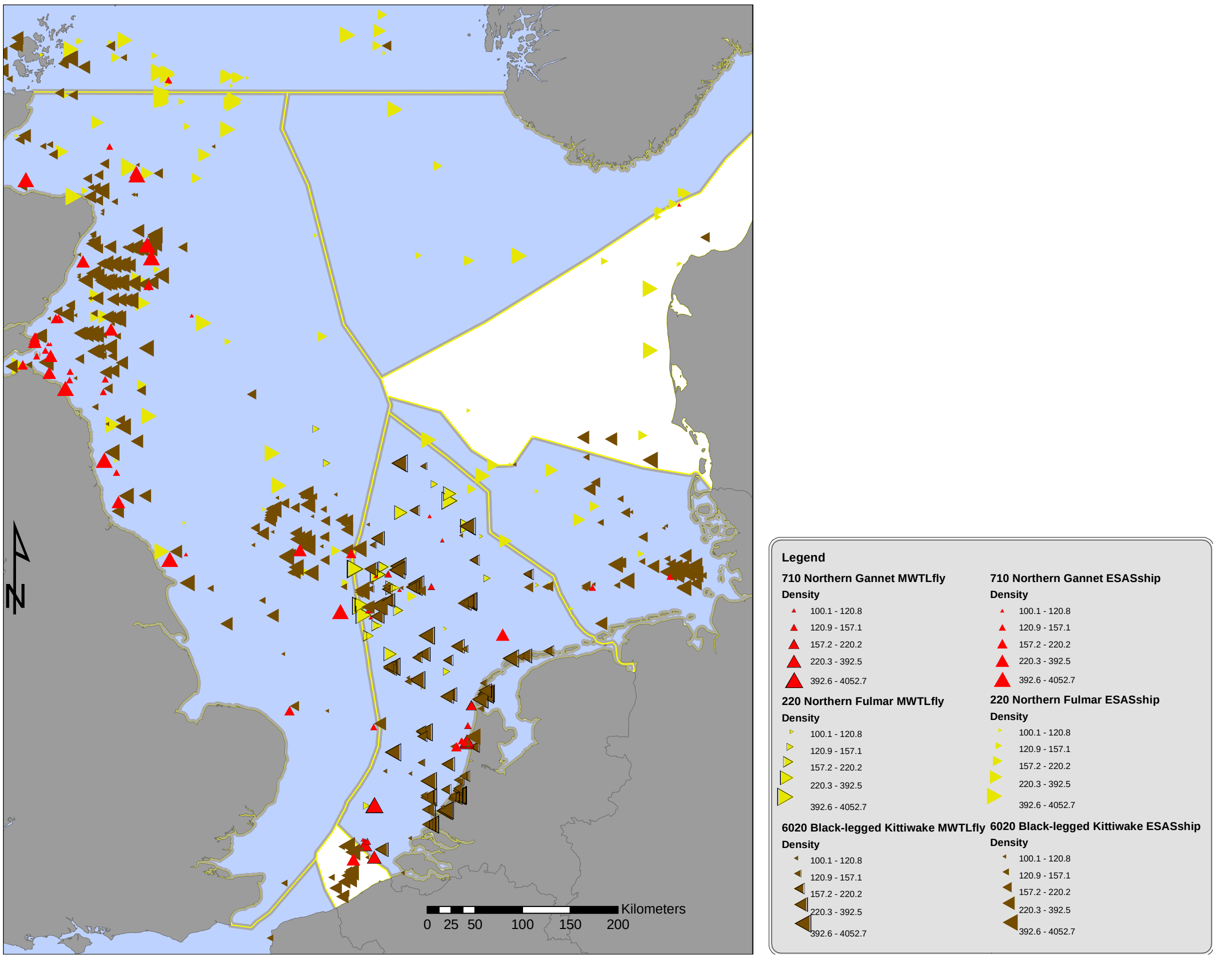

Figure 3. Individual bird counts with over 100 other ship following birds (northern gannet, northern fulmar and black-legged kittiwake) seen per km2. Arrows (note arrow direction in legend) point to the exact location. Lean arrows: ship based count data. Arrows with black or white margin: aerial survey data (note that these surveys were restricted to the Dutch Continental Shelf).

6 New distribution maps, new bird densities in offshore wind farm sites

By redistributing the major concentrations of the large gulls over the 11x11 squares neighbouring each square where these concentrations were encountered, the distribution maps for the target species change (Figures 4-6), and as a result also the numbers of birds projected in (future) wind farm sites (Table 1). The redistribution of both species of black-backed gulls resulted in fewer birds estimated to occur within the future wind farm sites, and as a carry-on effect, fewer casualties. In contrast, the cumulative numbers of Herring Gulls increase in the offshore wind farm sites, and so did the number of expected casualties. Given that the Herring Gull peak squares for Herring Gull were mainly situated nearshore, the redistribution of peaks resulted in a more seaward distribution pattern, interfering with wind farms projected relatively close to the shore. For all three species, total cumulative numbers of expected victims, as estimated by the extended-Bradbury method, remain below PBR. The peak count corrections applied, result in markedly lower numbers of expected victims for both black-backed gulls and in higher numbers of expected casualties for Herring Gulls (Figure 7).

