2nd Iteration: Effect of turbine capacity on collision numbers for three large gull species, based on revised density data, when assessing cumulative effects of offshore wind farms on birds in the southern North Sea

Jan Tjalling van der Wal, Ruben Fijn, Abel Gyimesi & Michaela Scholl

Additional note to IMARES report number C166/14
[confidential for 6 months from date of publication]

IMARES Wageningen UR

(IMARES - Institute for Marine Resources & Ecosystem Studies)

Client: Rijkswaterstaat
WVL afdeling Waterkwaliteit en Natuurbeheer
Maarten Platteeuw
Postbus 17, 8200 AA Lelystad

Publication date: 28 May 2015

IMARES WAGENINGEN UR

Bureau Waardenburg bv
Ecologie & landschap

IMARES vision:

- 'To explore the potential of marine nature to improve the quality of life'.

IMARES mission:

- To conduct research with the aim of acquiring knowledge and offering advice on the sustainable management and use of marine and coastal areas.

IMARES is:

- An independent, leading scientific research institute.

Recommended format for purposes of citation: Jan Tjalling van der Wal, Ruben Fijn**, Abel Gyimesi** & Michaela Scholl* (2015). 2nd Iteration: Effect of turbine capacity on collision numbers for three large gull species, based on revised density data, when assessing cumulative effects of offshore wind farms on birds in the southern North Sea. Additonal note to IMARES Report C166/14.*

**) IMARES **) Bureau Waardenburg*

P.O. Box 68	P.O. Box 77	P.O. Box 57	P.O. Box 167
1970 AB IJmuiden	4400 AB Yerseke	1780 AB Den Helder	1790 AD Den Burg Texel
Phone: +31 (0)317 48 09 00	Phone: +31 (0)317 48 09 00	Phone: +31 (0)317 48 09 00	Phone: +31 (0)317 48 09 00
Fax: +31 (0)317 48 73 26	Fax: +31 (0)317 48 73 59	Fax: +31 (0)223 63 06 87	Fax: +31 (0)317 48 73 62
E-Mail: imares@wur.nl	E-Mail: imares@wur.nl	E-Mail: imares@wur.nl	E-Mail: imares@wur.nl
www.imares.wur.nl	www.imares.wur.nl	www.imares.wur.nl	www.imares.wur.nl

Contents

1 Summary

This report is an additional note to the report of Leopold *et al.* (2014) that evaluates the cumulative effects of offshore wind farm development in accordance with the roadmap of the Social and Economic Agreement (in Dutch: SER-akkoord) on birds and bats in the southern North Sea. In that report, unacceptably high mortalities were predicted for three large gull species: lesser black-backed gull (*Larus fuscus*), great black-backed gull (*L. marinus*) and European herring gull (*L. argentatus*).

To more accurately assess the impact of the projected offshore wind farms as compared to Leopold *et al.* (2014, 2015), two options were jointly analysed in this second iteration:
- the density numbers for the aforementioned three gull species were revised; for the Dutch Continental Shelf (DCS) the calculations were based on aerial survey data from the MWTL monitoring programme only. The idea was, that since gulls tend to a aggregate near (active) fishing vessels, density numbers based on ship-based monitoring data (e.g. ESAS data) may (severely) skew the outcome of calculations (Leopold *et al.* 2015). Therefore, density numbers based only on MWTL data are regarded as more realistic densities.
- the options of mitigating collision rates by installing larger wind turbines were analysed with Band (2012) model settings for 4 MW and 5 MW turbines. Per turbine type, two variants (different rotor diameter and - as a result of the chosen method - higher hub height) were considered. Note: in the main study and the first iteration, a 3 MW turbine was assessed.

From the newly derived Band (2012) model outcomes we conclude that:
- performing the calculations as done by Leopold *et al.* (2014) on the basis of aerial counts (MWTL data; for the DCS) only, instead of ship-based and aerial counts (ESAS and MWTL data), the respective numbers of estimated collision victims become lower; in the overall analysis, this effect is less pronounced due to the fact that the number of gulls on the DCS are only a small fraction of the total numbers in the entire southern North Sea.
- larger wind turbines do have a mitigating effect on the number of collisions. The predicted differences between the minimum and maximum variants of the two considered MW types are small in comparison, suggesting that the mitigating effect is mainly due to the fact that the use of large turbine capacities means fewer turbines to achieve the same total wind farm capacity.
- while the '% collision/PBR' values for great black-backed gull and Eurpean herring gull are around the critical limit of 100, lesser black-backed gull, with a score of appr. 160, is still severely at risk.

Our recommendations correspond with what has been proposed earlier:
- make use of more (existing, but yet not readily available) data sources, for example data from aerial surveys in/of the neighbouring countries such as Germany, Denmark and the UK, to improve the reliability of input data off the DCS;
- carry out fieldwork studies to verify and validate model outcomes and underlying assumptions/ settings.
- analyse the DCS-ESAS data in isolation and compare the outcome with the results based on the MWTL data (not part of the assignment; note that the earlier analyses were based on a combined MWTL/ESAS dataset).

2 Introduction

In the second half of 2014 the IMARES and Bureau Waardenburg consortium performed calculations to estimate the cumulative effects (i.a. displacement and collision) of the planned development of offshore wind farms across the southern North Sea on seabirds, and migratory land birds and waterbirds. These species are protected by the Dutch 'Flora- en faunawet' and the 'Natuurbeschermingswet 1998' (the national laws that implement the EU Birds and Habitats Directives). The calculations showed that in the worst-case scenario significant effects arising from collisions can not be excluded for lesser black-backed gull (*Larus fuscus*) and great black-backed gull (*L. marinus*), and that these effects have to be judged as 'near-significant' for European herring gull (*L. argentatus*).

In early 2015, a first iteration cycle was performed by the same consortium. It was investigated whether some extremely high numbers of these three large gull species (peaks) that were observed behind fishing vessels were to blame for the predicted high collision rates. After all, high densities of birds in areas where offshore wind farms are projected will result in a high number of calculated collisions. Although this first iteration cycle showed that for great and lesser black-backed gull the predicted numbers of collision victims were significantly lower after applying correction factors for aggregating birds around fishing vessels, it was still found that the worst-case predictions result in significant effects, not only for these two gull species but now also for European herring gull. It was hypothesised that this may be an adverse side-effect of the method used. Peak densities of the gull species considered were spread out over a radial area, thought to be representative for attraction to an active fishing vessel. For offshore situations, birds could flock in from all directions, but in coastal situations, where most herring gulls are found, this modelling also 'attracted' gulls from land.

In the first iteration cycle, the newly calculated total numbers of the three gull species were compared to those of other surveys (colony counts of the lesser black-backed gull and earlier at-sea population estimates for great black-backed gull and herring gull). This reality check revealed that the estimates of lesser black-backed gulls, based on sea counts, could be by a factor of 1.6-3.5 too high, which could easily result in too high estimates of collision victims for this species in the same order of magnitude.

Another iteration cycle was considered nessecary. The density figures for the three large gull species that commonly occur on the DCS were to be reviewed again. Furthermore it was assumed that in the SER-wind farms to be built (hereafter referred to as 'new NL wind farms') fewer but larger wind turbines would be installed. Two turbine types of two different variants were to be considered: 4 MW (MWmin/max) and 5 MW (MWmin/max) turbines (see Table 1).

3 Aim of the project

In this second 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), we built on the results of the first iteration (Leopold *et al.* 2015). Based on the turbine capacities, selected by the client (RWS), the results of Leopold *et al.* (2014) related to these three species had to be re-assessed with the same methods as before: Band (2012; also called: extended Band, and Leopold *et al.* (2014). The parameter settings of the chosen wind turbines had to be in accordance with a study carried out by Bureau Waardenburg in the context of the permit process for lot Borssele (Gyimesi *et al.* 2015; Dutch title: 'Slachtofferberekeningen voor 14 windturbine varianten (4 MW - 10 MW) in Kavel I of II in windenergiegebied Borssele').

