East Anglia THREE
Offshore Windfarm

East Anglia THREE

Offshore Ornithology

East Anglia THREE Revised CRM for Increase in Draft Height, East Anglia ONE Revised CRM for Final Wind Farm Design & Updated Cumulative CRM Tables

Project Update Information for Deadline 5
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Author – MacArthur Green
East Anglia Offshore Wind Limited
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Erratum Note

The previous version of this document (Offshore Ornithology: East Anglia ONE CRM Revised for Final Wind Farm Design) submitted at Deadline 4 contained a reporting error in the assignment of mortality estimates to great black-backed gull and herring gull in Tables 6 and 7. It should be noted that the calculations as presented in Tables 4 and 5 were correct and it was only the summary Tables 6 and 7 and associated text which included this error. This has been corrected in the current document.

1 East Anglia THREE Collision Risk Update

1. The wind farm design submitted for East Anglia THREE (EATL 2015b) included turbines with a minimum draft height (the distance between lower rotor tip height and mean high water springs, MHWS) of 22m. The collision risk estimates were calculated using models and parameters agreed with Natural England through the Evidence Plan process.

2. In their Relevant Representation, the RSPB advised that the potential for adverse effects on gannets and kittiwakes arising from the East Anglia THREE wind farm could be reduced through an increase in draft height. They presented an illustration of how increasing the draft height would reduce collisions, although it should be noted that the RSPB used more conservative parameter values for several of the collision modelling inputs than the agreed ones used in EATL (2015). This had the effect of both increasing the number of collisions predicted by the RSPB and also the subsequent reductions following an increase in draft height.

3. Nonetheless, EATL does not dispute the rationale for the RSPB's position, which is that increasing turbine draft heights reduces the risk of collisions, since the density of flying seabirds decreases with increasing altitude.

4. However, increasing draft height has potentially significant technical and commercial implications affecting, and most likely reducing, the range of options available to the project. In addition, for the purposes of maintaining air defence radar coverage requirements, significant restrictions have been placed on turbine height as set out in requirement 33 of the draft Order. This requires that mitigation will be required in agreement with the MOD should EATL wish to construct turbines of a height greater than that permitted in each of the areas identified. Therefore the commercial and defence implications must be balanced against East Anglia THREE's small contribution to the cumulative collision totals and the small overall effect an increase in draft height would have on the total collision figures (using the modelling parameters advocated by Natural England).

5. Nonetheless, following careful consideration of the options available for increasing draft heights and balancing this against risk to the project, EATL has identified that an increase in draft height of 2m to 24m will be possible across 70% of the wind farm site. It is straightforward to recalculate the collision mortality for this design revision and it is not necessary to rerun the collision models. The update collision predictions have been calculated using the following steps:

    a. The percentage of flights at collision height (PCH) for both turbine heights was calculated for each species. Prior to submission of the ES, Natural

England advised that site specific data should be used for gannet and kittiwake as there were sufficient height observations for these species to generate robust estimates (251 and 208, respectively). There were fewer observations of lesser black-backed gull, great black-backed gull and herring gull (11, 38 and 29, respectively). Therefore generic flight height data were used for these species (Johnston et al. 2014).

b. To calculate PCH for gannet and kittiwake at the two draft heights, the observed numbers of birds recorded flying at 22m or higher and 24m or higher were divided by the total number of birds for which flight height was estimated.

c. For lesser black-backed gull, great black-backed gull and herring gull the PCH for the two draft heights were extracted from the generic height data in Johnston et al. (2014).

d. The original collision mortality estimates (EATL 2015) were split to represent the 30:70 ratio of differential turbine heights. The smaller number (30%) is the predicted mortality for the lower draft height turbines as per the original modelling. The larger number (70%) was multiplied by the ratio of the two PCH values (i.e. the PCH at 24m divided by the PCH at 22m) to obtain the revised collision risk for the higher turbines. The two mortality values were then summed to give the overall collision mortality for the wind farm with 30% of turbines with a draft height of 22m and 70% with a draft height of 24m.

6. The calculations for the updated collision risk estimates are presented in Table 1.

Table 1. Updated collision risk calculations for increased draft height for 70% of turbines at East Anglia THREE.

Species	Band model option	PCH @ 22m	PCH @ 24m	Ratio of PCH	ES annual CRM	30% ES CRM	70% ES CRM x PCH ratio	Summed CRM (30% @ 22m + 70% @ 24m)	Reduction in annual CRM
Gannet	1	6.77	5.58	0.824	56	17	32	49	7
Kittiwake	1	10.10	6.73	0.667	146	44	68	112	34
Lesser black-backed gull	2	23.91	21.05	0.880	10	3	6	9	1
Herring gull	2	27.73	24.76	0.893	26	8	16	24	2
Great black-backed gull	2	29.97	26.93	0.898	42	13	26	39	3

7. Increasing the draft height by 2m across 70% of the wind farm reduces the predicted annual collisions at East Anglia THREE by the following amounts: gannet – 7, kittiwake – 34, lesser black-backed gull – 1, great black-backed gull – 3, herring gull - 2. These updated estimates have been included in the cumulative

totals presented in subsequent sections of this document (Tables 7, 8, 9, A2.1, A2.2, A2.3, A2.4 and A2.5).

2 East Anglia ONE Collision Risk Update

8. Offshore wind farm collision risk assessments presented in Environmental Statements (ES) use the worst case scenario (WCS) wind farm design parameters in order to ensure that the highest mortality estimates are assessed. Following planning consent, offshore wind farm developers often take advantage of technological progress in turbine design which enables the same generating capacity to be achieved with fewer installed turbines. This typically results in a reduction in the number of predicted collisions, although the magnitude of reduction is dependent on both the change in number of turbines and also their specification (i.e. rotor diameter, etc.).

9. Since cumulative collision mortality has become a key consenting challenge for offshore wind farms, it is clearly beneficial to the assessment process if the collision mortality estimates for wind farms included in the cumulative totals reflect final wind farm designs rather than the WCSs presented in the respective assessments.

10. The challenge to updating the collision assessments for other wind farms to account for these design changes, particularly for wind farms which have been consented but not constructed, is in obtaining the necessary turbine parameter information (for the modelling) and also commitment from the developers that these represent the final designs. In the absence of these commitments statutory nature conservation advisors (SNCAs e.g. Natural England) consider the WCS estimates to be the only reliable figures which can be used (whilst acknowledging that this is a precautionary approach).

11. The East Anglia THREE cumulative collision risk assessment used consented (WCS) estimates for other North Sea wind farms, as agreed with Natural England. One of the other sites included in the assessment was East Anglia ONE, which is located to the south of East Anglia THREE and was consented in 2014. The consented wind farm was for up to 240 turbines and a generating capacity of 1,200MW. Following successful award of a Contract for Difference (CfD) from the UK Government for an installed capacity of 714MW the number of turbines has been reduced to 102. Because this wind farm is also being developed by ScottishPower Renewables, both the turbine design specifications and a commitment that this will be the final design and no further development will occur within the East Anglia ONE site (under this consent) are available to inform the East Anglia THREE cumulative collision assessment.

12. This note provides updated collision risk estimates for the East Anglia ONE wind farm for the following five species: gannet, kittiwake, lesser black-backed gull, great black-backed gull and herring gull. The updated East Anglia ONE estimates

are presented alongside the previous values (Band model outputs are provided in Appendix 1). Cumulative totals up to and including East Anglia THREE are also included to show how the update affects the estimated cumulative mortality (full cumulative tables including the East Anglia ONE update are provided in Appendix 2).

13. Following a request from the Examining Authority (second written questions, ECO17), collision estimates have also been calculated for East Anglia ONE for the non-material change consented by the Secretary of State decision which reduced the consented EA ONE turbine number to 150. Apart from the number of turbines, all other model parameters were the same as those presented in Tables 2, 3 and 4 (note 'final' turbine values were used). These estimates are presented in Appendix 3.

14. Note that East Anglia ONE Ltd (EAOL) intends to construct the East Anglia ONE project commencing in 2017. EAOL wrote to the SoS for Business, Energy and Industrial Strategy on 16th September 2016 to confirm that the project would be constructed using High Voltage Alternating Current technology based on 102 x 7 megawatt turbines. On providing this notification EAOL loses the right to construct the project using HVDC technology at up to 1200 megawatts in capacity. This officially confirms the project will be 714 megawatts in capacity using 7 megawatt turbines. Based on this, installation of 150 turbines could never be realised within the terms of the East Anglia ONE Order. It is also worthy of note that EAOL has a Contract for Difference for 714 megawatts, so there is no incentive to seek to install turbines beyond this capacity.