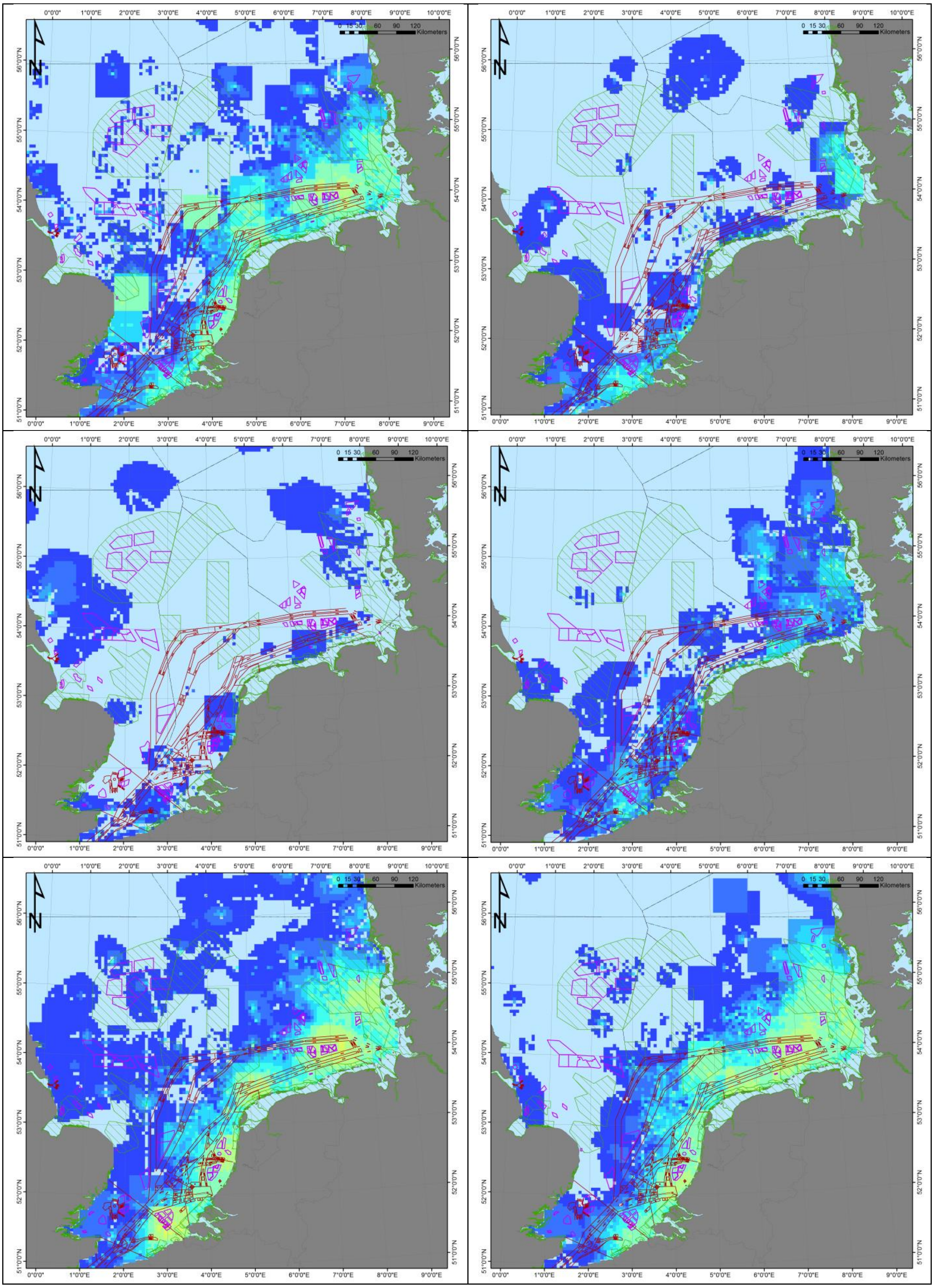

Figure 4 (replaces Figure 4.33 in Leopold et al. 2014). Lesser Black-backed Gull: distributions patterns in August/September, October/November, December/January, February/March, April/May and June/July, from top left to bottom right. For key to colours representing different densities: see Figure Key in Leopold et al. (2014).

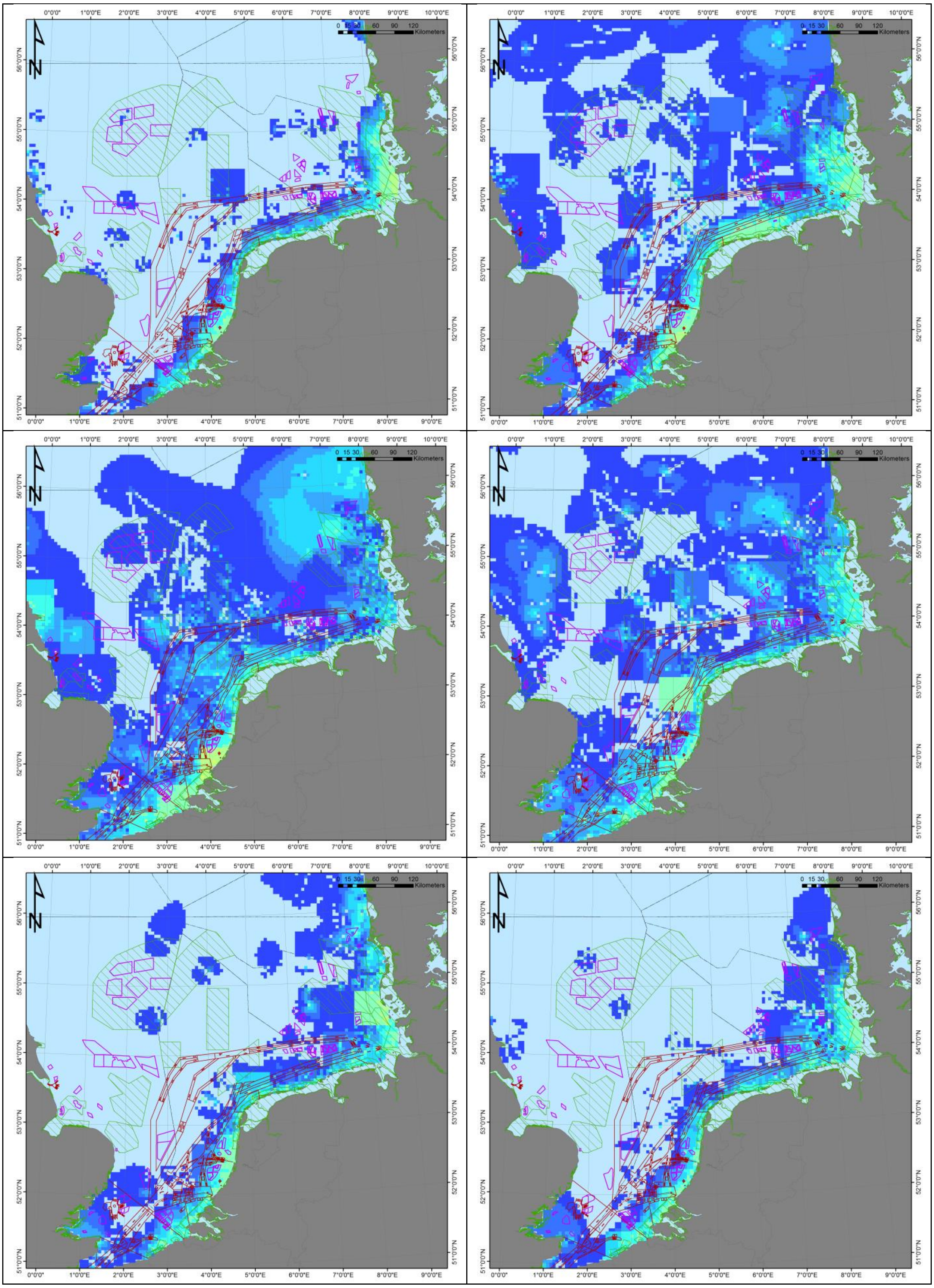

Figure 5 (replaces Figure 4.34 in Leopold et al. 2014). European Herring Gull: distributions patterns in August/September, October/November, December/January, February/March, April/May and June/July, from top left to bottom right. For key to colours representing different densities: see Figure Key in Leopold et al. (2014).