In interactive collaboration with the client, two options were jointly considered to more accurately assess the impact of the projected offshore wind farms. In this iteration:

- the density numbers for the aforementioned three gull species were revised, i.e. for the Dutch Continental Shelf (DCS) the calculations were only based on aerial survey data obtained in the MWTL monitoring programme. As mentioned before, since gulls tend to aggregate near (active) fishing vessels, densities based on ship-based monitoring data (here: ESAS data) may (severely) skew the outcome of calculations (Leopold *et al.* 2015). The revised densities based only on aerial survey data may thus be regarded as more realistic annual densities.

- the options of mitigating collision rates by installing larger wind turbines were analysed with Band (2012) model settings for 4 MW and 5 MW turbines. Two commercial types of the same capacity but different rotor diameter and – as a result of the method applied – different assumed hub heights were considered (hereafter indicated with 'MWmin' and 'MWmax; Table 1). Previously, in the main study and the first iteration, effects of 3 MW turbines were assessed.

The client realizes that the approach chosen has its own weaknesses because for the three large gull species considered a different approach is chosen for determining the rate of collision on the DCS as compared to the rest of the southern North Sea. Nevertheless, the modelled numbers of collision victims for the different areas are added together. Moreover, the distinction now made between the DCS and the rest of the southern North Sea was not made in Leopold *et al.* (2014).

4 Iteration

4.1 Assumptions

New NL wind farms: With regard to the MWTL-data we restricted the iteration to the same MWTL-counts as used in Leopold *et al.* (2014). More recent count data were not used.

In consultation with the client, it has been agreed to assume the same 'footprints' (wind farm areas) and total MW per wind farm as in Leopold *et al.* (2014). Thus, installation of turbines with a higher capacity leads to fewer turbines per offshore wind farm but not to a smaller area in use. The characteristics of all other wind farms except the 'new NL wind farms' (see Leopold *et al.* 2014) were maintained.

Wind turbine parameter settings: As requested by the client, the characteristics of the wind turbines to be considered were adopted from Gyimesi *et al.* (2015); see Table 1. The minimum/maximum variants relate to the hub height and are derived from the size of the rotor diameter. For the purpose of the calculations, the rotor is 'positioned' such that the tip, in its lowest position, is 25 m above sea level. Note that the Band (2012) model takes both parameters (hub height and rotor diameter) into account.

Table 1. Parameter settings (according to Gyimesi et al. 2015) of the analysed 4 and 5 MW turbine types.

Capacity MW	Turbines #	Total MW	Blades #	Blade width m	Rotor speed m/s	Rotor diameter m	Hub height m	Pitch	Distance b. turbines m
4 min	88	352	3	3.8	14.96	116	83	5.9	463
4 max	88	352	3	3.8	14.96	140	95	5.9	463
5 min	70	350	3	4.0	14.14	129	89.5	5.7	518
5 max	70	350	3	4.0	14.14	156	103	5.7	518

4.2 Method

In this study, data handling and processing were identical to the earlier approach (Leopold *et al.* 2014, Leopold *et al.* 2015) except for the amount of data used. As requested, we limited ourselves to data from just one source: the MWTL database, and DCS data only. As in the first iteration cycle we considered only the three large gull species: lesser black-backed gull (Euring 5910), European herring gull (Euring 5920) and great black-backed gull (Euring 6000); Table 2.

Table 2. Field codes of the database used.

EUring	ShortName	Name	NLnaam	Latin name
5910	LBBG	lesser black-backed gull	kleine mantelmeeuw	*Larus fuscus*
5920	EHG	European herring gull	zilvermeeuw	*Larus argentatus*
6000	GBBG	great black-backed gull	grote mantelmeeuw	*Larus marinus*

The data used were taken from the most appropriate intermediate point from the original study, i.c. the latest stage where data were still distinguishable by source. The existing script was modified to limit processing to the smaller area and the selected species.

Thereafter, the newly derived density values were determined for the Dutch offshore wind farm areas that have already been treated in the initial study: OWEZ, Prinses Amalia WindPark (both operational); Eneco Luchterduinen (under construction); Gemini East and West (both licensed); and ten projected offshore wind farm sites (SER1-SER10), the 'new NL wind farms' (see above).

The new statistics served as input for the Band (2012) model calculations of Bureau Waardenburg. Based on the revised gull densities of this second iteration, submitted per bi-monthly "season" (Aug/Sep, Oct/Nov, Dec/Jan, Feb/Mar, Apr/May, Jun/Jul), the Band-model calculations were re-done to assess the associated collision rates. For a detailed description of the methods used by Bureau Waardenburg, we refer to Leopold *et al.* (2014) and Gyimesi *et al.* (2015).

4.3 Results

Based on the the above-described method, new densities were generated (Table 3). The total numbers are also plotted graphically in Figure 1.

Table 3. Average seabird densities (left panel) and seabird numbers (right panel) for the entire DCS, for each of the three gull species and the six distinguished seasons.

Season code	Months	LBBG	EHG	GBBG	Season code	Months	LBBG	EHG	GBBG
1	Aug/Sep	5267.8	3642.0	360.9	1	Aug/Sep	131694	91050	9023
2	Oct/Nov	1039.1	12668.8	2642.7	2	Oct/Nov	25978	316720	66068
3	Dec/Jan	78.3	9053.8	2699.7	3	Dec/Jan	1959	226344	67493
4	Feb/Mar	1152.2	9366.1	978.7	4	Feb/Mar	28806	234152	24467
5	Apr/May	8716.2	4055.2	453.2	5	Apr/May	217904	101381	11331
6	Jun/Jul	10116.9	3706.5	141.3	6	Jun/Jul	252922	92662	3533

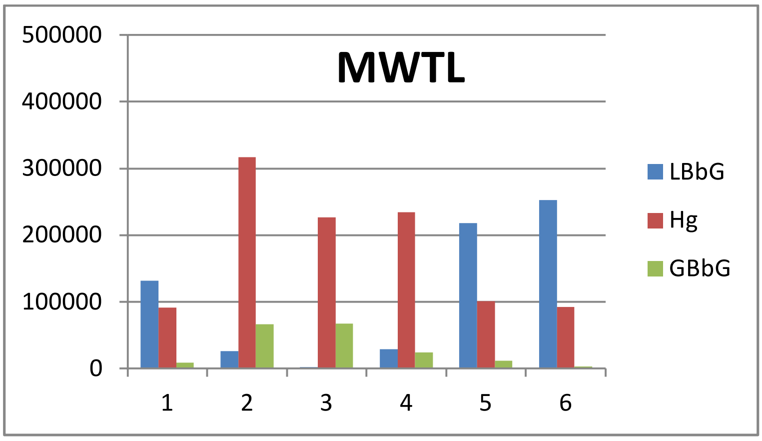

Figure 1. Birds numbers (y-axis), based on the MWTL subset, for the entire DCS, for each of the three gull species per bi-monthly season; x-axis: season code (see Table 3); LBbG = lesser black-backed gull; Hg = Herring gull; GBbG = great black-backed gull.