2.1 Methods

15. Turbine specifications were provided by East Anglia ONE (Table 2). The seabird input data for the collision modelling (Tables 3 and 4) were taken from APEM (2015) which was included in Appendix 13.1 of the East Anglia THREE Ornithology Assessment (EATL 2015a; document reference 6.3.13 (1)). The collision risk tables (Tables 5 and 6) present the East Anglia ONE collision risks obtained using Band Options 1 and 2. Copies of the CRM spreadsheets showing the calculations are supplied for the Option 1 outputs (Appendix 1) as these are the estimates used in the East Anglia THREE cumulative assessment.

Table 2. East Anglia ONE turbine specifications used in the collision risk modelling: consented and final.

Parameter	Consented value	Final value
No. of turbines	240	102
RPM	11	10.3
Rotor radius (m)	67.5	77
Max blade width (m)	4.8	5
Blade pitch (degrees)	15	15

Table 3. Species biometrics used in the East Anglia ONE collision risk modelling (from APEM 2015).

Species	Body length (m)	Wingspan (m)	Flight speed (ms^{-1})	Nocturnal activity factor (1 to 5)	Flight type	Proportion of flights at potential collision height
Gannet	0.94	1.72	14.9	2	Gliding	25.17
Kittiwake	0.39	1.08	13.1	3	Flapping	21.27
Lesser black-backed gull	0.58	1.42	13.1	3	Flapping	26.30
Herring gull	0.60	1.44	12.8	3	Flapping	29.38
Great black-backed gull	0.71	1.58	13.7	3	Flapping	23.33

Table 4. Seabird monthly density estimates (birds per km^2) used in the East Anglia ONE collision risk modelling and predicted monthly wind farm operational percentage.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Gannet	0.01611	0	0.0183	0	0	0	0	0.036111	0.057778	0.285584	1.451732	0.054583
Kittiwake	0.34643	0.20967	0.2594	0	0	0	0.019412	0	0	0.031974	1.628344	1.204574
Lesser black-backed gull	0.23464	0.0287	0.0114	0	0.014821	0	0.111784	0	0.073323	0.206373	0.392022	0.005461
Herring gull	0.04241	0.04475	0.0264	0	0.00974	0	0	0	0.023203	0	0.42306	0.112566
Great black-backed gull	0	0.022	0.0825	0	0	0.024167	0.000833	0	0.018626	0.000755	1.165847	0.0275
Wind Farm Operational time	95.23	93.65	92.30	91.04	91.78	88.86	90.00	89.60	92.20	94.29	95.40	95.03

2.2 Results

16. The monthly and annual collision mortality for the five species modelled at East Anglia ONE, estimated with species specific avoidance rates (and ranges as advised by Natural England) using Band Model Options 1 and 2 are provided in Tables 5 and 6.

Table 5. Seabird collision mortality at East Anglia ONE using Band Option 1. Monthly and annual values calculated for the updated wind farm design (Table 2) with annual total for the consented design included for comparison. Bird densities and biometrics from Tables 3 and 4.

Species	Avoidance rate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual total	Original annual total
Gannet	98.7	1	0	1	0	0	0	0	3	4	19	83	3	**113**	251
	98.9	1	0	1	0	0	0	0	2	3	16	70	3	**96**	213
	99.1	1	0	1	0	0	0	0	2	3	13	57	2	**78**	174
Kittiwake	98.7	16	9	13	0	0	0	1	0	0	2	73	54	**166**	371
	98.9	13	8	11	0	0	0	1	0	0	1	62	45	**141**	314
	99.1	11	6	9	0	0	0	1	0	0	1	50	37	**115**	257
Lesser black-backed gull	99.4	7	1	0	0	1	0	4	0	2	6	11	0	**33**	73
	99.5	6	1	0	0	0	0	3	0	2	5	9	0	**27**	61
	99.6	5	1	0	0	0	0	3	0	2	4	8	0	**22**	49
Herring gull	99.4	1	1	1	0	0	0	0	0	1	0	14	4	**22**	49
	99.5	1	1	1	0	0	0	0	0	1	0	11	3	**18**	41
	99.6	1	1	1	0	0	0	0	0	1	0	9	2	**15**	33
Great black-backed gull	99.4	0	1	3	0	0	1	0	0	1	0	33	1	**38**	85
	99.5	0	0	2	0	0	1	0	0	0	0	27	1	**32**	71
	99.6	0	0	2	0	0	1	0	0	0	0	22	1	**25**	57

Table 6. Seabird collision mortality at East Anglia ONE using Band Option 2. Monthly and annual values calculated for the updated wind farm design (Table 2) with annual total for the consented design included for comparison. Bird densities and biometrics from Tables 3 and 4.

Species	Avoidance rate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual total	Original annual total
Gannet	98.7	0	0	0	0	0	0	0	0	0	3	11	0	**15**	35
	98.9	0	0	0	0	0	0	0	0	0	2	9	0	**13**	29
	99.1	0	0	0	0	0	0	0	0	0	2	8	0	**11**	24
Kittiwake	98.7	3	2	3	0	0	0	0	0	0	0	16	12	**36**	79
	98.9	3	2	2	0	0	0	0	0	0	0	13	10	**30**	67
	99.1	2	1	2	0	0	0	0	0	0	0	11	8	**25**	55
Lesser black-backed gull	99.4	3	0	0	0	0	0	2	0	1	3	5	0	**15**	35
	99.5	3	0	0	0	0	0	1	0	1	3	4	0	**13**	29
	99.6	2	0	0	0	0	0	1	0	1	2	4	0	**11**	23
Herring gull	99.4	1	1	0	0	0	0	0	0	0	0	7	2	**12**	26
	99.5	0	0	0	0	0	0	0	0	0	0	6	2	**10**	22
	99.6	0	0	0	0	0	0	0	0	0	0	5	1	**8**	18
Great black-backed gull	99.4	0	0	2	0	0	0	0	0	0	0	25	0	**28**	64
	99.5	0	0	2	0	0	0	0	0	0	0	21	0	**24**	54
	99.6	0	0	1	0	0	0	0	0	0	0	17	0	**20**	43

17. For all species except herring gull, the reductions at East Anglia ONE exceed or match the mortalities estimated for the revised East Anglia THREE wind farm (including the reductions due to increasing draft height discussed in section 1 above; Note for herring gull the reduction at East Anglia ONE is one (1) less than the prediction at East Anglia THREE). Consequently this design update offsets the contributions from East Anglia THREE for these species (Table 7).

Table 7: Comparison of the consented and updated collision risk mortalities for East Anglia ONE with the collisions predicted for East Anglia THREE (ES estimates and revised estimates for the increase in draft height discussed above). Figures for East Anglia ONE were derived using Band model Option 1 and agreed avoidance rates. For all species the reduction in mortality at East Anglia ONE is greater than or the same as the mortality for the revised East Anglia THREE predictions (see section 1 above).

Species	East Anglia ONE			East Anglia THREE	
	Consented	Updated	**Reduction**	ES design	Updated design (see section 1 above)
Gannet	213	96	**-117**	56	49
Kittiwake	314	141	**-173**	146	112
Lesser black-backed gull	61	27	**-34**	10	9
Herring gull	41	18	**-23**	26	24
Great black-backed gull	71	32	**-39**	42	39

18. The cumulative annual totals for consented wind farms (i.e. up to and including Hornsea Project 2), using the original and updated East Anglia ONE mortality estimates are presented in Table 8, alongside the updated cumulative total including the revised East Anglia THREE estimates. Complete cumulative collision mortality tables for each species incorporating the updated East Anglia ONE estimates are provided in Appendix 2. Note that these tables are an update of the ones submitted at Deadline 2 (EATL 2016), with the addition of herring gull.

Table 8: Comparison of the cumulative collision risk for consented projects (up to and including Hornsea Project 2) with the consented mortality for East Anglia ONE, the updated mortality for East Anglia ONE and the updated cumulative total including the revised East Anglia THREE estimates (see section 1 above). See Appendix 2 for individual wind farm estimates.