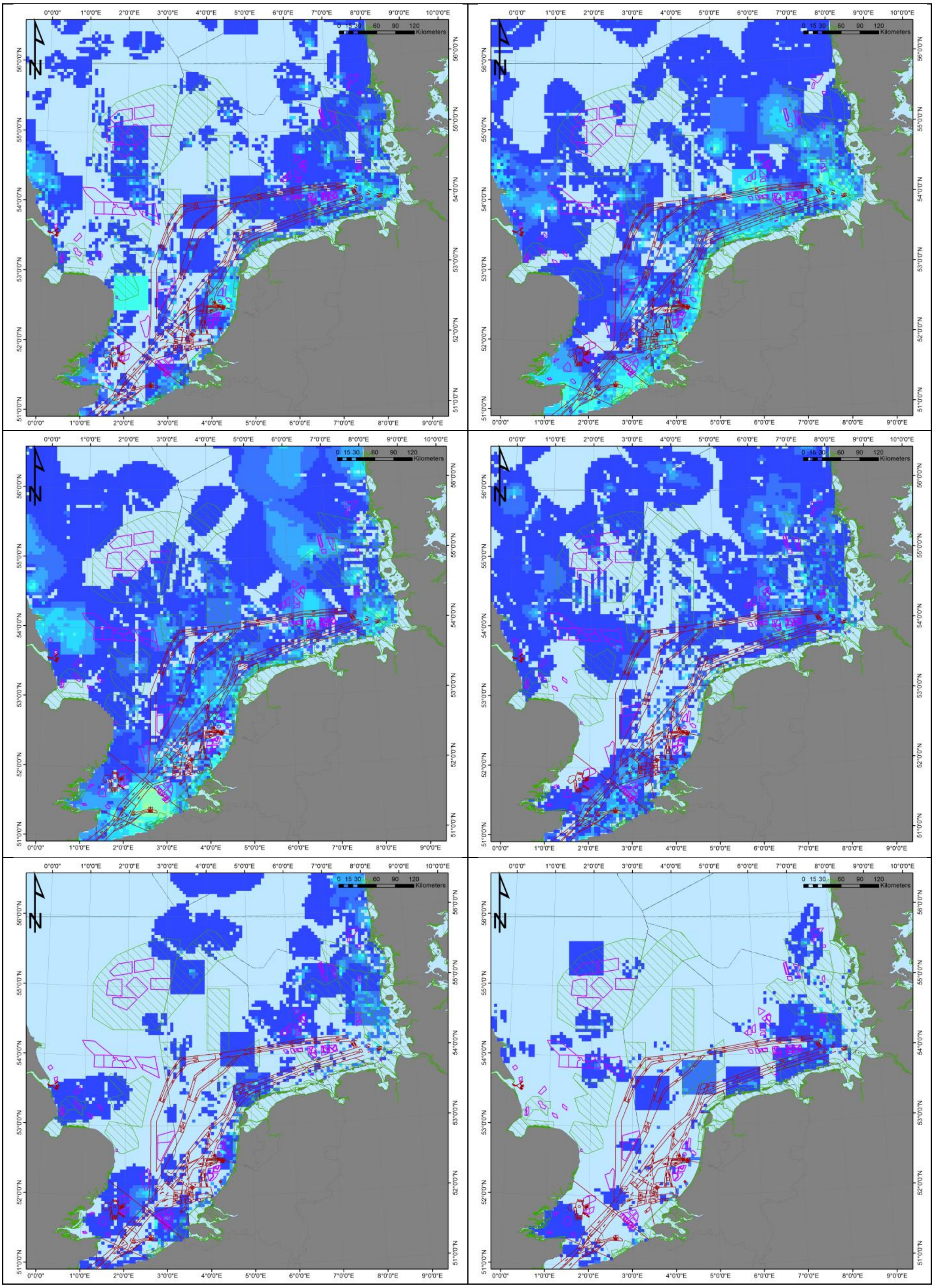

Figure 6 (replaces Figure 4.35 in Leopold et al. 2014). Great Black-backed Gull: distributions patterns in August/September, October/November, December/January, February/March, April/May and June/July, from top left to bottom right. For key to colours representing different densities: see Figure Key in Leopold et al. (2014).

Table 1. Average, cumulative numbers of large gulls (respectively: Lesser Black-backed Gull, European Herring Gull and Great Black-backed Gull) during the year in all projected offshore wind farms in the southern North Sea, with total expected numbers of collisions and birds expected to die because of displancement; these numbers compared with PBR levels, without (Leopold et al. 2014) and with peak count corrections (this report). The numbers of collisons and displaced birds have been calculated with the extended-Bradbury method (see Leopold et al. 2014).

Species	AVG n/yr	AVG n-collsn	AVG n-displ	AVG mort	collsn/ PBR	displ/ PBR	mort/ PBR	Peak count correction
LBB	30714	3686	246	3902	0.488	0.033	0.516	No
LBB	19375	2325	155	2461	0.308	0.021	0.326	Yes
EHG	5401	882	43	918	0.211	0.010	0.220	No
EHG	7116	1162	57	1210	0.278	0.014	0.289	Yes
GBB	6169	1008	99	1090	0.243	0.024	0.263	No
GBB	4875	796	78	862	0.192	0.019	0.208	Yes