When re-producing GIS-maps, now based on the MWTL-counts only, the seasonal distribution pattern of the three gull species is as follows (Figure 2-4):

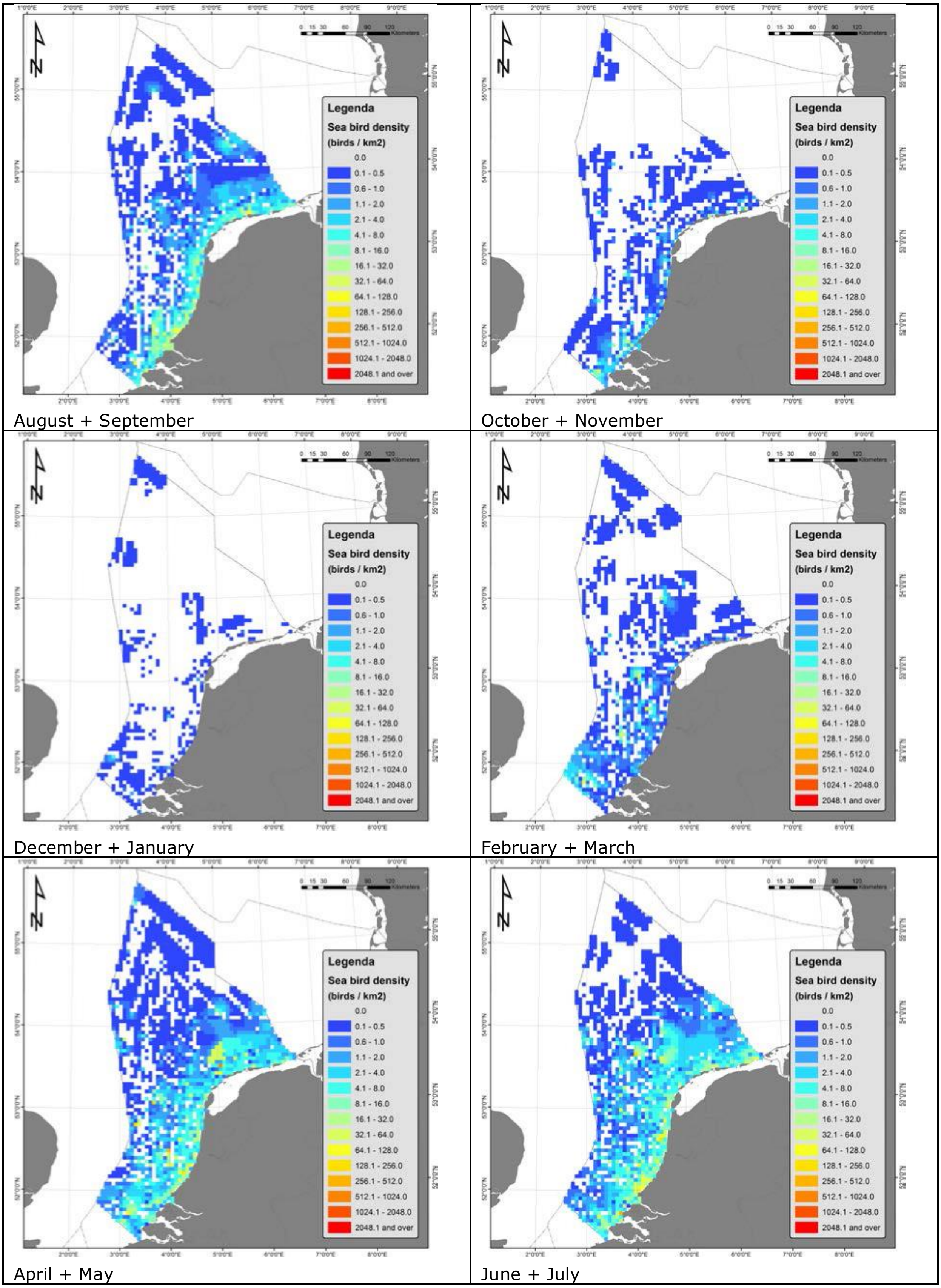

Figure 1. (to be compared to Figure 4.33 in Leopold et al. 2014 and Figure 4 in Leopold et al. 2015). Distribution patterns for lesser black-backed gull in the six distinguished seasons, and DCS only.

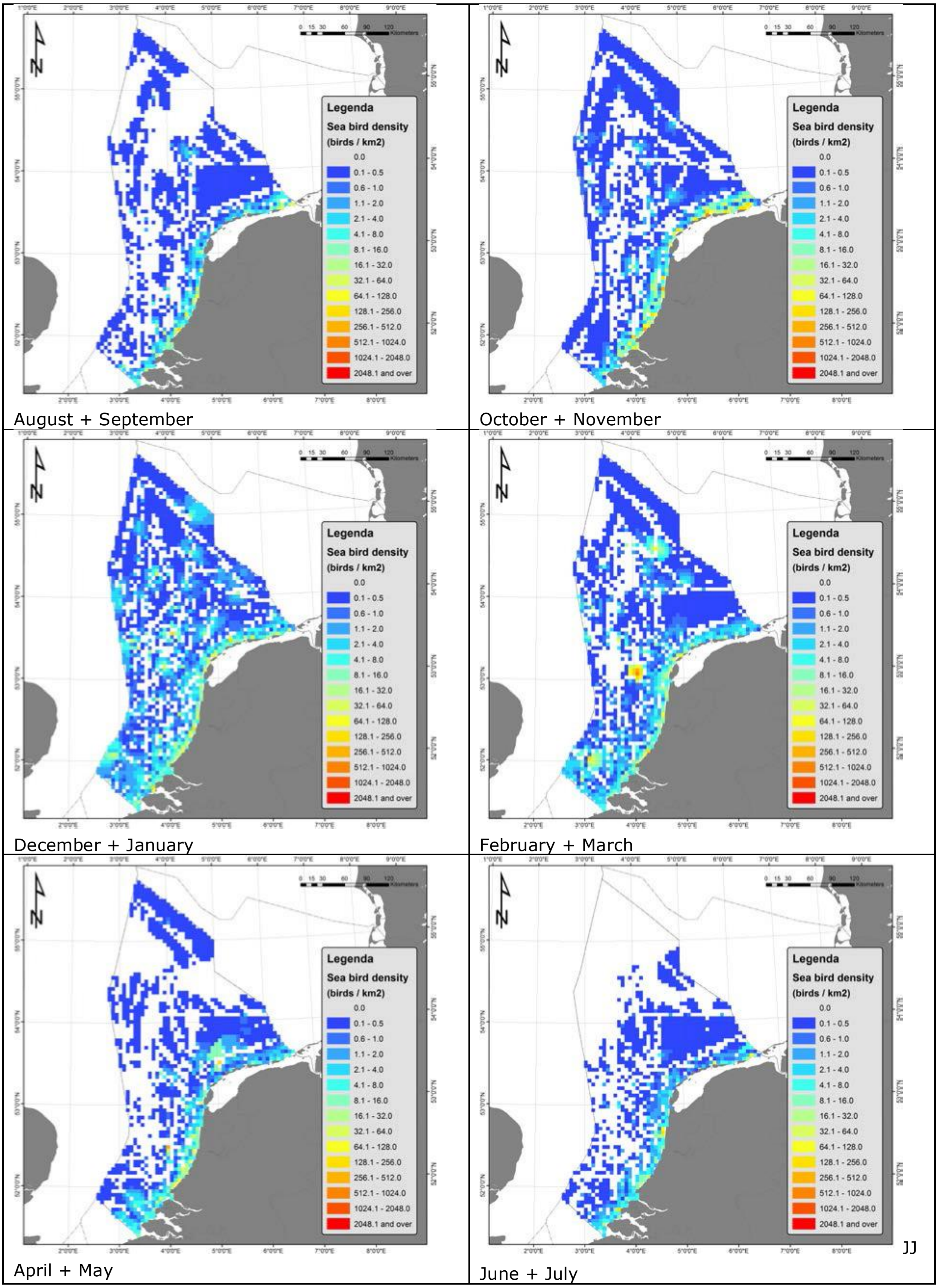

Figure 3. (to be compared to Figure 4.34 in Leopold et al. 2014 and Figure 5 in Leopold et al. 2015). Distribution patterns for European herring gull in the six distinguished seasons, and DCS only.