Species	Cumulative consented total up to Hornsea Project 2		Updated cumulative total including revised East Anglia THREE estimates
	With consented East Anglia ONE estimates	With updated East Anglia ONE estimates	
Gannet	2942	2825	2874
Kittiwake	3507	3334	3447
Lesser black-backed gull	499	465	475
Great black-backed gull	840	801	840
Herring gull	701	678	701

19. For gannet, kittiwake and lesser black-backed gull the updated cumulative totals including East Anglia THREE are lower than the most recent previously consented cumulative totals (for the Hornsea Project 2 Wind Farm), despite the additional wind farm. For herring gull and great black-backed gull the updated cumulative totals are the same as the previously consented totals.

20. A similar situation can be seen for the in-combination mortality of gannet and kittiwake from the Flamborough and Filey Coast pSPA (FFC; Table 9). The updated in-combination gannet mortality is unchanged from the previously consented total, while that for kittiwake is slightly reduced (by 2) from the consented total.

Table 9: Comparison of the in-combination collision risk for the FFC pSPA populations of gannet and kittiwake for consented projects (up to and including Hornsea Project 2) with the consented mortality for East Anglia ONE, the updated mortality for East Anglia ONE and the updated in-combination total up to and including the revised East Anglia THREE estimates (see section 1 above). East Anglia THREE mortalities at FFC have been updated for the increase in draft height as detailed in section 1 above.

Species	In-combination consented total up to Hornsea Project 2		In-combination consented total up to and including revised East Anglia THREE estimates
	With consented East Anglia ONE estimates	With updated East Anglia ONE estimates	
Gannet	173	165	173
Kittiwake	322	312	320

2.3 Note on cumulative collision totals in relation to previous estimates

21. Natural England (2016) provided comments on a previous version of this report (EATL 2016) in which they accepted the key point that the collision mortality for East Anglia THREE was largely offset by the reductions at East Anglia ONE (subject to the design changes on which it is based being legally binding). However, in Natural England (2016) it was also noted that there were differences between the cumulative totals presented in EATL (2016) compared with those in previous assessments. The following sections provide an explanation of the source of these differences.

22. Firstly, in Natural England (2016) it was noted that there were differences in the totals presented in the previous iteration of this document when compared with those in the East Anglia THREE ES (EATL 2015b). However, the ES figures to which this refers were superseded in a project update (EATL 2016; for gannet, kittiwake, lesser black-backed gull and great black-backed gull). This update was required to take into account revisions to the Hornsea Project Two Wind Farm which were reported after the East Anglia THREE ES was submitted. Thus, this discrepancy noted by Natural England (2016) related to out of date values which had been revised. Furthermore, aside from the updates to East Anglia ONE and East Anglia THREE collision estimates discussed in the current note, there are no discrepancies between the cumulative totals in EATL (2016) and those provided in the current document (and the previous iteration of this note which Natural England reviewed).

23. It should be noted that the current note also provides an update of the cumulative mortality presented for herring gull in EATL (2015b). It was not necessary to update this species in EATL (2016) because there was no update to the Hornsea Project Two figures. Following the design updates for East Anglia ONE and East Anglia THREE discussed in this note, the cumulative totals for this species have been updated (Appendix 2, Table A2.5). This table replaces Table 13.48 – Cumulative Collision Risk for Herring Gull in the ES.

24. The second discrepancy noted by Natural England (2016) was between the cumulative totals in the previous iteration of this note and those accepted by Natural England at the end of the Hornsea Project Two examination. As noted in Natural England (2016), it is difficult to determine the source of differences because a full list of individual projects was not presented in the Memorandum of Understanding at the end of the Hornsea Project Two examination (or the previous iteration of the current note). However, if it is assumed that the list of projects assessed for Hornsea Project Two remained the same at the conclusion of the examination as was used in the project's ES (SmartWind 2015b), the following projects which are included in the East Anglia THREE assessment were not included for Hornsea Project Two:

- Beatrice Demonstrator
- Gunfleet Sands
- Lynn and Inner Dowsing
- Scroby Sands
- Rampion

25. For the first four of these wind farms (i.e. all except Rampion) the mortality estimates for all species are small (<5) or zero and thus this creates minimal differences. However, the collision estimates for Rampion are much larger for most species (e.g. annual mortalities for gannet: 102; kittiwake: 121; lesser black-backed gull: 8; great black-backed gull: 26; herring gull: 155). Therefore this is likely to account for at least some of the difference referred to by Natural England.

26. There also appear to be other differences in the cumulative figures presented for the two projects which are harder to identify. For example, the Hornsea Project Two cumulative assessment included attempts to account for revised wind farm designs in their assessment, but it is not always straightforward to determine if these estimated values were used in the assessment or provided for information.

27. In order that the values used for the East Anglia THREE cumulative assessment can be fully scrutinised, the full tables and source references are included in Appendix 2 of this note (including the updated East Anglia ONE and East Anglia THREE values). These tables should also provide the starting point for subsequent cumulative assessments.

28. The same comment (about discrepancies) was made in Natural England (2016) in relation to the in-combination totals attributed to the Flamborough and Filey Coast pSPA populations of gannet and kittiwake. The causes for these differences are the same as for the cumulative totals discussed above (i.e. revised cumulative tables and different selections of wind farms for inclusion).

2.4 Conclusion

29. This note presents updated collision mortality estimates for the East Anglia ONE wind farm derived using parameters for the final wind farm design and East Anglia THREE for an increase in draft height. The change in the design at East Anglia ONE, compared with the consented project, has considerably reduced the project's collision risk and hence also the cumulative total. The consequence of this is that for three out of the five species considered most at risk of collisions at the East Anglia THREE wind farm (gannet, kittiwake and lesser black-backed gull) the updated cumulative mortality totals are now lower than those assessed for the most recently consented wind farm (Hornsea Project 2) even with the inclusion of East Anglia THREE. For herring

gull and great black-backed gull the reductions are not quite as large, however the cumulative totals with the inclusion of East Anglia THREE have remained unchanged from the previously consented totals (for Hornsea Project 2).

30. It is also informative to note that similar reductions in collision mortality are likely to result from changes in wind farm design at other consented but not constructed wind farms in the North Sea which are included in the cumulative and in-combination totals. This could include up to 12 sites (Firth of Forth Alpha and Bravo, Hornsea Project One and Two, Inch Cape, Moray Firth, Neart na Gaoithe, Beatrice, Race Bank, Rampion, Dogger Bank Creyke Beck A & B and Teesside A & B and Triton Knoll). Together these wind farms are predicted to cause 2,400 gannet collisions per year, 80% of the cumulative total. If mortality at these wind farms was halved (i.e. as seen at East Anglia ONE) the cumulative total would be reduced from 2,874 to 1,674, which is less than 60% of the current total.

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Appendix 1 - Band CRM outputs for the updated East Anglia ONE wind farm

Gannet

COLLISION RISK ASSESSMENT			used in overall collision risk sheet								used in available hours sheet			
Sheet 1 - Input data			used in migrant collision risk sheet								used in large array correction sheet			
			used in single transit collision risk sheet or extended model								not used in calculation but stated for reference			
	Units	**Value**		**Data sources**										
Bird data														
Species name		**Gannet**												
Bird length	m	0.94												
Wingspan	m	1.72												
Flight speed	m/sec	14.9												
Nocturnal activity factor (1-5)		2												
Flight type, flapping or gliding		gliding												
				Data sources										
Bird survey data			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daytime bird density	birds/sq km		0.01611	0	0.0183	0	0	0	0	0.03611	0.05778	0.28558	1.45173	0.054583
Proportion at rotor height	%	25.2%												
Proportion of flights upwind	%	50.0%												
				Data sources										
Birds on migration data														
Migration passages	birds		0	0	0	0	0	0	0	0	0	0	0	0
Width of migration corridor	km	8												
Proportion at rotor height	%	25%												
Proportion of flights upwind	%	50.0%												
	Units	**Value**		**Data sources**										
Windfarm data														
Name of windfarm site		**EA ONE**												
Latitude	degrees	52.67												
Number of turbines		102												
Width of windfarm	km	33.25												
Tidal offset	m	0												
	Units	**Value**		**Data sources**										
Turbine data														
Turbine model		**7MW turbine**												
No of blades		3												
Rotation speed	rpm	10.3												
Rotor radius	m	77												
Hub height	m	99.65	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly proportion of time operational	%		95%	94%	92%	91%	92%	89%	90%	90%	92%	94%	95%	95%
Max blade width	m	5.000												
Pitch	degrees	15												
Avoidance rates used in presenting results				**Data sources (if applicable)**										
		98.70%												
		98.90%												
		99.10%												