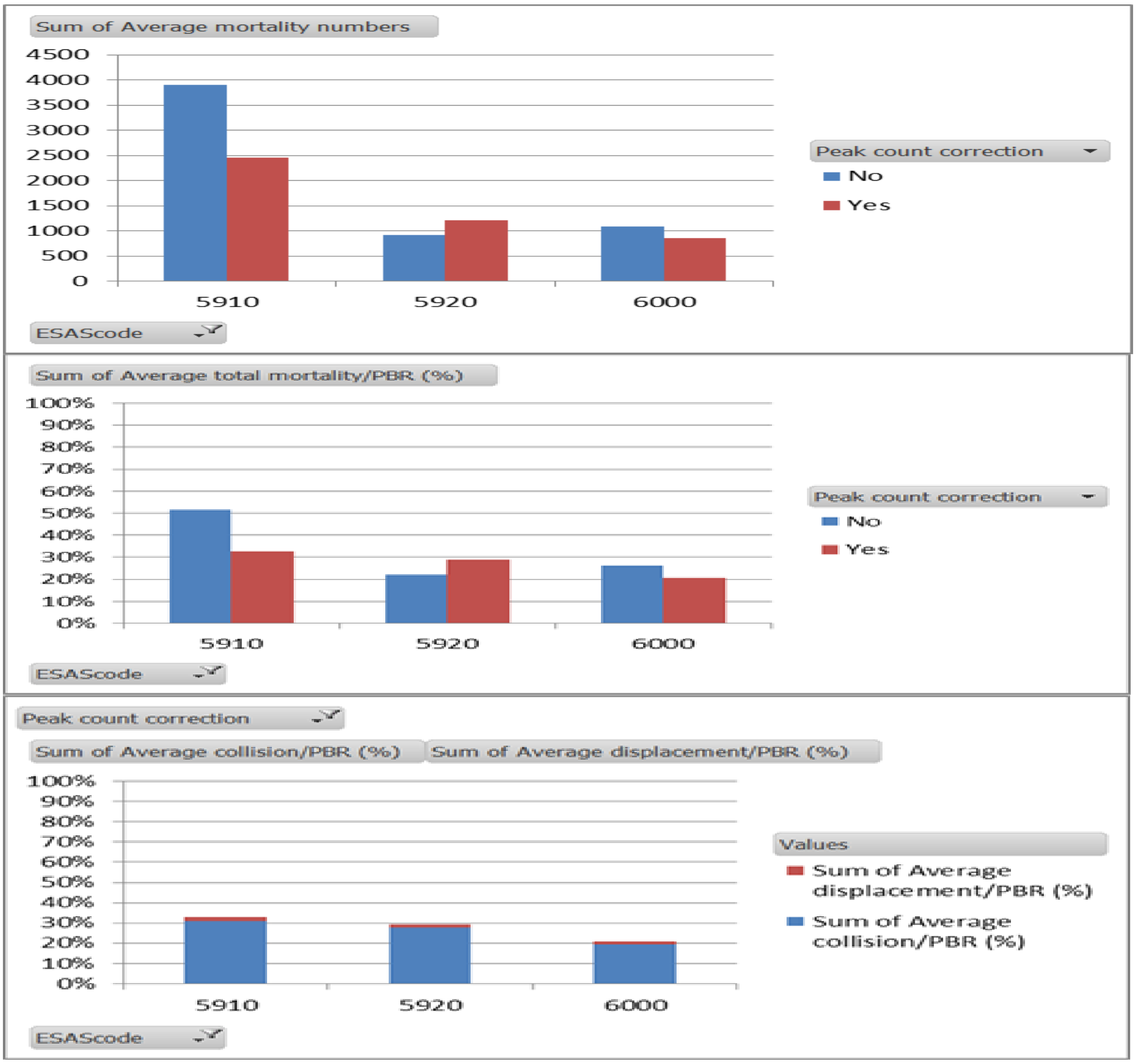

Figure 7. Cumulative numbers of expected casualties (collision and displacement victims combined in upper two panels), as total numbers per year (top panel), in comparison with the PBR levels (middle panel) and split into collision and displacement victims in relation to PBR) lower panel, for respectively Lesser Black-backed Gull (Euring code 5910), European Herring Gull (5920) and Great Black-backed Gull (6000).

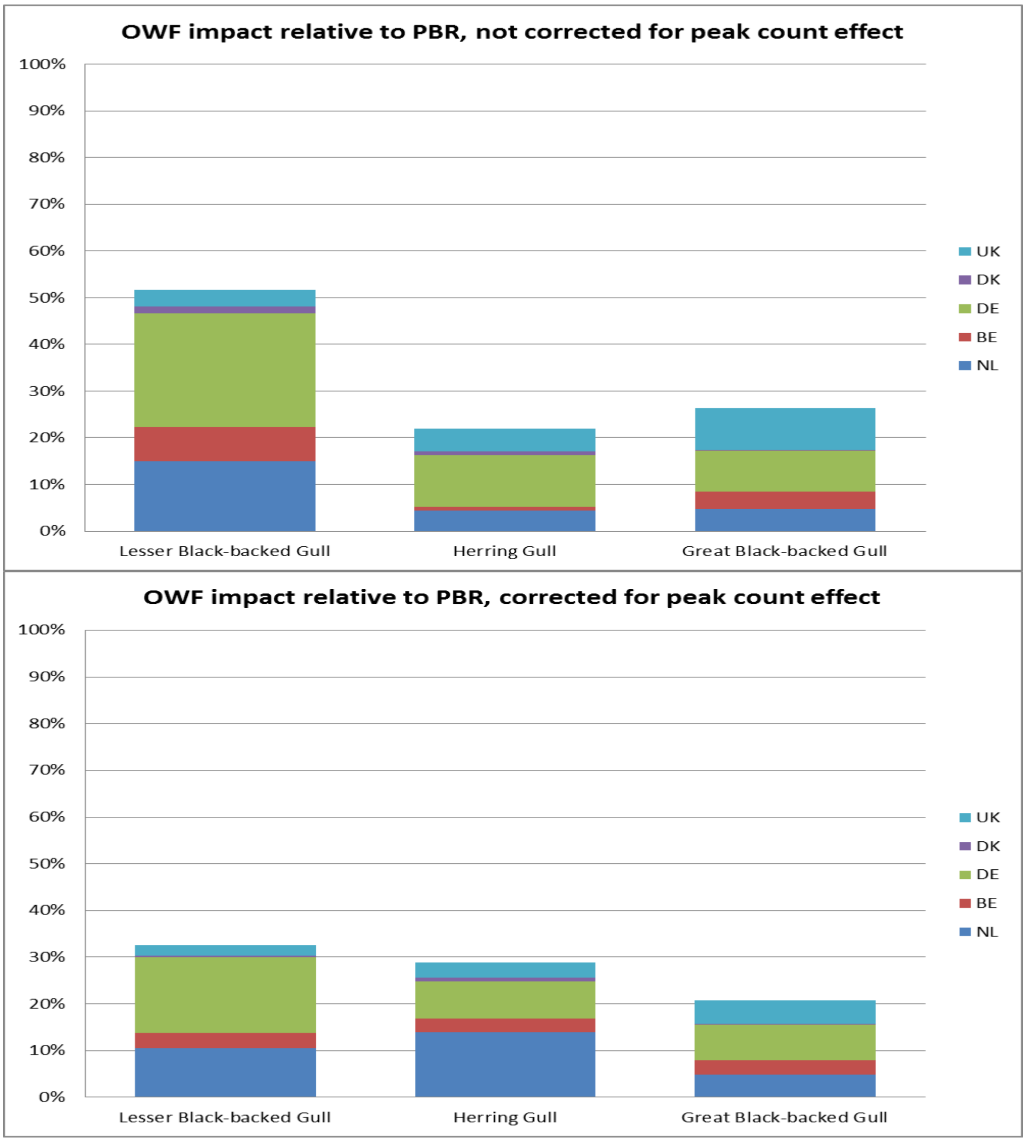

Figure 8. Cumulative numbers of expected casualties (collision and displacement victims combined relative to the PBR levels without (top) and with peak count correction (bottom) for respectively Lesser Black-backed Gull, European Herring Gull and Great Black-backed Gull for the five national continental shelves within the southern North Sea.

The main, overall result of this exercise (following the extended-Bradbury method), was a large reduction of expected Lesser Black-backed Gull casualties. Note that the relative number of casualties in wind farms in the Dutch sector increased, compared to the earlier exercise in Leopold *et al*. (2014), particularly for the Herring Gull (Figure 8).

7 Numbers of collisions as estimated by the Band model

The effects of reduced numbers of black-backed gulls and increased numbers of Herring Gulls in the projected offshore wind farm sites on numbers of collisions have been evaluated with the extended-Band model (Table 2). As with the extended-Bradbury method, numbers of predicted casualties are lower for the two black-backed gulls and higher for Herring Gull. Predicted collision mortalities remain higher than PBR levels of the two black-backed gulls, but have come down considerably. The predicted mortality of Herring Gulls, in contrast, now exceeds the PBR level (but see Discussion).

Table 2. The total number of collisions per large gull species (respectively: Lesser Black-backed Gull, European Herring Gull and Great Black-backed Gull) in the southern North Sea is compared with the applicable Potential Biological Removal (PBR) level (based on the status of the population) and the Ornis committee criterion of 1% of the annual mortality. Upper panel: the outcome of the calculations after peak count correction; lower pannel: without this correction, as presented earlier in Leopold et al. (2014).

Peak count correction	Species	Total n collisions southern North Sea	applicable PBR	% collision/ PBR	Ornis criterion 1% of annual mortality	% collision/ 1% annual mort.
yes	LBBG	13938	7560	184.37%	220	6335.45%
yes	EHG	5845	4184	139.70%	531	1100.75%
yes	GBBG	4659	4144	112.43%	107	4354.21%
no	LBBG	23674	7560	313.15%	220	10760.91%
no	EHG	3381	4184	80.81%	531	636.72%
no	GBBG	5441	4144	131.30%	107	5085.05%

8 Updated windspeed map

Given that many peaks in gull densities occurred in nearhore waters, the re-distribution of these peaks has the carry-on effect that bird densities will be elevated, slightly further offshore. This also means that a broader band of nearshore waters than depicted in Leopold *et al*. (2014), Figure 5.2, now comes in the category 'high concern'. This is visualised in Figure 9, the updated Windspeed map.