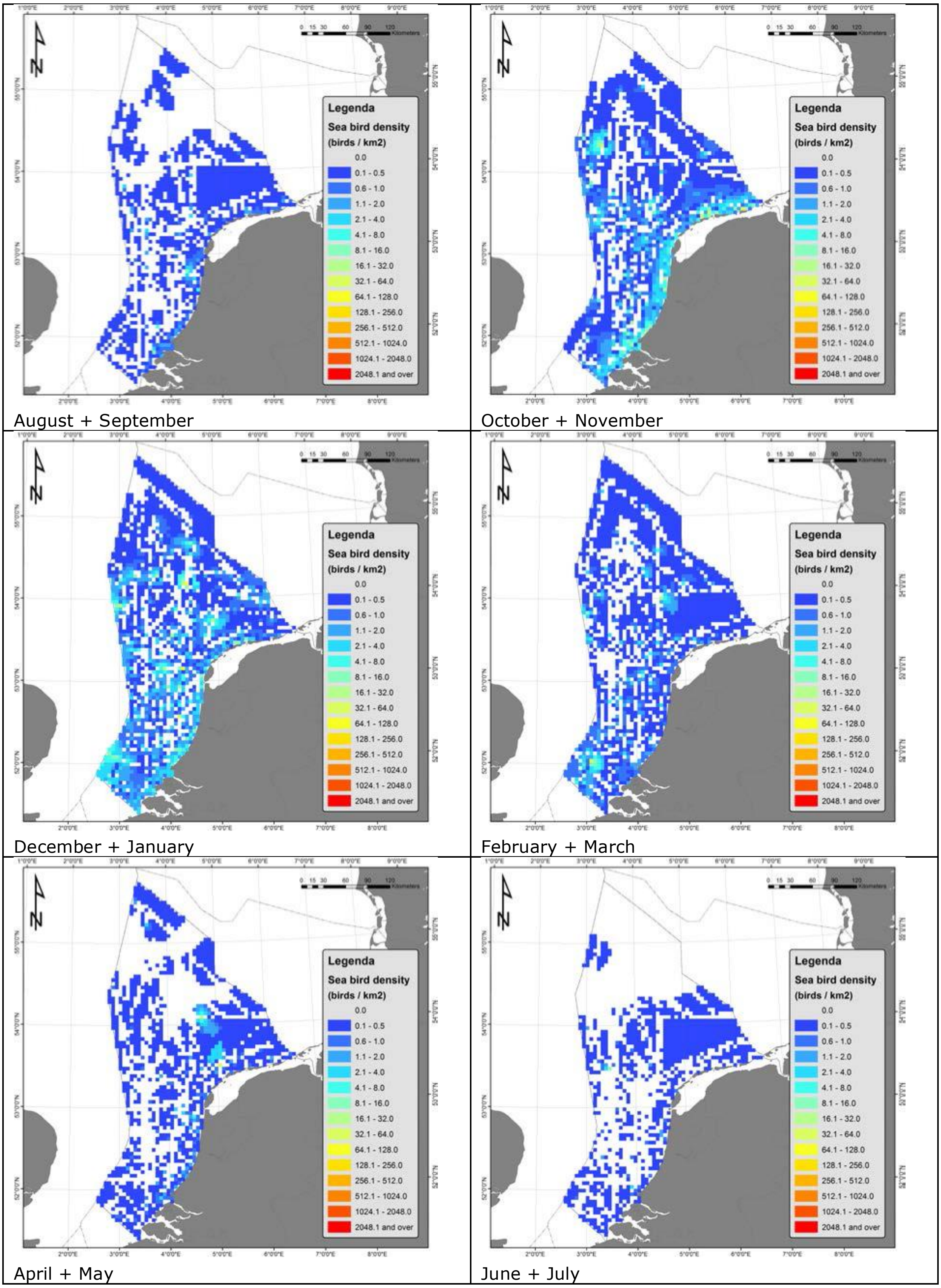

Figure 4. (to be compared to Figure 4.35 in Leopold et al. 2014 and Figure 6 in Leopold et al. 2015). Distribution patterns for great black-backed gull in the six distinguished seasons, and DCS only.

5 Re-calculation of collision victim numbers, based on Band (2012)

For the purpose of this second iteration, Bureau Waardenburg re-calculated the annual collision victim numbers, to be expected according to the Band (2012)-model, for the three large gull species considered and the situation in 2023 when all projected 'new NL wind farms' are realised in addition to:

1. all existing and operational offshore wind farms in the Dutch waters: OWEZ, Prinses Amalia Windpark;
2. the offshore wind farms in Dutch waters being under construction/licensed: Eneco Luchterduinen en Gemini West en East;
3. all foreign offshore wind farms according to the main study (Leopold *et al.* 2014).

Note that the wind farm and turbine characteristics of the wind farms described under 1 and 2 were adjusted to the actual turbine specifications that have been or are going to be installed (in contrast to Leopold *et al.* 2014), and that the wind farm and turbine characteristics of the wind farms described under 3 were similar to the original characteristics that were used in the calculations done by Leopold *et al.* 2014. For the 'new NL wind farms' on the DCS, the assumption was made that wind turbines of either 4 MW (two sizes: min and max) or 5 MW (two sizes: min and max) will be installed. The revision of gull densities holds for the DCS only; no changes in seasonal bird densities were made for the wind farms outside the DCS.

The results of the recalculations, based on the selected data (chapter 4), are presented in Table 4-7.

Table 4. Number of predicted collision victims per year for the three considered gull species, in the ten 'new NL wind farms' based on Band (2012)-modelling, per capacity-type: 4 MW and 5 MW, and two variants: min/max (see 4.1; Table 1).

Wind farm	Variant	lesser black-backed gull	European herring gull	great black-backed gull
SER1	4MW min	104	74	29
	4MW max	102	73	28
	5MW min	81	58	22
	5MW max	80	57	22
SER2	4MW min	66	60	25
	4MW max	65	58	24
	5MW min	51	46	19
	5MW max	50	45	19
SER3	4MW min	33	36	32
	4MW max	32	36	32
	5MW min	25	28	25
	5MW max	25	28	25
SER4	4MW min	118	91	34
	4MW max	117	89	34
	5MW min	92	71	27
	5MW max	91	69	26
SER5	4MW min	308	31	9
	4MW max	303	31	9
	5MW min	239	24	7
	5MW max	236	24	7
SER6	4MW min	365	56	7
	4MW max	360	55	7
	5MW min	284	44	6
	5MW max	280	43	6

SER7	4MW min	125	62	18
	4MW max	123	61	18
	5MW min	97	49	14
	5MW max	96	48	14
SER8	4MW min	254	38	7
	4MW max	250	37	7
	5MW min	197	30	6
	5MW max	195	29	5
SER9	4MW min	114	28	25
	4MW max	112	28	25
	5MW min	89	22	20
	5MW max	88	22	20
SER10	4MW min	87	59	47
	4MW max	85	58	47
	5MW min	67	46	37
	5MW max	66	45	37
Total	4MW min	1573	537	233
	4MW max	1550	526	231
	5MW min	1223	418	183
	5MW max	1206	409	181

Table 5. Number of collision victims per gull species and NL wind farms (existing/operational and under construction) based on Band (2012)-modelling.

Wind farm	lesser black-backed gull	European herring gull	great black-backed gull
OWEZ	168	160	19
Prinses Amaliawindpark	124	97	100
Eneco Luchterduinen	67	30	9
Gemini East	11	5	15
Gemini West	9	5	6
Total	380	297	150

Table 6. Number of collision victims per gull species in all other wind farms based on Band (2012)-modelling. Here, the underlying data concern peak-corrected densities as in the first iteration (Leopold et al. 2015).