COLLISION RISK ASSESSMENT																		
Sheet 2 - Overall collision risk			**All data input on Sheet 1:**						from Sheet 1 - input data									
			no data entry needed on this sheet!						from Sheet 6 - available hours									
Bird details:									from Sheet 3 - single transit collision risk									
	Species		Gannet						from survey data									
	Flight speed	m/sec	14.9						calculated field									
	Nocturnal activity factor (1-5)		2															
	Nocturnal activity (% of daytime)		25%															
Windfarm data:																		
	Latitude	degrees	52.7															
	Number of turbines		102															
	Rotor radius	m	77															
	Minimum height of rotor	m	99.65															
	Total rotor frontal area	sq m	1899903															
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**year average**		
	Proportion of time operational	%		95%	94%	92%	91%	92%	89%	90%	90%	92%	94%	95%	95%	92.4%		
Stage A - flight activity																		
	Daytime areal bird density	birds/sq km		0.01611	0	0.0183	0	0	0	0	0.036111	0.057778	0.285584	1.451732	0.054583			
	Proportion at rotor height	%	25.2%															
	Total daylight hours per month	hrs		255	275	367	417	488	503	506	457	382	331	264	240			
	Total night hours per month	hrs		489	397	377	303	256	217	238	287	338	413	456	504			
	Flux factor			4022	0	5582	0	0	0	0	12630	17839	82049	363020	13212			
Option 1 -Basic model - Stages B, C and D																**per annum**		
	Potential bird transits through rotors			1012	0	1405	0	0	0	0	3179	4490	20652	91372	3325	**125435**		
	Collision risk for single rotor transit	(from sheet 3)	7.3%															
	Collisions for entire windfarm, allowing for non-op time, assuming no avoidance	birds per month or year		**71**	**0**	**95**	**0**	**0**	**0**	**0**	**208**	**303**	**1424**	**6376**	**231**	**8708**		
Option 2-Basic model using proportion from flight distribution				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
Option 3-Extended model using flight height distribution																		
	Proportion at rotor height	(from sheet 4)	0.0%															
	Potential bird transits through rotors	Flux integral	0.0457	184	0	255	0	0	0	0	577	815	3748	16583	604	**22766**		
	Collisions assuming no avoidance	Collision integral	0.00212	**8**	**0**	**11**	**0**	**0**	**0**	**0**	**24**	**35**	**164**	**733**	**27**	**1001**		
	Average collision risk for single rotor transit		4.6%															
Stage E - applying avoidance rates																		
	Using which of above options?	**Option 1**	0.00%	71	0	95	0	0	0	0	208	303	1424	6376	231	**8708**		
Collisions assuming avoidance rate		birds per month or year	0.00%	71	0	95	0	0	0	0	208	303	1424	6376	231	**8708**		
			98.70%	1	0	1	0	0	0	0	3	4	19	83	3	**113**		
			98.90%	1	0	1	0	0	0	0	2	3	16	70	3	**96**		
			99.10%	1	0	1	0	0	0	0	2	3	13	57	2	**78**		
Collisions after applying large array correction			0.00%	70	0	94	0	0	0	0	206	299	1408	6304	229	**8610**		
			98.70%	1	0	1	0	0	0	0	3	4	19	83	3	**113**		
			98.90%	0.8	0.0	1.0	0.0	0.0	0.0	0.0	2.3	3.3	15.7	70.1	2.5	**96**		
			99.10%	1	0	1	0	0	0	0	2	3	13	57	2	**78**		

Kittiwake

COLLISION RISK ASSESSMENT			used in overall collision risk sheet								used in available hours sheet				
Sheet 1 - Input data			used in migrant collision risk sheet								used in large array correction sheet				
			used in single transit collision risk sheet or extended model								not used in calculation but stated for reference				
	Units	**Value**		**Data sources**											
Bird data															
Species name		**Kittiwake**													
Bird length	m	0.39													
Wingspan	m	1.08													
Flight speed	m/sec	13.1													
Nocturnal activity factor (1-5)		3													
Flight type, flapping or gliding		flapping													
				Data sources											
Bird survey data			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daytime bird density	birds/sq km		0.34643	0.20967	0.2594	0	0	0	0.01941	0	0	0.03197	1.62834	1.204574	
Proportion at rotor height	%	21.3%													
Proportion of flights upwind	%	50.0%													
				Data sources											
Birds on migration data															
Migration passages	birds		0	0	0	0	0	0	0	0	0	0	0	0	
Width of migration corridor	km	8													
Proportion at rotor height	%	25%													
Proportion of flights upwind	%	50.0%													
	Units	**Value**		**Data sources**											
Windfarm data															
Name of windfarm site		**EA ONE**													
Latitude	degrees	52.67													
Number of turbines		102													
Width of windfarm	km	33.25													
Tidal offset	m	0													
	Units	**Value**		**Data sources**											
Turbine data															
Turbine model		**7MW turbine**													
No of blades		3													
Rotation speed	rpm	10.3													
Rotor radius	m	77													
Hub height	m	99.65	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly proportion of time operational	%		95%	94%	92%	91%	92%	89%	90%	90%	92%	94%	95%	95%	
Max blade width	m	5.000													
Pitch	degrees	15													
Avoidance rates used in presenting results				**Data sources (if applicable)**											
		98.70%													
		98.90%													
		99.10%													

COLLISION RISK ASSESSMENT																	
Sheet 2 - Overall collision risk			**All data input on Sheet 1:**								from Sheet 1 - input data						
			no data entry needed on this sheet!								from Sheet 6 - available hours						
Bird details:											from Sheet 3 - single transit collision risk						
	Species		Kittiwake								from survey data						
	Flight speed	m/sec	13.1								calculated field						
	Nocturnal activity factor (1-5)		3														
	Nocturnal activity (% of daytime)		50%														
Windfarm data:																	
	Latitude	degrees	52.7														
	Number of turbines		102														
	Rotor radius	m	77														
	Minimum height of rotor	m	99.65														
	Total rotor frontal area	sq m	1899903														
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		**year average**
	Proportion of time operational	%		95%	94%	92%	91%	92%	89%	90%	90%	92%	94%	95%	95%		92.4%
Stage A - flight activity																	
	Daytime areal bird density	birds/sq km		0.34643	0.20967	0.2594	0	0	0	0.019412	0	0	0.031974	1.628344	1.204574		
	Proportion at rotor height	%	21.3%														
	Total daylight hours per month	hrs		255	275	367	417	488	503	506	457	382	331	264	240		
	Total night hours per month	hrs		489	397	377	303	256	217	238	287	338	413	456	504		
	Flux factor			100682	57786	83803	0	0	0	7060	0	0	9998	466037	344705		
Option 1 -Basic model - Stages B, C and D																	**per annum**
	Potential bird transits through rotors			21415	12291	17825	0	0	0	1502	0	0	2127	99126	73319		**227604**
	Collision risk for single rotor transit	(from sheet 3)	5.9%														
	Collisions for entire windfarm, allowing for non-op time, assuming no avoidance	birds per month or year		**1209**	**682**	**975**	**0**	**0**	**0**	**80**	**0**	**0**	**119**	**5606**	**4130**		**12802**
Option 2-Basic model using proportion from flight distribution				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		**0**
Option 3-Extended model using flight height distribution																	
	Proportion at rotor height	(from sheet 4)	0.0%														
	Potential bird transits through rotors	Flux integral	0.0457	4599	2640	3828	0	0	0	323	0	0	457	21289	15747		**48883**
	Collisions assuming no avoidance	Collision integral	0.00141	**135**	**76**	**109**	**0**	**0**	**0**	**9**	**0**	**0**	**13**	**627**	**462**		**1431**
	Average collision risk for single rotor transit		3.1%														
Stage E - applying avoidance rates																	
	Using which of above options?	**Option 1**	0.00%	1209	682	975	0	0	0	80	0	0	119	5606	4130		**12802**
Collisions assuming avoidance rate		birds per month or year	0.00%	1209	682	975	0	0	0	80	0	0	119	5606	4130		**12802**
			98.70%	16	9	13	0	0	0	1	0	0	2	73	54		**166**
			98.90%	13	8	11	0	0	0	1	0	0	1	62	45		**141**
			99.10%	11	6	9	0	0	0	1	0	0	1	50	37		**115**
Collisions after applying large array correction			0.00%	1198	676	966	0	0	0	79	0	0	118	5555	4093		**12685**
			98.70%	16	9	13	0	0	0	1	0	0	2	73	54		**166**
			98.90%	13.3	7.5	10.7	0.0	0.0	0.0	0.9	0.0	0.0	1.3	61.7	45.4		**140.8**
			99.10%	11	6	9	0	0	0	1	0	0	1	50	37		**115**