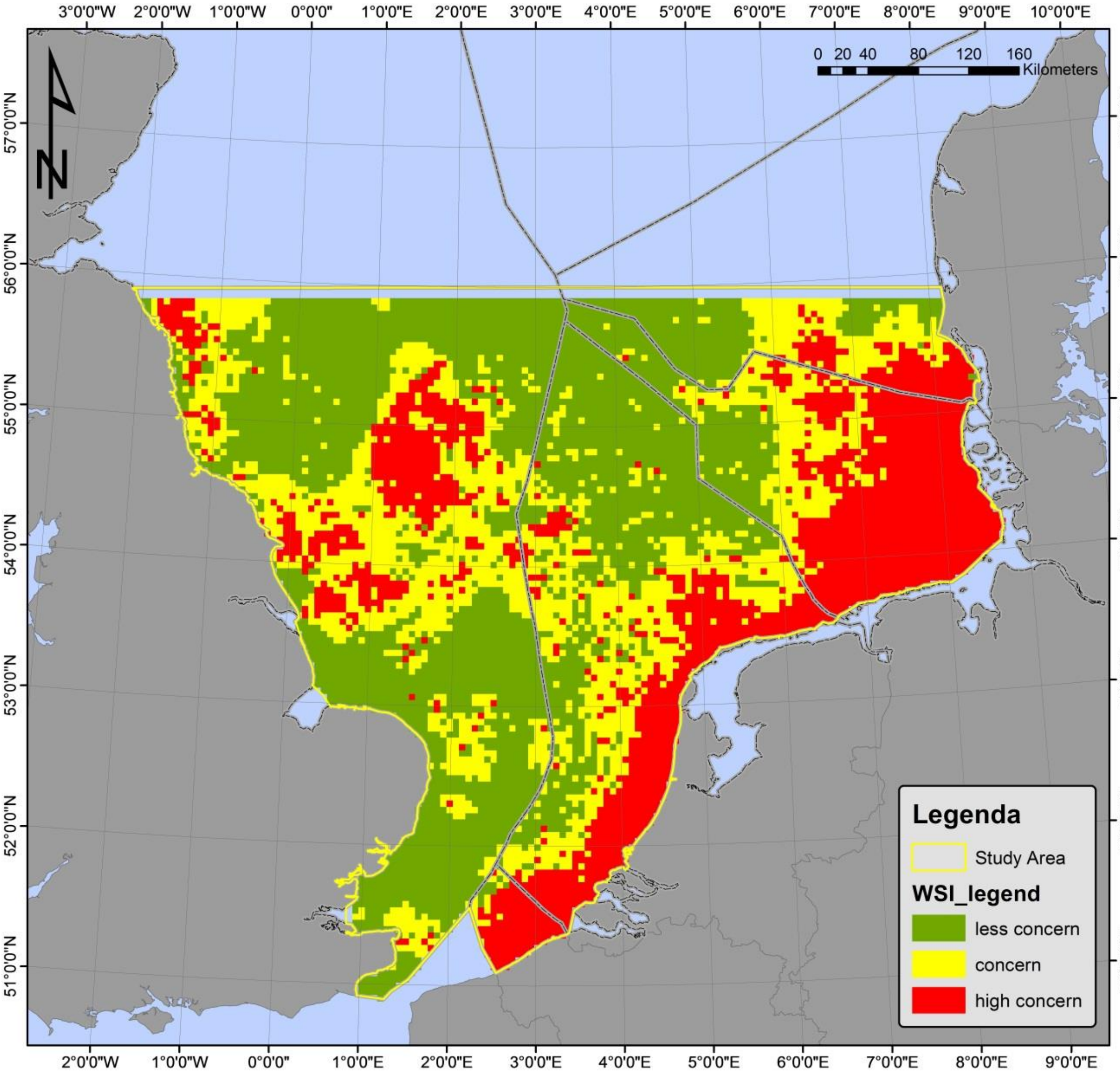

Figure 8. Updated, integrated seabirds wind farm sensitivity map for the southern North Sea. Seabird sensitivity summed for relevant seabird species in plotted on a 5x5 km grid, using density-weighted species-specific vulnerability assessments (following the extended-Bradbury method; Bradbury et al. 2014) based on presumed collision and displacement risks. Peak counts of large gulls have been redistributed over the 11x11 squares of 5x5 km neighbouring each square where these concentrations were encountered, before drawing this map.

9 Discussion

The gulls that are specifically considered in this report often occur in large, rather short-lived concentrations at sea. These temporal hotspots may, or may not, be encountered during seabirds at sea counts. As they are part of the normal life of these gulls, the concentrations are real and should not be ignored, but at the same time are probably not necessarily indicative of the conservation value of that particular spot. Rather, they represent a temporal feeding opportunity, e.g., as provided by a passing fishing vessel. For this reason, temporal concentrations not linked to basis environmental variables, pose a problem for both the making of distribution maps, and the evaluation of the possible effects of future wind warms at sea. For instance, the spatio-temporal peaks in gull presence violate a basic assumption of interpolating techniques, commonly used to predict densities in unsurveyed areas. Here we used inverse distance weighting (IDW) to predict bird densities in unsurveyed parts of the southern North Sea, but this technique relies on the premise that the availble observations are representative for the surrounding area. This is clearly not the case for datapoints representing temporal concentrations of birds, and it does not really matter if temporarily clumped birds were attracted to a fishing ship or to a short-lived natural phenomenon such as a passing school of fish.

At the same time, birds do not flock in areas where they do not normally occur, as shown in Figures 3 and 4 of this report. Herring Gulls, for instance, mostly flocked in nearshore waters off the European mainland while black-backed gulls also flocked further offshore. Any flock of birds comprises individuals attracting from the surrounding area. Therefore, it is defendable to redistribute flocks over the supposed attraction area. In this report we used a fixed radius of the attraction area, based on how far a gull would be able to see a fishing vessel, but this appears to have worked better for offshore situations than for nearshore situations. Herring Gulls, living in a narrow strip of nearshore waters, bounded on one side by land (where these gulls also occur in large numbers) and on the other side by offshore waters (where they hardly go), probably have been drawn into offshore waters slightly too much by redistributing their peak numbers over a standard wider area.

Correcting of peak counts had the expected effect for the two more pelagic species. After redistributing the high local densities of gulls larger (attraction) areas, local peak densities decreased and also the probabilities that such local peak densities coincided with projected offshore wind farms sites. This resulted, overall, in lower numbers of gulls expected to occur in offshore wind farm sites, and hence, in lower numbers of estimated casualties. The results for the Herring Gull showed a shortcoming of this method: relatively large numbers of birds were relocated to more offshore squares, which is probably beyond their normal key distribution area. This artefact resulted in higher predicted densities in wind farms projected relatively nearshore, most notably in Dutch and Belgian waters, and in higher total estimated casualties.

Numbers of predicted victims were considerably reduced in the Lesser Black-backed Gull, the species with the highest number of predicted wind farm victims without the peak count corrections. According to the extended-Bradbury method, numbers of casulties were below PBR with and without correction, but considerably lower for Lesser Black-backed Gull after peak count correction.