Wind farm	lesser black-backed gull	European herring gull	great black-backed gull
Albatros	55	34	27
Alpha Ventus Nord	29	3	14
Alpha Ventus S☐d	29	3	14
Amrumbank West	230	181	55
BARD Offshore 1	65	9	44
Belwind Alstom Haliade Demonstration	3	1	2
Belwind1	327	114	203
Belwind2	162	62	109
Blyth	1	1	1
Borkum Riffgrund I	332	35	48
Borkum Riffgrund II	392	50	79
Borkum Riffgrund West 1	97	9	27

Wind farm	lesser black-backed gull	European herring gull	great black-backed gull
Borkum Riffgrund West 2	85	7	24
Borkum West II Phase 1	165	46	48
Borkum West II Phase 2	171	46	49
Breesea Offshore Wind Farm (Hornsea Project Two)	11	0	4
Butendiek	180	64	25
Creyke Beck A (Tranche A)	2	0	8
Creyke Beck B (Tranche A)	2	1	7
DanTysk	86	38	43
Delta Nordsee 1	210	20	17
Delta Nordsee 2	192	18	15
Deutsche Bucht	15	3	23
Dudgeon	1	1	2
East Anglia Four	51	24	39
East Anglia One	26	22	32
East Anglia Three	31	4	21
EnBW He Dreiht	77	11	55
EnBW Hohe See	83	13	33
Galloper	8	6	11
Global Tech 1	77	31	32
Global Tech 2	113	19	62
Gode Wind 01	342	36	25
Gode Wind 02	277	19	11
Gode Wind 03	101	8	6
Gode Wind 04	283	20	16
Greater Gabbard	16	12	15
Gunfleet Sands Demonstration Project	0	1	1
Gunfleet Sands I + II	11	23	17
Heron Wind Offshore Wind Farm (Hornsea Project One)	1	0	4
Horns Rev 1	47	22	14
Horns Rev 2	47	33	9
Horns Rev 3	33	38	11
Hornsea Project II – Optimus W.	3	2	7
Hornsea SPC 5	12	4	10
Hornsea SPC 6	5	5	10
Hornsea SPC 7	15	10	15
Hornsea SPC 8	8	16	13
Humber Gateway	2	1	5
Inner Dowsing	1	1	2
Innogy Nordsee 1	286	38	61
Innogy Nordsee 2	290	30	26
Innogy Nordsee 3	347	39	49
Kaikas	54	32	24
Kentish Flats 1	8	17	18

Wind farm	lesser black-backed gull	European herring gull	great black-backed gull
Kentish Flats 2	4	9	9
Lincs	3	2	5
London Array 1	43	63	79
Lynn	1	1	2
Meerwind S☐d/Ost	245	177	81
MEG Offshore I	382	69	123
Nördlicher Grund	47	17	35
NaREC Offshore Wind Demonstration Project	7	8	6
Njord Offshore Wind Farm (Hornsea Project One)	1	1	9
Nordergr☐nde	32	38	8
Nordpassage	71	42	35
Nordsee Ost	143	101	31
Norther	371	187	150
Northwind	280	136	143
OWP West	85	6	27
Race Bank	2	2	3
RENTEL	341	159	141
Riffgat	105	54	27
Sandbank 24	33	38	45
Sandbank 24 Extension	19	19	26
Scroby Sands	33	1	20
Seastar	201	80	124
Sheringham Shoal	1	1	1
Teesside	0	12	8
Teesside A	5	5	2
Teesside B	8	1	16
Teesside C	4	4	9
Teesside D	4	3	3
Thanet	43	45	66
Thornton Bank I	729	338	289
Thornton Bank II	726	331	280
Thornton Bank III	718	305	309
THV Mermaid	93	18	50
Triton Knoll	4	2	5
Veja Mate	45	5	34
Westermost Rough	4	4	8
Total	10332	3568	3752

Table 7. Total number of collision victims due to the impact of all offshore wind farms in the southern North Sea in 2023 (according to Leopold et al. 2014) for the three considered gull species, based on Band (2012)-modelling. Given are the numbers per capacity-type: 4 MW and 5 MW and two variants: min/max (see 4.1; Table 1).

Variant	lesser black-backed gull	European herring gull	great black-backed gull
4MW min	12284	4401	4135
4MW max	12262	4391	4133
5MW min	11935	4283	4084
5MW max	11918	4274	4082

6 Impact relative to PBR

The newly derived collision numbers were assessed with the same method as in Leopold *et al.* (2014) through comparison with the relevant Potential Biological Removal values (Table 8).

Table 8. Total number of collision victims due to the impact of all offshore wind farms in the southern North Sea in 2023 (according to Leopold et al. 2014) per large gull species (GBBG = great black-backed gull; EHG = European herring gull; LBBG = lesser black-backed gull) set against the Potential Biological Removal (PBR) level (based on the status of the population). Given are the numbers per capacity: 4 MW and 5 MW, and two variants: min/max (see 4.1; Table 1). PBR levels from Leopold et al. (2014), based on Wetlands International (2014).

Species	Variant	Total n collisions	Applicable PBR	% collision/PBR
GBBG	4MW min	4135	4144	99.78
	4MW max	4133		99.73
EHG	4MW min	4401	4184	105.19
	4MW max	4391		104.95
LBBG	4MW min	12284	7560	162.49
	4MW max	12262		162.20
GBBG	5MW min	4084	4144	98.55
	5MW max	4082		98.50
EHG	5MW min	4283	4184	102.37
	5MW max	4274		102.15
LBBG	5MW min	11935	7560	157.87
	5MW max	11918		157.65

For comparison, we also present the figures estimated earlier, subdivided for the Dutch offshore wind farms and the wind farms of all other countries combined (Table 9).

Table 9. Comparative overwiew of total numbers of collision victims due to the impact of all offshore wind farms in the southern North Sea in 2023 per large gull species, for all offshore wind farms (OWF's) in the study area (shaded: proportion of foreign OWF's), set against the Potential Biological Removal (PBR). Given are the results from the various calculations (main study, 1st and 2nd iteration; see Leopold et al. 2014, 2015 and this study, respectively).

Report	Total number of collision victims					
	lesser black-backed gull		European herring gull		great black-backed gull	
	Total OWFs	Foreign OWFs	Total OWFs	Foreign OWFs	Total OWFs	Foreign OWFs
Main study	23674	18590	3381	2612	5441	4592
1st iteration	13938	10332	5845	3568	4659	3752
2nd iteration	11918-12284	10332	4274-4401	3568	4082-4135	3752
	PBR	% coll./PBR	PBR	% coll./PBR	PBR	% coll./PBR
Main study	7560	313.15	4184	80.81	4144	131.30
1st iteration	7560	184.37	4184	139.70	4144	112.43
2nd iteration	7560	157.65-162.49	4184	102.15-105.19	4144	98.50-99.78

7 Discussion

7.1 Results

In this iteration we strived to more accurately assess the impact of the projected offshore wind farms on the three large gulls species that we already focused on in the first iteration.

Based on Band (2012), Gyimesi *et al.* (2015) studied the influence of different types of turbines, i.e. their characteristics (capacity, rotor diameter, total turbine height, hub height, blade width, distance between turbines, etc.), on the number of collision victims predicted for lot Borssele (southern DCS). They found that, in general, larger wind turbine types result in lower collision numbers as compared to smaller types (3 or 4 MW) and that among the same three large gull species as in our study, the collision numbers at Borssele differed by a factor of approximately three between the smallest (4 MW) and largest (10 MW) turbine type (Gyimesi *et al.* 2015). Their findings suggest that a smaller number of large turbines yields smaller numbers of collision victims overall, compared to a large number of smaller turbines. Choosing larger turbines (in MWs) could thus potentially mitigate the overall numbers of collision victims.

The decrease in collision numbers by using large turbines can partly be explained by a lower calculated collision risk of an individual bird passing an individual turbine. Since the vast majority of seabirds fly at low altitudes, the collision risk, which is highest near the nacelle, decreases as the nacelle is at higher altitudes. But apart from this and despite the fact that larger rotors cover a larger part of the airspace, all seabirds 'benefit' from high-capacity turbines, because fewer turbines have to be installed to realise the same capacity per wind farm.

In the main study (Leopold *et al.* 2014) and for the purpose of the first iteration (Leopold *et al.* 2015), by way of worst-case approach all calculations were carried out with the smallest variant, the 3 MW turbine type, resulting in collision numbers well above critical limits for lesser en great black-backed gull; European herring gull can be regarded as a separate methodological case (see Introduction). In this second iteration, larger turbine types (4 and 5 MW) were considered in the expectation that the predicted numbers of collision victims caused by these types, might drop below the critical limits (expressed as '%

collision/PBR'). The results (Table 4) show that these larger turbine types do lead to lower collision rates as compared to the 3 MW type. However, we still found values above PBR. The results for European herring gull and great black backed gull are only just above and below 100% respectively, while the differences between the 4 and 5 MW type in both variants for these species are very small: approximately +2.8 and -1.5 percentage point respectively. By contrast, for lesser black-backed gull the number of victims still remain well above PBR. Although the new results can not simply be compared with the earlier estimates because of the different underlying datasets, the '% collision/PBR' for lesser black-backed gull becomes considerably lower with larger turbines: 313.15 (main study; MWTL/ESAS data; 3 MW), 184.37 (first iteration; MWTL/ESAS data, peaks corrected; 3 MW), and 162.49 to 157.65 (this iteration; for DCS MWTL data only, uncorrected; 4 MW min and 5 MW max resp. in 'new NL wind farms'); see Table 9.