Lesser black-backed gull

COLLISION RISK ASSESSMENT			used in overall collision risk sheet							used in available hours sheet					
Sheet 1 - Input data			used in migrant collision risk sheet							used in large array correction sheet					
			used in single transit collision risk sheet or extended model							not used in calculation but stated for reference					
	Units	**Value**		**Data sources**											
Bird data															
Species name		**Lesser black-backed gull**													
Bird length	m	0.58													
Wingspan	m	1.42													
Flight speed	m/sec	13.1													
Nocturnal activity factor (1-5)		3													
Flight type, flapping or gliding		flapping													
				Data sources											
Bird survey data			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daytime bird density	birds/sq km		0.23464	0.0287	0.0114	0	0.01482	0	0.11178	0	0.07332	0.20637	0.39202	0.005461	
Proportion at rotor height	%	26.3%													
Proportion of flights upwind	%	50.0%													
				Data sources											
Birds on migration data															
Migration passages	birds		0	0	0	0	0	0	0	0	0	0	0	0	
Width of migration corridor	km	8													
Proportion at rotor height	%	25%													
Proportion of flights upwind	%	50.0%													
	Units	**Value**		**Data sources**											
Windfarm data															
Name of windfarm site		**EA ONE**													
Latitude	degrees	52.67													
Number of turbines		102													
Width of windfarm	km	33.25													
Tidal offset	m	0													
	Units	**Value**		**Data sources**											
Turbine data															
Turbine model		**7MW turbine**													
No of blades		3													
Rotation speed	rpm	10.3													
Rotor radius	m	77													
Hub height	m	99.65	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly proportion of time operational	%		95%	94%	92%	91%	92%	89%	90%	90%	92%	94%	95%	95%	
Max blade width	m	5.000													
Pitch	degrees	15													
Avoidance rates used in presenting results				**Data sources (if applicable)**											
		99.40%													
		99.50%													
		99.60%													

COLLISION RISK ASSESSMENT																		
Sheet 2 - Overall collision risk			**All data input on Sheet 1:**								from Sheet 1 - input data							
			no data entry needed on this sheet!								from Sheet 6 - available hours							
Bird details:											from Sheet 3 - single transit collision risk							
	Species	Lesser black-backed gull									from survey data							
	Flight speed	m/sec	13.1								calculated field							
	Nocturnal activity factor (1-5)		3															
	Nocturnal activity (% of daytime)		50%															
Windfarm data:																		
	Latitude	degrees	52.7															
	Number of turbines		102															
	Rotor radius	m	77															
	Minimum height of rotor	m	99.65															
	Total rotor frontal area	sq m	1899903															
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**year average**		
	Proportion of time operational	%		95%	94%	92%	91%	92%	89%	90%	90%	92%	94%	95%	95%	92.4%		
Stage A - flight activity																		
	Daytime areal bird density	birds/sq km		0.23464	0.0287	0.0114	0	0.014821	0	0.111784	0	0.073323	0.206373	0.392022	0.005461			
	Proportion at rotor height	%	26.3%															
	Total daylight hours per month	hrs		255	275	367	417	488	503	506	457	382	331	264	240			
	Total night hours per month	hrs		489	397	377	303	256	217	238	287	338	413	456	504			
	Flux factor			68193	7910	3683	0	5312	0	40656	0	23507	64530	112198	1563			
Option 1 -Basic model - Stages B, C and D																**per annum**		
	Potential bird transits through rotors			17935	2080	969	0	1397	0	10693	0	6182	16971	29508	411	**86146**		
	Collision risk for single rotor transit	(from sheet 3)	6.7%															
	Collisions for entire windfarm, allowing for non-op time, assuming no avoidance	birds per month or year		**1146**	**131**	**60**	**0**	**86**	**0**	**646**	**0**	**383**	**1074**	**1890**	**26**	**5442**		
Option 2-Basic model using proportion from flight distribution				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
Option 3-Extended model using flight height distribution																		
	Proportion at rotor height	(from sheet 4)	0.0%															
	Potential bird transits through rotors	Flux integral	0.0457	3115	361	168	0	243	0	1857	0	1074	2948	5125	71	**14963**		
	Collisions assuming no avoidance	Collision integral	0.00141	**92**	**10**	**5**	**0**	**7**	**0**	**52**	**0**	**31**	**86**	**151**	**2**	**434**		
	Average collision risk for single rotor transit		3.1%															
Stage E - applying avoidance rates																		
	Using which of above options?	**Option 1**	0.00%	1146	131	60	0	86	0	646	0	383	1074	1890	26	**5442**		
Collisions assuming avoidance rate		birds per month or year	0.00%	1146	131	60	0	86	0	646	0	383	1074	1890	26	**5442**		
			99.40%	7	1	0	0	1	0	4	0	2	6	11	0	**33**		
			99.50%	6	1	0	0	0	0	3	0	2	5	9	0	**27**		
			99.60%	5	1	0	0	0	0	3	0	2	4	8	0	**22**		
Collisions after applying large array correction			0.00%	1135	129	59	0	85	0	639	0	379	1063	1870	26	**5386**		
			99.40%	7	1	0	0	1	0	4	0	2	6	11	0	**33**		
			99.50%	5.7	0.7	0.3	0.0	0.4	0.0	3.2	0.0	1.9	5.4	9.4	0.1	**27.2**		
			99.60%	5	1	0	0	0	0	3	0	2	4	8	0	**22**		

Great black-backed gull

COLLISION RISK ASSESSMENT			used in overall collision risk sheet								used in available hours sheet			
Sheet 1 - Input data			used in migrant collision risk sheet								used in large array correction sheet			
			used in single transit collision risk sheet or extended model								not used in calculation but stated for re			
	Units	Value		Data sources										
Bird data														
Species name		Great black-backed gull												
Bird length	m	0.71												
Wingspan	m	1.58												
Flight speed	m/sec	13.7												
Nocturnal activity factor (1-5)		3												
Flight type, flapping or gliding		flapping												
				Data sources										
Bird survey data			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daytime bird density	birds/sq km		0	0.022	0.0825	0	0	0.02417	0.00083	0	0.01863	0.00076	1.16585	0.0275
Proportion at rotor height	%	23.3%												
Proportion of flights upwind	%	50.0%												
				Data sources										
Birds on migration data														
Migration passages	birds		0	0	0	0	0	0	0	0	0	0	0	0
Width of migration corridor	km	8												
Proportion at rotor height	%	25%												
Proportion of flights upwind	%	50.0%												
	Units	Value		Data sources										
Windfarm data														
Name of windfarm site		EA ONE												
Latitude	degrees	52.67												
Number of turbines		102												
Width of windfarm	km	33.25												
Tidal offset	m	0												
	Units	Value		Data sources										
Turbine data														
Turbine model		7MW turbine												
No of blades		3												
Rotation speed	rpm	10.3												
Rotor radius	m	77												
Hub height	m	99.65	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly proportion of time operational	%		95%	94%	92%	91%	92%	89%	90%	90%	92%	94%	95%	95%
Max blade width	m	5.000												
Pitch	degrees	15												
Avoidance rates used in presenting results				Data sources (if applicable)										
		99.40%												
		99.50%												
		99.60%												