9.1 Uncertainties

The behaviour of gulls and other ship followers is unlikely to remain constant. The new fisheries policy with regards to discards is likely to impact on both the population sizes and the behaviour of the gulls. With the discard ban in place fishermen are no longer feeding these gulls and gull numbers are likely to decrease. Once the gulls become accustomed to this new behaviour of fishing vessels they may adjust their behaviour and become less focussed on fishing vessels. As a result, they are likely to disperse more evenly and to rely – once more – on natural (though smaller) feeding opportunities. This will to some degree lower the mitigating effect on gull casualties inside offshore wind farms, that is expected if fishing will not be allowed here. Still, a fishing ban inside offshore wind farm will mean lower gull densities here than in the surrounding waters, where fishing is continued and this will result in fewer casualties.

9.2 A reality check on estimated numbers of gulls at sea

The estimated numbers of casualties due to offshore wind development are based on a number of input variables. Ultimately, bird presence, or density dictates the probability that casualties occur. Bird densities at sea were determined from available data derived from sea seabird surveys, by plane as well as by ship. There are several caveats that might bias estimates of at-sea densities: birds may be missed by observers, or be attracted to them (e.g. to the ship from which the counts were conducted); birds may be clumped and more clumps than expected might be present in the counts; birds may be incorrectly or poorly identified (as in juvenile gulls) and, when unsurveyed parts of the sea must be addressed, densities must be extrapolated from surrounding, surveyed areas. All these factors influence the final outcome (birds/km^2) and when overlapping with offshore wind farms the estimated numbers of casualties.

In this report, we specifically looked at the problem of clumping, in connection with extrapolation into unsurveyed parts of the sea. It is therefore useful to compare estimated numbers of gulls (the subjects of this exercise) before and after data treatment: the re-distribution of birds over the supposed attraction area for clumps as encountered by the at-sea observers. Second, it is useful to compare total estimated numbers of gulls in a given area, with known (or supposed) numbers of gulls living at sea, as found by other methods. In Table 3, both comparisons are presented for the Dutch part of the North Sea, known as the Dutch Continental Shelf (DCS). First the season (two-month period) was determined in which peak numbers of gulls (Lesser Black-backed Gull, European Herring Gull and Greater Black-backed Gull) were found in the area. Second, estimated numbers for the entire DCS, using Inverse Distance Weighting (IDW) to "fill in" unsurveyed parts of the DCS are compared to the estimates that also used re-distribution of clumps. A reduction in total numbers present of 9 and 13% was found for Lesser Black-backed Gull and Greater Black-backed Gull, respectively, but an increase in numbers by 8% for European Herring Gull.

Total estimated numbers by either method may be compared to earlier estimates given by Camphuysen & Leopold (1994). These numbers, and the peak seasons compare well for European Herring Gull and Great Black-backed Gull, but poorly for Lesser Black-backed Gull. The new estimates for Lesser Black-backed Gull are four times higher than the estimate of Camphuysen & Leopold (1994), and probably unrealistically high. For the reference population, we may consider the current number of breeding pairs in the Netherlands (90,000 pairs). If we assume that only local (Dutch) birds occur in the area, while one bird of each pair is probably tied to land at this time of year, but that these birds may be compensated at sea by non-breeders (immatures and "floaters), then no more than 180,000 birds may be expected to be found at sea. This is still twice the number estimated at sea by Camphuysen & Leopold (1994). Our new estimate for this species, even after correction for clumps, therefore appears to be at least 100,000 birds, or 60% too high, and is 3.5 times the estimate given by Camphuysen & Leopold (1994).
From these numbers, we may tentatively consider that follow-up estimates, i.c. for numbers of casualties, might be roughly correct for European Herring Gull and Great Black-backed Gull, but may be 1.6-3.5 times too high for Lesser Black-backed Gull. Such a large bias cannot be a calculus problem, as the same treatment was given to the count data for all three gull species.

Table 3. Peak seasons for three large gulls in the Dutch sector or the North Sea (DCS), with peak numbers as estimated using Inverse Distance Weighting (IDW) (Leopold et al. 2015) and after re-distribution of birds over the supposed attraction area for clumps encountered by the at-sea observers (this report) and estimated by Camphuysen & Leopold (1994) for roughly the same area. Numbers of wintering European Herring Gull and Great Black-backed Gull are compared to numbers estimated to winter in the entire North Sea, an area circa 10 times the DCS.

Species	peak season	max nrs DCS_IDW	peak nrs DCS after peak correction	Reduction	peak nrs DCS (C&L'94)	peak season (C&L'94)	Reference population
Lesser BB Gull	Jun/Jul	318,004	288,936	9%	82,900	Apr/May	90,000 pairs NL (Camphuysen 2013)
Herring Gull	Dec/Jan	144,927	155,913	-8%	171,300	Dec/Jan	918,000 individuals wintering in the North Sea (Skov et al. 2007)
Great BB Gull	Oct/Nov	85,671	74,315	13%	63,500	Oct/Nov	300,000 individuals wintering in the North Sea (Skov et al. 2007)

9.3 Extended-Bradbury method versus Band model outcomes

Normally, the proportions of each species flying at rotor height are calculated from data recorded during the ship-based surveys. Based on ship-based surveys only flying birds recorded as 'in transect', thus within the snapshot count (Tasker *et al*. 1984; Camphuysen *et al*. 2004), and not associated with human activities or structures that would not be present in a future wind farm (including fishing vessels), are included when calculating species-specific densities of flying birds for collision rate modelling, with in the UK e.g. the heights of flying birds being recorded in 5m categories. In this study both aerial as well as ship-based data were used, with aerial data lacking information about behaviour of the birds (sitting on the water versus flying, and also no information on associations with human activities, and for the flying birds no information on flight heights). In Leopold *et al.* (2015) therefore the estimated proportion of flying according Bradbury *et al*. (2014) has been used to translate overall densities of seabirds into species specific densities of flying birds, including birds associated with human activities as fishing vessels. Potentially the densities of flying gulls are overextrapolated as high densities of gulls behind fishing vessels are also included in the Band-model approach with Bradbury-constructed flying densities compared to studies in which 'directly' in the field measured densities of flying birds were used based on the ESAS snapshot methodology. Furthermore, gulls associated with fishing fessels are generally flying at lower altitudes or are even not flying at all on the moment of observation, yielding lower densities of flying birds at rotor height compared to Leopold *et al*. (2015).

Both methods of estimating numbers of victims are highly sensitive to the input variable: local bird density. Reducing this value will thus lead to lower numbers of predicted casualties, as was found in this study. For the Lesser Black-backed Gull, the species that was, and still is, the peak correction has resulted in a circa 40% reduction of predicted casualties. Both methods, therefore, appear to be equally sensitive to (high) bird densities for this species.

9.4 Knowledge gaps

This exercise, of modelling cumulative, future numbers of victims of offshore wind development, remains theoretical. True numbers of victims can only be assessed in the field, by good studies in wind farms, after these have become operational. Such studies will greatly help to evaluate, and fine-tune, the outcomes of pre-construction modelling exercises such as this one. Good pre-construction surveys of development sites will also greatly help to fill the gaps in the existing database. Extrapolating bird densities into unsurveyed parts of the sea is risky, particularly if there is a lot of variation among the count data that is not easily explained by environmental co-variables.