7.2 Uncertainties

From this study and the previous work (Leopold *et al.* 2014 and 2015) more experience has been gained with modelling and treating seabird densities in relation to offshore wind energy developments. Because of the flocking behaviour of the three larger gulls that commonly aggregate behind fishing vessels, it is challenging to obtain reliable estimates of their (seaonal) densities from survey data. As an alternative to the first iteration cycle, this study was set up to improve the estimates by relying on aerial counts (MWTL-database) only, as this method is regarded to be less prone to overestimations of gull densities. Ship-based counts have the intrinsic problem that gulls are attracted to the vessel from which the counts are conducted, in contrast to aerial surveys. On the other hand, it must be kept in mind that the exclusive use of MWTL data was only possible for the DCS, and that the database-modification is, therefore, a small-scale and selective one.

The most important uncertainty, not overcome in the exercises so far, relates to the availability of data. A number of surveys, specifically with regard to the development of offshore wind in the UK, Germany, and probably Denmark, are carried out in/by these countries, but the survey data are not (readily) available. At this time, reliable density estimations for seabirds outside the DCS seem to be the biggest weakness in our analyses performed. The inclusion of survey data (from foreign countries) would be an important step forward to improve the overall confidence of the model outcomes. It remains to be seen whether this would result in lower or higher densities of seabirds, in which seasons and locations, and how this would translate into casualties. Improved data will probably not only change the results for the three large gull species, but for all other species as well.

The numbers of the three large gull species, estimated in this iteration for the DCS, may be compared to earlier estimates for this area based on ship-based counts ((Table 10; Camphuysen and Leopold 1994, Table 4.3). The estimates for great black-backed gull are very similar, the estimate for herring gull is almost double the estimate made in the 1990s, and the estimate for lesser black-backed gull is three times the earlier estimate. Numbers of lesser black-backed gulls breeding in the Netherlands have increased three-fold in the years between the two estimates (Camphuysen 2013, Figure 1.1), but numbers of herring gulls have dropped rather than increased. Estimating true numbers of gulls at sea remains a major challenge, that probably needs more scrutiny for teasing apart numbers of gulls not associating with fishing vessels from those that are found flocking around vessels, thus creating temporary hotspots that have proved difficult to deal with in gull density modelling.

Table 10. Estimates of for lesser black-backed gull, European herring gull, and great black-backed gull from Camphuysen and Leopold (1994) in comparison with the results of this iteration.

Species	2nd iteration	Camphuysen and Leopold (1994)
LBBG	253000	82900
EHG	317000	171300
GBBG	67500	63500

Another uncertainty concerns the PBR. The comparison between predicted numbers of collisions and the safe limit set by PBR relies on both measures stemming from the same population, and in case this population goes through drastic changes in size, the same year(s) of assessment. In the case of the lesser black-backed gull, input data for collision modelling stem from the past ten years of at-sea surveys, while population assessment for setting PBR may stem from a longer period of time. Given that the population of lesser black-backed gulls had shown a rapid increase over the past decades, at least in the Netherlands, PBR levels may have been set too low. In order to overcome this problem, it might be an option to re-perform the exercise, including the calculation of PBR-values, only for the Dutch waters, and only for the Dutch breeding population, which means that the entire PBR-population modelling needs to be redone with more recent NL-data than those used so far for the whole catchment area (data source: Wetlands International 2014). In addition, as pointed out in the main study (Leopold et al. 2014), it must be kept in mind that the PBR approach includes all sources of human-caused mortality. Therefore, changes in these sources should also be considered, when PBR values are recalculated with a future perspective.

7.3 Knowledge gaps

This exercise of modelling cumulative, future numbers of collision victims of offshore wind development, remains theoretical. True numbers of victims can only be obtained from thorough field studies in offshore wind farms, after these farms have become operational. Such studies will greatly help to evaluate, and fine-tune, the outcomes of pre-construction modelling exercises such as this one. Pre-construction surveys of development sites will also greatly help to fill the gaps in the existing database(s). 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. The effects of flocking behaviour of gulls on the modelling of gull numbers at sea needs to be explored further, as this might greatly influence numbers of birds estimated to be at sea at large, or at particular locations, such as projected offshore wind farm sites.

Although the applied Band (2012) method deals with flight altitudes, fieldwork studies in the projected wind farm areas are needed to validate model outcomes.

8 Conclusions and recommendations

Although in this second iteration, the modifications at the input side could only be made on a sub-set of the data, i.e. the DCS, while the recalculations of collision victim numbers were again carried out cumulatively for the entire southern North Sea, insight could be gained into the effect of using aerial count data only, and larger wind turbines in the ‘new NL wind farms’. From the newly derived Band (2012) model outcomes we conclude that:

- performing the calculations as done by Leopold *et al.* (2014) on the basis of aerial counts (MWTL data; for the DCS only), instead of ship-based and aerial counts (ESAS and MWTL data), and by modelling for larger turbines, the respective numbers of collision victims become lower; in the overall analysis, this effect is less pronounced due to the fact that the number of gulls on the DCS are only a fraction of the total numbers in the entire southern North Sea.
- larger wind turbines do have a mitigating effect on the number of collisions. The predicted differences between the minimum and maximum variants of the two considered MW types are small in

comparison, suggesting that the mitigating effect is mainly due to the fact that the use of large turbine capacities means fewer turbines to achieve the same total wind farm capacity.
- while the '% collision/PBR' values for great black-backed gull and Eurpean herring gull are around the critical limit of 100, lesser black-backed gull, with a score of approximately 160, is still severely at risk.

Our recommendations correspond with what has been proposed earlier:
- make use of more (existing, but yet not readily available) data sources, for example data from aerial surveys in/of the neighbouring countries such as Germany, Denmark and the UK, to improve the reliability of input data off the DCS;
- carry out fieldwork studies to verify and validate model outcomes and underlying assumptions/settings.
- analyse the DCS-ESAS data in isolation and compare the outcome with the results based on the MWTL data (not part of the assignment; note that the earlier analyses were based on a combined MWTL / ESAS dataset).

9 References

Band W. 2012. Using a collision risk model to assess bird collision risks for offshore windfarms. SOSS, The Crown Estate, London, UK. www.bto.org/science/wetland-and-marine/soss/projects.

Bradbury G., Trinder, M., Furness, B., Banks, A. N., Caldow, R. W. G., & Hume, D. 2014. Mapping seabird sensitivity to offshore wind farms. PloS One, 9(9), e106366. doi:10.1371/journal.pone.0106366

Camphuysen, C.J. 2013. A historical ecology of two closely related gull species (Laridae): multiple adaptations to a man-made environment. Ph.D.-thesis, Univ. Groningen, Groningen.

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.

Corman, A.-M., S. Garthe 2014. What flight heights tell us about foraging and potential conflicts with wind farms: a case study in Lesser Black-backed Gullls (Larus fuscus). Journal of Ornithology (2014) 155: 1037-1043.

Gyimesi, A., M.P. Collier & R.C. Fijn 2015. Slachtofferberekeningen voor 14 windturbine varianten (4 MW - 10 MW) in Kavel I of II in windenergiegebied Borssele. Bureau Waardenburg notitie 14-282/15.01562/RubFi, Culemborg, Nederland.