COLLISION RISK ASSESSMENT																		
Sheet 2 - Overall collision risk			**All data input on Sheet 1:**						from Sheet 1 - input data									
			no data entry needed on this sheet!						from Sheet 6 - available hours									
Bird details:									from Sheet 3 - single transit collision risk									
	Species	Great black-backed gull							from survey data									
	Flight speed	m/sec	13.7						calculated field									
	Nocturnal activity factor (1-5)		3															
	Nocturnal activity (% of daytime)		50%															
Windfarm data:																		
	Latitude	degrees	52.7															
	Number of turbines		102															
	Rotor radius	m	77															
	Minimum height of rotor	m	99.65															
	Total rotor frontal area	sq m	1899903															
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			**year average**
	Proportion of time operational	%		95%	94%	92%	91%	92%	89%	90%	90%	92%	94%	95%	95%			92.4%
Stage A - flight activity																		
	Daytime areal bird density	birds/sq km		0	0.022	0.0825	0	0	0.024167	0.000833	0	0.018626	0.000755	1.165847	0.0275			
	Proportion at rotor height	%	23.3%															
	Total daylight hours per month	hrs		255	275	367	417	488	503	506	457	382	331	264	240			
	Total night hours per month	hrs		489	397	377	303	256	217	238	287	338	413	456	504			
	Flux factor			0	6341	27873	0	0	8992	317	0	6245	247	348952	8230			
Option 1 -Basic model - Stages B, C and D																		**per annum**
	Potential bird transits through rotors			0	1479	6503	0	0	2098	74	0	1457	58	81410	1920			**94999**
	Collision risk for single rotor transit	(from sheet 3)	7.1%															
	Collisions for entire windfarm, allowing for non-op time, assuming no avoidance	birds per month or year		**0**	**98**	**424**	**0**	**0**	**132**	**5**	**0**	**95**	**4**	**5485**	**129**			**6371**
Option 2-Basic model using proportion from flight distribution				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			**0**
Option 3-Extended model using flight height distribution																		
	Proportion at rotor height	(from sheet 4)	0.0%															
	Potential bird transits through rotors	Flux integral	0.0457	0	290	1273	0	0	411	14	0	285	11	15941	376			**18602**
	Collisions assuming no avoidance	Collision integral	0.00175	**0**	**10**	**45**	**0**	**0**	**14**	**0**	**0**	**10**	**0**	**583**	**14**			**677**
	Average collision risk for single rotor transit		3.8%															
Stage E - applying avoidance rates																		
	Using which of above options?	**Option 1**	0.00%	0	98	424	0	0	132	5	0	95	4	5485	129			**6371**
Collisions assuming avoidance rate		birds per month or year	0.00%	0	98	424	0	0	132	5	0	95	4	5485	129			**6371**
			99.40%	0	1	3	0	0	1	0	0	1	0	33	1			**38**
			99.50%	0	0	2	0	0	1	0	0	0	0	27	1			**32**
			99.60%	0	0	2	0	0	1	0	0	0	0	22	1			**25**
Collisions after applying large array correction			0.00%	0	97	419	0	0	130	5	0	94	4	5426	127			**6302**
			99.40%	0	1	3	0	0	1	0	0	1	0	33	1			**38**
			99.50%	0.0	0.5	2.1	0.0	0.0	0.7	0.0	0.0	0.5	0.0	27.4	0.6			**31.9**
			99.60%	0	0	2	0	0	1	0	0	0	0	22	1			**25**

Herring gull

COLLISION RISK ASSESSMENT			used in overall collision risk sheet							used in available hours sheet			
Sheet 1 - Input data			used in migrant collision risk sheet							used in large array correction sheet			
			used in single transit collision risk sheet or extended model							not used in calculation but stated for re			
	Units	**Value**		**Data sources**									
Bird data													
Species name		**Herring gull**											
Bird length	m	0.60											
Wingspan	m	1.44											
Flight speed	m/sec	12.8											
Nocturnal activity factor (1-5)		3											
Flight type, flapping or gliding		flapping											
				Data sources									
Bird survey data			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daytime bird density	birds/sq km		0.04241	0.04475	0.0264	0	0.00974	0	0	0	0.0232	0	0.42306	0.112566
Proportion at rotor height	%	29.4%												
Proportion of flights upwind	%	50.0%												
				Data sources										
Birds on migration data														
Migration passages	birds		0	0	0	0	0	0	0	0	0	0	0	0
Width of migration corridor	km	8												
Proportion at rotor height	%	25%												
Proportion of flights upwind	%	50.0%												
	Units	**Value**		**Data sources**										
Windfarm data														
Name of windfarm site		**EA ONE**												
Latitude	degrees	52.67												
Number of turbines		102												
Width of windfarm	km	33.25												
Tidal offset	m	0												
	Units	**Value**		**Data sources**										
Turbine data														
Turbine model		**7MW turbine**												
No of blades		3												
Rotation speed	rpm	10.3												
Rotor radius	m	77												
Hub height	m	99.65	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly proportion of time operational	%		95%	94%	92%	91%	92%	89%	90%	90%	92%	94%	95%	95%
Max blade width	m	5.000												
Pitch	degrees	15												
Avoidance rates used in presenting results				**Data sources (if applicable)**										
		99.40%												
		99.50%												
		99.60%												

COLLISION RISK ASSESSMENT																	
Sheet 2 - Overall collision risk			**All data input on Sheet 1:**						from Sheet 1 - input data								
			no data entry needed on this sheet!						from Sheet 6 - available hours								
Bird details:									from Sheet 3 - single transit collision risk								
	Species		Herring gull						from survey data								
	Flight speed	m/sec	12.8						calculated field								
	Nocturnal activity factor (1-5)		3														
	Nocturnal activity (% of daytime)		50%														
Windfarm data:																	
	Latitude	degrees	52.7														
	Number of turbines		102														
	Rotor radius	m	77														
	Minimum height of rotor	m	99.65														
	Total rotor frontal area	sq m	1899903														
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**year average**	
	Proportion of time operational	%		95%	94%	92%	91%	92%	89%	90%	90%	92%	94%	95%	95%	92.4%	
Stage A - flight activity																	
	Daytime areal bird density	birds/sq km		0.04241	0.04475	0.0264	0	0.00974	0	0	0	0.023203	0	0.42306	0.112566		
	Proportion at rotor height	%	29.4%														
	Total daylight hours per month	hrs		255	275	367	417	488	503	506	457	382	331	264	240		
	Total night hours per month	hrs		489	397	377	303	256	217	238	287	338	413	456	504		
	Flux factor			12043	12051	8334	0	3411	0	0	0	7269	0	118308	31475		
Option 1 -Basic model - Stages B, C and D																**per annum**	
	Potential bird transits through rotors			3538	3541	2448	0	1002	0	0	0	2135	0	34759	9247	**56671**	
	Collision risk for single rotor transit	(from sheet 3)	6.9%														
	Collisions for entire windfarm, allowing for non-op time, assuming no avoidance	birds per month or year		**231**	**228**	**155**	**0**	**63**	**0**	**0**	**0**	**135**	**0**	**2277**	**603**	**3693**	
Option 2-Basic model using proportion from flight distribution				**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	
Option 3-Extended model using flight height distribution																	
	Proportion at rotor height	(from sheet 4)	0.0%														
	Potential bird transits through rotors	Flux integral	0.0457	550	551	381	0	156	0	0	0	332	0	5405	1438	**8812**	
	Collisions assuming no avoidance	Collision integral	0.00183	**21**	**21**	**14**	**0**	**6**	**0**	**0**	**0**	**12**	**0**	**206**	**55**	**334**	
	Average collision risk for single rotor transit		4.0%														
Stage E - applying avoidance rates																	
	Using which of above options?	**Option 1**	0.00%	231	228	155	0	63	0	0	0	135	0	2277	603	**3693**	
Collisions assuming avoidance rate		birds per month or year	0.00%	231	228	155	0	63	0	0	0	135	0	2277	603	**3693**	
			99.40%	1	1	1	0	0	0	0	0	1	0	14	4	**22**	
			99.50%	1	1	1	0	0	0	0	0	1	0	11	3	**18**	
			99.60%	1	1	1	0	0	0	0	0	1	0	9	2	**15**	
Collisions after applying large array correction			0.00%	229	225	154	0	63	0	0	0	134	0	2253	597	**3654**	
			99.40%	1	1	1	0	0	0	0	0	1	0	14	4	**22**	
			99.50%	1.2	1.1	0.8	0.0	0.3	0.0	0.0	0.0	0.7	0.0	11.4	3.0	**18.5**	
			99.60%	1	1	1	0	0	0	0	0	1	0	9	2	**15**	

Appendix 2 – Revised Cumulative and In-combination CRM for Gannet, Kittiwake, Lesser black-backed gull, Great black-backed gull and Herring gull

Table A2.1. Updated gannet collision risk. This table includes revised estimates for Hornsea Project Two and updated values for East Anglia ONE. Collisions have been apportioned to the Flamborough and Filey Coast pSPA in each season and summed for the year. The percentage apportioned in the breeding season has been calculated using the percentages presented in EATL (2015c).