A large part of the data collected in the Dutch sector of the southern North Sea stem from aerial surveys (MWTL data), that lack information on the birds behaviour (flying versus swimming) and flying height. A Bradbury key, 'guestimating' the proportion of flying birds, was used to make these data compatible with the ship bases survey data, that do have this information. We recommend to look into this problem in more detail, given that flying height is so important for estimating collision risk. For instance using ship-based data only, or ship-based estimations of flying heights rather than the Bradbury 'guestimate', could further improve the modelling results.

10 Conclusions and recommendations

The very high numbers of predicted offshore wind farm victims among certain large gulls were expected to be partly related to the structure of the survey data, that were used as model input. As expected, predicted numbers of casualties among black-backed gulls decreased after local peak densities were re-distributed over the presumed attraction areas, from where the gulls had moved to join the concentration of their conspecifics. However, this came 'at a cost': numbers of victims among Herring

Gulls increased, probably because their peak numbers were re-distributed too far into offshore waters, the realm of future wind farms.

Total estimated numbers of gulls at sea seemed in accordance with numbers to be expected for total numbers of (wintering) Herring Gulls and Great Black-backed Gulls, but numbers of estimated Lesser Black-backed Gulls in summer on the DCS were quite a bit higher than expected from local numbers of breeders. This overestimation has carry-on effects on the numbers of predicted collision victims, which then also will be too high. Numbers of gulls predicted to be a sea should thus be estimated in a different manner, either on the basis of better count data, or using other modelling techniques.

Overall, the reduction in predicted casulaties among Lesser Black-backed Gulls, after peak count corrections, was 37% according to the extended-Bradbury method and 41% according to the Band method. For Great Black-backed Gull these reductions were lower: 21% and 14% respectively. The predicted mortalities for both species remained under PBR according to the extended-Bradbury method, and remained above PBR according to the Band modelling.

In contrast, predicted numbers of victims among Herring Gulls increased after peak count correction, respectively by 32% and 42%, becoming higher than the PBR level in the Band modelling case. This was, however, probably an artifact due to pulling out birds too far into offshore waters with the –standard-around-peak redistribution process.

We want to highlight, that other birds than habitual ship-followers were considered to be at risk. Some over-sea migrants, such as swans and waders were predicted to face large mortatities as well, and these cannot be explained by them concentrating around fishing vessels. Their predicted numbers at sea were not even based on at-sea survey data, but solely on assessments of population sizes and migratory pathways. For these birds too, a good monitoring of numbers of victims, as well as their future population trends, must be a priority.

11 References

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12 Quality Assurance

IMARES utilises an ISO 9001:2008 certified quality management system (certificate number: 124296-2012-AQ-NLD-RvA). This certificate is valid until 15 December 2015. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V. Furthermore, the chemical laboratory of the Fish Division has NEN-EN-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 1th of April 2017 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation.

Justification

Report : Iteration cycle: Dealing with peaks in counts of birds following active fishing vessels when assessing cumulative effects of offshore wind farms and other human activities in the Southern North Sea

Project number : 431 21000 05

The scientific quality of this report has been peer reviewed by:

Approved: Drs. J. Asjes
Head of the Department of Ecosystems

Signature:

Date: 2 March 2015

Annex A: Predicted numbers of the three gull species in combined offshore wind farms before (updated from Annex H in Leopold et al. 2014) and after correction of peak counts.

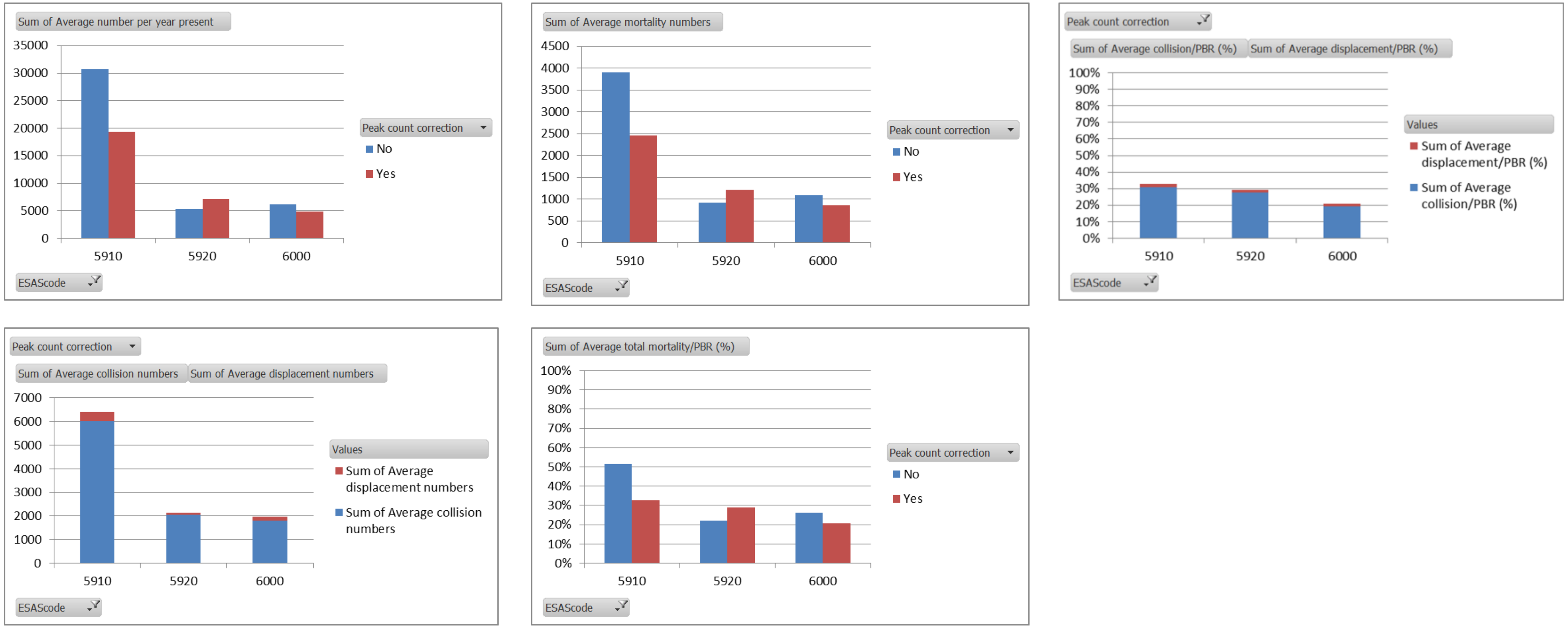

Figure A-1. Effect of correction of peaks for several parameters in OWF combined.