Leopold, M.F.; Boonman, M.; Collier, M.P.; Davaasuren, N.; Fijn, R.C.; Gyimesi, A.; de Jong, J.; Jongbloed, R.H.; Jonge Poerink, B.; Kleyheeg-Hartman, J.C.; Krijgsveld, K.L.; Lagerveld, S.; Lensink, R.; Poot, M.J.M.; van der Wal. J.T.; Scholl, M. (2014). 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. IMARES Report C166/14 [confidential for 6 months from date of publication]

Leopold, M.F.; Collier, M.P.; Gyimesi, A.; Jongbloed, R.H.; Poot, M.J.M.; van der Wal, J.T.; Scholl, M. (2015). 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. Additional note to IMARES report number C166/14. [confidential for 6 months from date of publication].

Wetlands International (2014). "Waterbird Population Estimates". Retrieved from wpe.wetlands.org Nov 2014, publication WPE 5.

10 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 : Additional note to C166/14
Project number : 431 21000 10

The scientific quality of this report has been peer reviewed by the a colleague scientist and the head of the department of IMARES.

Approved: Drs. M.F. Leopold
Marine ornithologist

Signature:

Date: 28 May 2015

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

Signature:

Date: 28 May 2015

Annex A: Overview of the numbers of the three gull species (lesser black-backed gull, great black-backed gul land herring gull) on the DCS.

OWPteller	OWPname	EUring	Season	SeasonCode	Avg
0	SER1	5910	1	AS	0.719621122
0	SER1	5910	2	ON	0.743118725
0	SER1	5910	3	DJ	0.043624481
0	SER1	5910	4	FM	1.243616236
0	SER1	5910	5	AM	9.832450497
0	SER1	5910	6	JJ	2.583127608
0	SER1	5920	1	AS	3.297486889
0	SER1	5920	2	ON	0.221077798
0	SER1	5920	3	DJ	0.589112993
0	SER1	5920	4	FM	1.786248845
0	SER1	5920	5	AM	2.46118968
0	SER1	5920	6	JJ	0.2271946
0	SER1	6000	1	AS	0.062189835
0	SER1	6000	2	ON	0.688468408
0	SER1	6000	3	DJ	0.571592038
0	SER1	6000	4	FM	1.032774092
0	SER1	6000	5	AM	0.39509503
0	SER1	6000	6	JJ	0.159885516
1	SER3	5910	1	AS	0.260205665
1	SER3	5910	2	ON	0.094349254
1	SER3	5910	3	DJ	0.04883114
1	SER3	5910	4	FM	2.326366372
1	SER3	5910	5	AM	0.938933731
1	SER3	5910	6	JJ	1.323684225
1	SER3	5920	1	AS	0.04719372
1	SER3	5920	2	ON	0.213827531
1	SER3	5920	3	DJ	2.539234216
1	SER3	5920	4	FM	1.087578024
1	SER3	5920	5	AM	0.603104144
1	SER3	5920	6	JJ	0.052431429
1	SER3	6000	1	AS	0.075789136
1	SER3	6000	2	ON	0.321455382
1	SER3	6000	3	DJ	1.737369638
1	SER3	6000	4	FM	1.064228266
1	SER3	6000	5	AM	0.159771081
1	SER3	6000	6	JJ	0.047586674
2	SER5	5910	1	AS	0.678886788
2	SER5	5910	2	ON	0.030543098
2	SER5	5910	3	DJ	0
2	SER5	5910	4	FM	0.728511383
2	SER5	5910	5	AM	18.75644832
2	SER5	5910	6	JJ	23.4116029
2	SER5	5920	1	AS	0.015960138

OWPteller	OWPname	EUring	Season	SeasonCode	Avg
2	SER5	5920	2	ON	0.115032378
2	SER5	5920	3	DJ	0.805465458
2	SER5	5920	4	FM	0.711246539
2	SER5	5920	5	AM	1.940219391
2	SER5	5920	6	JJ	0.085906225
2	SER5	6000	1	AS	0.003103898
2	SER5	6000	2	ON	0.065647516
2	SER5	6000	3	DJ	0.705783204
2	SER5	6000	4	FM	0.096300148
2	SER5	6000	5	AM	0.059352112
2	SER5	6000	6	JJ	0
3	SER6	5910	1	AS	1.274264623
3	SER6	5910	2	ON	0.119459159
3	SER6	5910	3	DJ	0
3	SER6	5910	4	FM	0.727602285
3	SER6	5910	5	AM	24.26308819
3	SER6	5910	6	JJ	25.51083816
3	SER6	5920	1	AS	0.104745658
3	SER6	5920	2	ON	0.320077183
3	SER6	5920	3	DJ	0.89960224
3	SER6	5920	4	FM	0.366204802
3	SER6	5920	5	AM	4.524869527
3	SER6	5920	6	JJ	0.166449229
3	SER6	6000	1	AS	0.008266981
3	SER6	6000	2	ON	0.211115616
3	SER6	6000	3	DJ	0.389803341
3	SER6	6000	4	FM	0.081198548
3	SER6	6000	5	AM	0.024127122
3	SER6	6000	6	JJ	0.035941741
4	SER7	5910	1	AS	2.543771739
4	SER7	5910	2	ON	0.12344332
4	SER7	5910	3	DJ	0.001424339
4	SER7	5910	4	FM	1.224424124
4	SER7	5910	5	AM	9.549003864
4	SER7	5910	6	JJ	4.647794392
4	SER7	5920	1	AS	0.931184921
4	SER7	5920	2	ON	2.915149035
4	SER7	5920	3	DJ	0.32446655
4	SER7	5920	4	FM	0.732862094
4	SER7	5920	5	AM	1.939612894
4	SER7	5920	6	JJ	0.505580286
4	SER7	6000	1	AS	0.083407162
4	SER7	6000	2	ON	1.258833596
4	SER7	6000	3	DJ	0.11122514
4	SER7	6000	4	FM	0.24250954

OWPteller	OWPname	EUring	Season	SeasonCode	Avg
4	SER7	6000	5	AM	0.11722382
4	SER7	6000	6	JJ	0.033744053
5	SER8	5910	1	AS	2.604609894
5	SER8	5910	2	ON	0.127996721
5	SER8	5910	3	DJ	0.000612613
5	SER8	5910	4	FM	0.411156086
5	SER8	5910	5	AM	10.67602152
5	SER8	5910	6	JJ	22.08699247
5	SER8	5920	1	AS	0.104317911
5	SER8	5920	2	ON	1.401167353
5	SER8	5920	3	DJ	1.200825292
5	SER8	5920	4	FM	0.439860832
5	SER8	5920	5	AM	1.111315197
5	SER8	5920	6	JJ	0.309517462
5	SER8	6000	1	AS	0.019173654
5	SER8	6000	2	ON	0.235409382
5	SER8	6000	3	DJ	0.272165362
5	SER8	6000	4	FM	0.188366067
5	SER8	6000	5	AM	0
5	SER8	6000	6	JJ	0.024031818
6	SER9	5910	1	AS	0.472504492
6	SER9	5910	2	ON	0.181285836
6	SER9	5910	3	DJ	0
6	SER9	5910	4	FM	10.9142928
6	SER9	5910	5	AM	3.876852575
6	SER9	5910	6	JJ	2.386596005
6	SER9	5920	1	AS	0.137524525
6	SER9	5920	2	ON	0.295626447
6	SER9	5920	3	DJ	1.490427203
6	SER9	5920	4	FM	0.664455122
6	SER9	5920	5	AM	0.194998785
6	SER9	5920	6	JJ	0.669291034
6	SER9	6000	1	AS	0.227849466
6	SER9	6000	2	ON	0.380950459
6	SER9	6000	3	DJ	1.538986324
6	SER9	6000	4	FM	0.173701338
6	SER9	6000	5	AM	0.249404425
6	SER9	6000	6	JJ	0.050392811
7	SER10	5910	1	AS	2.413577275
7	SER10	5910	2	ON	0.362824931
7	SER10	5910	3	DJ	0
7	SER10	5910	4	FM	3.008798307
7	SER10	5910	5	AM	4.007793995
7	SER10	5910	6	JJ	3.086467687
7	SER10	5920	1	AS	0.939099493