Tier	Project	Breeding season			Post-breeding			Pre-breeding			Annual		Ref.*
		Total	% FFC pSPA	FFC pSPA	Total	% FFC pSPA	FFC pSPA	Total	% FFC pSPA	FFC pSPA	Total	FFC pSPA	
1	Beatrice Demonstrator	0.6	0	0.0	0.9	1.9	0.02	0.7	3.3	0.02	2.2	0.0	1
1	Greater Gabbard	14.0	0	0.0	8.8	4.2	0.37	4.8	5.6	0.27	27.5	0.6	2
1	Gunfleet Sands	0.0	0	0.0	0.0	4.2	0.00	0.0	5.6	0.00	0.0	0.0	1
1	Kentish Flats	1.4	0	0.0	0.8	4.2	0.03	1.1	5.6	0.06	3.3	0.1	1
1	Lincs	2.1	100	2.1	1.3	4.2	0.05	1.7	5.6	0.09	5.0	2.2	2
1	London Array	2.3	0	0.0	1.4	4.2	0.06	1.8	5.6	0.10	5.5	0.2	2
1	Lynn and Inner Dowsing	0.2	100	0.2	0.1	4.2	0.01	0.2	5.6	0.01	0.5	0.2	1
1	Scroby Sands	0.0	100	0.0	0.0	4.2	0.00	0.0	3.3	0.00	0.0	0.0	1
1	Sheringham Shoal	14.1	100	14.1	3.5	4.2	0.15	0.0	3.3	0.00	17.6	14.2	2
1	Teesside	4.9	50	2.4	1.7	1.5	0.03	0.0	5.6	0.00	6.7	2.5	2
1	Thanet	1.1	0	0.0	0.0	4.2	0.00	0.0	5.6	0.00	1.1	0.0	2
1	Humber Gateway	1.9	100	1.9	1.1	4.2	0.05	1.5	5.6	0.08	4.5	2.0	2
1	Westermost Rough	0.2	100	0.2	0.1	1.5	0.00	0.2	5.6	0.01	0.5	0.2	2
3	Beatrice	37.4	0	0.0	48.8	1.9	0.93	9.5	3.3	0.31	95.7	1.2	3
3	Blyth Demonstration Project	3.5	0	0.0	2.1	1.5	0.03	2.8	5.6	0.16	8.4	0.2	2
3	Dogger Bank Creyke Beck Projects A and B	5.6	50	2.8	6.6	1.5	0.10	4.3	5.6	0.24	16.5	3.1	4
3	Dudgeon	22.3	100	22.3	38.9	4.2	1.64	19.1	5.6	1.07	80.3	25.0	1
3	East Anglia ONE	2.3	100	2.3	89.1	4.2	3.74	4.3	5.6	0.24	96.0	6.3	6
3	EOWDC	4.2	0	0.0	5.1	1.8	0.09	0.1	3.4	0.00	9.3	0.1	2
3	Firth of Forth Alpha and Bravo	800.8	0	0.0	49.3	1.8	0.89	65.8	3.4	2.24	915.9	3.1	1
3	Galloper	18.1	0	0.0	30.9	4.2	1.30	12.6	5.6	0.71	61.6	2.0	2
3	Hornsea Project One	11.5	100	11.5	32.0	4.2	1.34	22.5	5.6	1.26	66.0	14.1	4
3	Inch Cape	336.9	0	0.0	29.2	1.8	0.53	5.2	3.4	0.18	371.3	0.7	2
3	Moray Firth (EDA)	80.6	0	0.0	35.4	1.9	0.67	8.9	3.3	0.29	124.9	1.0	1
3	Neart na Gaoithe	509.3	0	0.0	26.1	1.8	0.47	34.8	3.4	1.18	570.1	1.7	2
3	Race Bank	33.7	100	33.7	11.7	4.2	0.49	4.1	5.6	0.23	49.5	34.4	2
3	Rampion	36.2	0	0.0	63.5	4.2	2.67	2.1	5.6	0.12	101.8	2.8	1
3	Dogger Bank Teesside Projects A and B	14.8	50	7.4	10.1	1.5	0.15	10.8	5.6	0.61	35.7	8.1	4

Tier	Project	Breeding season			Post-breeding			Pre-breeding			Annual		Ref.*
		Total	% FFC pSPA	FFC pSPA	Total	% FFC pSPA	FFC pSPA	Total	% FFC pSPA	FFC pSPA	Total	FFC pSPA	
4	Triton Knoll	26.8	100	26.8	64.1	4.2	2.69	30.1	5.6	1.69	121.0	31.1	2
4	Hornsea Project Two	7.0	100	7.0	14.0	4.2	0.59	6.0	5.6	0.34	27.0	7.9	5
4	East Anglia THREE	6.1	100	6.1	33.3	4.2	1.40	9.6	5.6	0.54	49.0	8.1	6
	TOTAL	1999.6		140.8	610.1		20.5	264.5		12.0	2874.5	173.3	

*Data sources:

1. Natural England (2014)
2. SmartWind (2015c)
3. Beatrice Offshore Windfarm Ltd. (2013)
4. Forewind (2014)
5. SmartWind (2015a)
6. Current document

Table A2.2. Updated kittiwake collision risk. This table includes revised estimates for Hornsea Project Two and updated values for East Anglia ONE. Collisions have been apportioned to the Flamborough and Filey Coast pSPA in each season and summed for the year. The percentage apportioned in the breeding season has been calculated using the percentages presented in EATL (2015b; EA3 method) and also using the method presented in NE (2015; NE method) to assist comparison with the previous assessment for both wind farms. The annual total for FFC includes the breeding season estimates calculated using the EA3 method.

Tier	Project	Breeding season – EA3 method			Breeding season – NE method			Post-breeding			Pre-breeding			Annual		Ref.*
		Total	% FFC pSPA	FFC pSPA	Total	% FFC pSPA	FFC pSPA	Total	% FFC pSPA	FFC pSPA	Total	% FFC pSPA	FFC pSPA	Total	FFC pSPA	
1	Beatrice Demonstrator	0	16.8	0.0			0.0	2.1	5.4	0.11	1.7	7.2	0.12	4.95	0.2	1
1	Greater Gabbard	1.1	16.8	0.2			0.0	15	5.4	0.81	11.4	7.2	0.82	27.5	1.8	1
1	Gunfleet Sands	0	16.8	0.0			0.0	0	5.4	0.00	0	7.2	0.00	0	0.0	2
1	Kentish Flats	0	16.8	0.0			0.0	0.9	5.4	0.05	0.7	7.2	0.05	2.2	0.1	1
1	Lincs	0.70	16.8	0.1	0.92	100	0.9	1.16	5.4	0.06	0.69	7.2	0.05	2.75	0.2	1
1	London Array	1.4	16.8	0.2			0.0	2.3	5.4	0.12	1.8	7.2	0.13	5.5	0.5	1
1	Lynn and Inner Dowsing	0	16.8	0.0			0.0	0	5.4	0.00	0	7.2	0.00	0	0.0	2
1	Scroby Sands	0	16.8	0.0			0.0	0	5.4	0.00	0	7.2	0.00	0	0.0	2
1	Sheringham Shoal	0	16.8	0.0			0.0	0	5.4	0.00	0	7.2	0.00	0	0.0	2
1	Teesside	38.4	16.8	6.5			0.0	24	5.4	1.30	2.5	7.2	0.18	77.08	7.9	1
1	Thanet	0.3	16.8	0.1			0.0	0.5	5.4	0.03	0.4	7.2	0.03	1.1	0.1	1
1	Humber Gateway	1.9	100	1.9	2.55	100	2.6	3.19	5.4	0.17	1.9	7.2	0.14	7.7	2.2	1
1	Westermost Rough	0.10	100	0.1	0.18	100	0.2	0.22	5.4	0.01	0.132	7.2	0.01	0.55	0.1	1
3	Beatrice	94.7	16.8	15.9			0.0	10.7	5.4	0.58	39.8	7.2	2.87	145.2	19.4	3
3	Blyth Demonstration Project	1.4	16.8	0.2			0.0	2.3	5.4	0.12	1.4	7.2	0.10	5.39	0.5	1
3	Dogger Bank Creyke Beck Projects A and B	288.0	16.8	48.4	288	19.3	55.6	135	5.4	7.29	295	7.2	21.24	718.85	76.9	1
3	Dudgeon	0.0	16.8	0.0	0	100	0.0	0	5.4	0.00	0	7.2	0.00	0	0.0	1
3	East Anglia ONE	0.9	16.8	0.2			0.0	108.4	5.4	5.85	31.5	7.2	2.27	140.8	8.3	5
3*	EOWDC	11.8	16.8	2.0			0.0	5.8	5.4	0.31	1.1	7.2	0.08	18.7	2.4	1
3	Firth of Forth Alpha and Bravo	153.1	16.8	25.7			0.0	313.1	5.4	16.91	247.6	7.2	17.83	715	60.5	1
3	Galloper	6.3	16.8	1.1			0.0	27.8	5.4	1.50	31.8	7.2	2.29	65.89	4.8	1