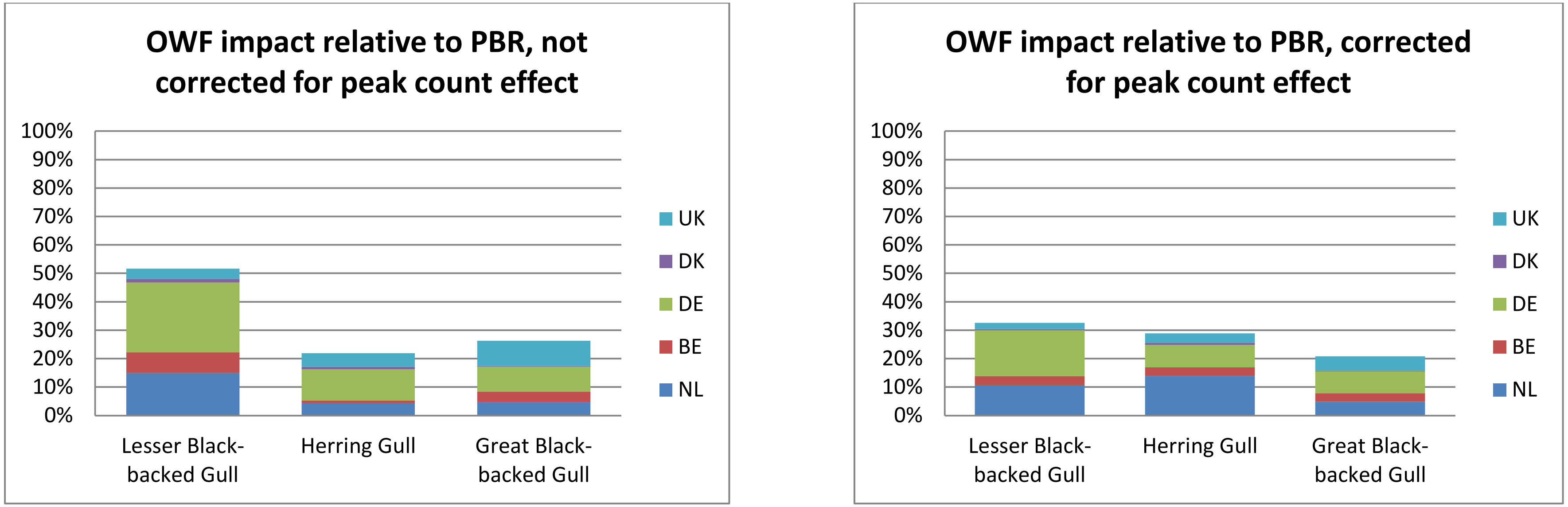

Figure A-2: OWF impact relative to PBR of the three selected large gull species (shown is the contribution per country); not corrected for the influence of peak counts (left; derived from Figure 5.1. in Leopold et al. 2014) and corrected for the influence of peaks (right; this note).

Number of birds in OWP area (3 large gull species)

Number of Lesser black-backed gulls in OWF area

Collided birds (3 large gull species)

Number of Herring gulls in OWF area

Ratio collided birds/PBR (%) (3 large gull species)

Number of Great black-backed gulls in OWF area

Figure A-3: Effect of correction of peak counts shown for the three large gull species and several parameters; x-axis numbers refer to OWF's (see Leopold et al. 2014).

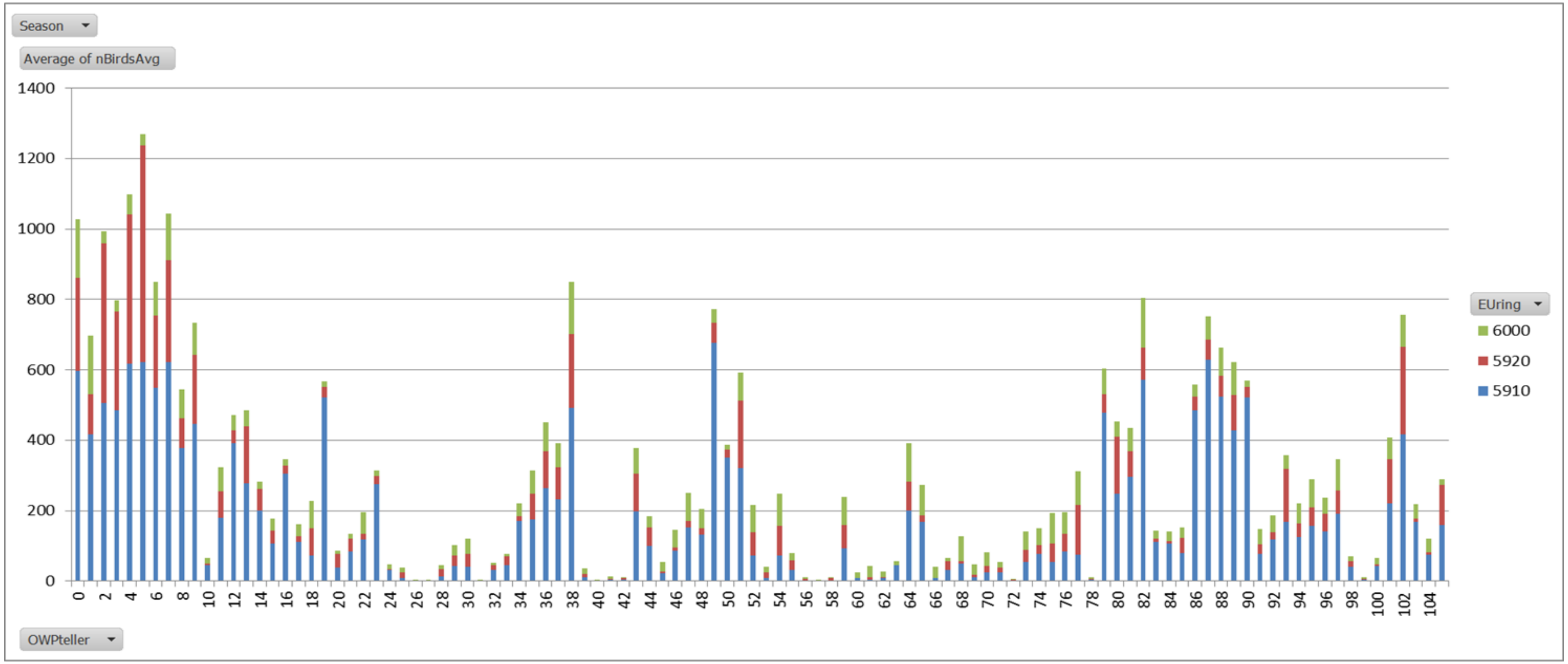

Figure A-4: Summed average number of the three large gull species present per OWF area (106 wind farms). Correction for peak count effect is applied; in addition to Figure H-2 of report Leopold et al. (2014).

Table A-1: Summary of results: the correction of the peak count effect on the presence of the three large gull species in the OWF area and the risks of collision and displacement.

ESAScode	NameEN	Average number per year present	Average collision numbers	Average displacement numbers	Average mortality numbers	Average collision/PBR	Average displacement/PBR	Average total mortality/PBR	Peak count correction	Large gull species	Change of peak correction i.r.t. non correction (%)
5910	Lesser Black-backed Gull	30714	3686	246	3902	0.488	0.033	0.516	No	Yes	
5910	Lesser Black-backed Gull	19375	2325	155	2461	0.308	0.021	0.326	Yes	Yes	-37%
5920	Herring Gull	5401	882	43	918	0.211	0.010	0.220	No	Yes	
5920	Herring Gull	7116	1162	57	1210	0.278	0.014	0.289	Yes	Yes	32%
6000	Great Black-backed Gull	6169	1008	99	1090	0.243	0.024	0.263	No	Yes	
6000	Great Black-backed Gull	4875	796	78	862	0.192	0.019	0.208	Yes	Yes	-21%