OWPteller	OWPname	EUring	Season	SeasonCode	Avg
7	SER10	5920	2	ON	2.802367142
7	SER10	5920	3	DJ	1.840645584
7	SER10	5920	4	FM	0.438062278
7	SER10	5920	5	AM	0.600315083
7	SER10	5920	6	JJ	0.534259171
7	SER10	6000	1	AS	3.015310781
7	SER10	6000	2	ON	0.785285813
7	SER10	6000	3	DJ	0.512911577
7	SER10	6000	4	FM	0.132267704
7	SER10	6000	5	AM	0.096582157
7	SER10	6000	6	JJ	0.037570024
8	SER4	5910	1	AS	0.289640403
8	SER4	5910	2	ON	0.00721221
8	SER4	5910	3	DJ	0.066602612
8	SER4	5910	4	FM	15.61861318
8	SER4	5910	5	AM	1.669433765
8	SER4	5910	6	JJ	1.436706736
8	SER4	5920	1	AS	0.056540513
8	SER4	5920	2	ON	0.020595763
8	SER4	5920	3	DJ	1.170496251
8	SER4	5920	4	FM	9.846983773
8	SER4	5920	5	AM	0.229960555
8	SER4	5920	6	JJ	0.102190621
8	SER4	6000	1	AS	0.011935229
8	SER4	6000	2	ON	0.273029301
8	SER4	6000	3	DJ	1.398419534
8	SER4	6000	4	FM	1.810871571
8	SER4	6000	5	AM	0.038009491
8	SER4	6000	6	JJ	0.050470758
9	SER2	5910	1	AS	0.354298155
9	SER2	5910	2	ON	0.005025783
9	SER2	5910	3	DJ	0.13248065
9	SER2	5910	4	FM	1.199496375
9	SER2	5910	5	AM	6.325004852
9	SER2	5910	6	JJ	1.606619841
9	SER2	5920	1	AS	2.227412367
9	SER2	5920	2	ON	0.100084929
9	SER2	5920	3	DJ	1.090103658
9	SER2	5920	4	FM	1.62277585
9	SER2	5920	5	AM	1.57958817
9	SER2	5920	6	JJ	0.349842973
9	SER2	6000	1	AS	0
9	SER2	6000	2	ON	0.36833425
9	SER2	6000	3	DJ	0.907888227
9	SER2	6000	4	FM	0.996257333

OWPteller	OWPname	EUring	Season	SeasonCode	Avg
9	SER2	6000	5	AM	0.218618188
9	SER2	6000	6	JJ	0.060931398
10	Prinses Amaliawindpark	5910	1	AS	0.327414655
10	Prinses Amaliawindpark	5910	2	ON	0.455341416
10	Prinses Amaliawindpark	5910	3	DJ	0
10	Prinses Amaliawindpark	5910	4	FM	0.958228781
10	Prinses Amaliawindpark	5910	5	AM	14.4399721
10	Prinses Amaliawindpark	5910	6	JJ	1.489060088
10	Prinses Amaliawindpark	5920	1	AS	0.096446695
10	Prinses Amaliawindpark	5920	2	ON	0.534287302
10	Prinses Amaliawindpark	5920	3	DJ	10.86479443
10	Prinses Amaliawindpark	5920	4	FM	0.84960525
10	Prinses Amaliawindpark	5920	5	AM	0.218469304
10	Prinses Amaliawindpark	5920	6	JJ	0.204055243
10	Prinses Amaliawindpark	6000	1	AS	0.008673873
10	Prinses Amaliawindpark	6000	2	ON	0.160295042
10	Prinses Amaliawindpark	6000	3	DJ	10.74737667
10	Prinses Amaliawindpark	6000	4	FM	0.178670641
10	Prinses Amaliawindpark	6000	5	AM	0.222025826
10	Prinses Amaliawindpark	6000	6	JJ	0.149917079
11	OWEZ	5910	1	AS	3.813362466
11	OWEZ	5910	2	ON	0.575593971
11	OWEZ	5910	3	DJ	0.002513252
11	OWEZ	5910	4	FM	1.25733872
11	OWEZ	5910	5	AM	8.863054708
11	OWEZ	5910	6	JJ	41.7216734
11	OWEZ	5920	1	AS	0.930149451
11	OWEZ	5920	2	ON	17.49314662
11	OWEZ	5920	3	DJ	1.42490196
11	OWEZ	5920	4	FM	3.288468356
11	OWEZ	5920	5	AM	12.99081912
11	OWEZ	5920	6	JJ	8.109402012
11	OWEZ	6000	1	AS	0.41210823
11	OWEZ	6000	2	ON	3.02453921
11	OWEZ	6000	3	DJ	0.709247025
11	OWEZ	6000	4	FM	0.222371134
11	OWEZ	6000	5	AM	0.275921181
11	OWEZ	6000	6	JJ	0.096304392
12	Gemini East	5910	1	AS	0.191514582
12	Gemini East	5910	2	ON	0
12	Gemini East	5910	3	DJ	0
12	Gemini East	5910	4	FM	0
12	Gemini East	5910	5	AM	1.065904401
12	Gemini East	5910	6	JJ	0.573623167
12	Gemini East	5920	1	AS	0.012297314

OWPteller	OWPname	EUring	Season	SeasonCode	Avg
12	Gemini East	5920	2	ON	0.01226258
12	Gemini East	5920	3	DJ	0.512397684
12	Gemini East	5920	4	FM	0.034047893
12	Gemini East	5920	5	AM	0.089379745
12	Gemini East	5920	6	JJ	0.051800316
12	Gemini East	6000	1	AS	0.01979685
12	Gemini East	6000	2	ON	0.020086152
12	Gemini East	6000	3	DJ	1.625915805
12	Gemini East	6000	4	FM	0.291379858
12	Gemini East	6000	5	AM	0.014744704
12	Gemini East	6000	6	JJ	0.005481901
13	Gemini West	5910	1	AS	0.17739646
13	Gemini West	5910	2	ON	0
13	Gemini West	5910	3	DJ	0
13	Gemini West	5910	4	FM	0
13	Gemini West	5910	5	AM	0.692668683
13	Gemini West	5910	6	JJ	0.750962693
13	Gemini West	5920	1	AS	0.010617903
13	Gemini West	5920	2	ON	0.004315547
13	Gemini West	5920	3	DJ	0.272307855
13	Gemini West	5920	4	FM	0.029133391
13	Gemini West	5920	5	AM	0.057004398
13	Gemini West	5920	6	JJ	0.386485354
13	Gemini West	6000	1	AS	0.122560416
13	Gemini West	6000	2	ON	0.020511708
13	Gemini West	6000	3	DJ	0.44146351
13	Gemini West	6000	4	FM	0.188587036
13	Gemini West	6000	5	AM	0.019624716
13	Gemini West	6000	6	JJ	0.003478706
14	Eneco Luchterduinen	5910	1	AS	0.646324535
14	Eneco Luchterduinen	5910	2	ON	0
14	Eneco Luchterduinen	5910	3	DJ	0
14	Eneco Luchterduinen	5910	4	FM	1.97895314
14	Eneco Luchterduinen	5910	5	AM	16.91902237
14	Eneco Luchterduinen	5910	6	JJ	1.972336442
14	Eneco Luchterduinen	5920	1	AS	0.033067908
14	Eneco Luchterduinen	5920	2	ON	2.554428105
14	Eneco Luchterduinen	5920	3	DJ	0.425573168
14	Eneco Luchterduinen	5920	4	FM	0.652201124
14	Eneco Luchterduinen	5920	5	AM	3.392930469
14	Eneco Luchterduinen	5920	6	JJ	0.468391388
14	Eneco Luchterduinen	6000	1	AS	0.100324641
14	Eneco Luchterduinen	6000	2	ON	1.297270165
14	Eneco Luchterduinen	6000	3	DJ	0.050171587
14	Eneco Luchterduinen	6000	4	FM	0.347776661

OWPteller	OWPname	EUring	Season	SeasonCode	Avg
14	Eneco Luchterduinen	6000	5	AM	0.171120056
14	Eneco Luchterduinen	6000	6	JJ	0