Tier	Project	Breeding season – EA3 method			Breeding season – NE method			Post-breeding			Pre-breeding			Annual		Ref.*
		Total	% FFC pSPA	FFC pSPA	Total	% FFC pSPA	FFC pSPA	Total	% FFC pSPA	FFC pSPA	Total	% FFC pSPA	FFC pSPA	Total	FFC pSPA	
3	Hornsea Project One	44.0	16.8	7.4	47.9	66.6	31.9	55.9	5.4	3.02	20.9	7.2	1.50	122	11.9	1
3	Inch Cape	13.1	16.8	2.2			0.0	224.8	5.4	12.14	63.5	7.2	4.57	301.42	18.9	1
3	Moray Firth (EDA)	43.6	16.8	7.3			0.0	2	5.4	0.11	19.3	7.2	1.39	45.4	8.8	1
3	Neart na Gaoithe	32.9	16.8	5.5			0.0	56.1	5.4	3.03	4.4	7.2	0.32	93.39	8.9	1
3	Race Bank	1.90	16.8	0.3	1.86	100	1.9	23.9	5.4	1.29	5.59	7.2	0.40	31.35	2.0	1
3	Rampion	54.40	16.8	9.1			0.0	37.4	5.4	2.02	29.7	7.2	2.14	121	13.3	1
3	Dogger Bank Teesside Projects A and B	136.9	16.8	23.0	136.9	19.3	26.4	90.7	5.4	4.90	216.9	7.2	15.62	444.4	43.5	1
4	Triton Knoll	24.60	16.8	4.1	24.6	100	24.6	139	5.4	7.51	45.4	7.2	3.27	209	14.9	1
4	Hornsea Project Two	16.0	16.8	2.7	16	83	13.3	9	5.4	0.49	3	7.2	0.22	27	3.4	4
4	East Anglia THREE	6.14	16.8	1.0			0.0	69	5.4	3.73	37.6	8.2	3.08	112.74	7.8	5
	TOTAL			165.2			157.3			73.5			80.7	3446.9	319.4	

*Data sources:

1. Natural England (2015)
2. Natural England (2014)
3. Beatrice Offshore Windfarm Ltd. (2013)
4. SmartWind (2015a)
5. Current document

Table A2.3. Updated lesser black-backed gull collision risk and updated values for East Anglia ONE. This table includes revised estimates for Hornsea Project Two. All collisions during the breeding season at wind farms located within 141 km of the Alde-Ore SPA have been apportioned to that population.

Tier	Project	Breeding season			Nonbreeding season	Annual	Ref.*
		Total	% Alde-Ore SPA	Alde-Ore SPA	Total	Total	
1	Beatrice Demonstrator	0.0			0.0	0.0	1
1	Greater Gabbard	12.4	100	12.4	49.6	62.0	2
1	Gunfleet Sands	1.0			0.0	1.0	1
1	Kentish Flats	0.3	100	0.3	1.3	1.6	3
1	Lincs	1.7			6.8	8.5	2
1	London Array	0.0			0.0	0.0	NA
1	Lynn and Inner Dowsing	0.0			0.0	0.0	1
1	Scroby Sands	0.0			0.0	0.0	1
1	Sheringham Shoal	1.7	100	1.7	6.6	8.3	2
1	Teesside	0.0			0.0	0.0	NA
1	Thanet	3.2	100	3.2	12.8	16.0	2
1	Humber Gateway	0.3			1.1	1.3	2
1	Westermost Rough	0.1			0.3	0.3	2
3	Beatrice	0.0			0.0	0.0	NA
3	Blyth Demonstration Project	0.0			0.0	0.0	NA
3	Dogger Bank Creyke Beck Projects A and B	2.6			10.4	13.0	2
3	Dudgeon	7.7	100	7.7	30.6	38.3	1
3	East Anglia ONE	4.0	100	4.0	23.0	27.0	7
3	EOWDC	0.0			0.0	0.0	NA
3	Firth of Forth Alpha and Bravo	2.1			8.4	10.5	2
3	Galloper	27.8	100	27.8	111.0	138.8	4
3	Hornsea Project One	4.4			17.4	21.8	2
3	Inch Cape	0.0			0.0	0.0	NA
3	Moray Firth (EDA)	0.0			0.0	0.0	NA
3	Neart na Gaoithe	0.3			1.2	1.5	1
3	Race Bank	43.2			10.8	54.0	2
3	Rampion	1.6			6.3	7.9	1
3	Dogger Bank Teesside Projects A and B	2.4			9.6	12.0	2
4	Triton Knoll	7.4			29.6	37.0	5
4	Hornsea Project Two	2.0			2.0	4.0	6
4	East Anglia THREE	1.8	100	1.8	8.2	10.0	7
	TOTAL	127.7		58.8	346.9	474.6	

*Data sources:

1. E.ON (2013a)
2. SmartWind (2015b)
3. KFOWL (2011)
4. RWE (2011)
5. Kentish Flats Offshore Wind Farm Extension (2011)
6. SmartWind (2015a)
7. Current document

Table A2.4. Updated great black-backed gull collision risk and updated values for East Anglia ONE. This table includes revised estimates for Hornsea Project Two.

Tier	Project	Breeding season	Nonbreeding season	Annual	Ref.*
1	Beatrice Demonstrator	0.0	0.0	0.0	NA
1	Greater Gabbard	15.0	60.0	75.0	1
1	Gunfleet Sands	0.0	0.0	0.0	2
1	Kentish Flats	0.1	0.2	0.3	2
1	Lincs	0.0	0.0	0.0	2
1	London Array	0.0	0.0	0.0	2
1	Lynn and Inner Dowsing	0.0	0.0	0.0	NA
1	Scroby Sands	0.0	0.0	0.0	NA
1	Sheringham Shoal	0.0	0.0	0.0	NA
1	Teesside	8.7	34.8	43.6	3
1	Thanet	0.1	0.4	0.5	3
1	Humber Gateway	1.3	5.1	6.3	2
1	Westermost Rough	0.0	0.0	0.1	2
3	Beatrice	30.2	120.8	151.0	4
3	Blyth Demonstration Project	1.3	5.1	6.3	5
3	Dogger Bank Creyke Beck Projects A and B	5.8	23.3	29.1	3
3	Dudgeon	0.0	0.0	0.0	NA
3	East Anglia ONE	0.0	32.0	32.0	8
3	EOWDC	0.6	2.4	3.0	3
3	Firth of Forth Alpha and Bravo	13.4	53.4	66.8	3
3	Galloper	4.5	18.0	22.5	6
3	Hornsea Project One	17.2	68.6	85.8	2
3	Inch Cape	0.0	36.8	36.8	2
3	Moray Firth (EDA)	9.5	25.5	35.0	2
3	Neart na Gaoithe	0.9	3.6	4.5	2
3	Race Bank	0.0	0.0	0.0	NA
3	Rampion	5.2	20.8	26.0	8
3	Dogger Bank Teesside Projects A and B	6.4	25.5	31.9	3
4	Triton Knoll	24.4	97.6	122.0	2
4	Hornsea Project Two	3.0	20.0	23.0	7
4	East Anglia THREE	4.6	34.4	39.0	8
	TOTAL	152.1	688.3	840.4	

*Data sources:

1. Banks et al. (2006)
2. SmartWind (2014)
3. SmartWind (2015b)
4. Beatrice Offshore Windfarm Ltd. (2013)
5. Engena (2007)
6. RWE (2011)
7. SmartWind (2015a)
8. Current document

Table A2.5. Updated herring gull collision risk and updated values for East Anglia ONE. This table includes revised estimates for Hornsea Project Two.

Tier	Project	Breeding season	Nonbreeding season	Annual	Ref.*
1	Beatrice Demonstrator	0.0		0.0	NA
1	Greater Gabbard	0.0		0.0	1
1	Gunfleet Sands	0.0		0.0	1
1	Kentish Flats	0.5	1.7	2.2	1
1	Lincs	0.0		0.0	1
1	London Array	0.0		0.0	1
1	Lynn and Inner Dowsing	0.0		0.0	NA
1	Scroby Sands	0.0		0.0	NA
1	Sheringham Shoal	0.0		0.0	NA
1	Teesside	8.7	34.5	43.2	1
1	Thanet	4.9	19.6	24.5	1
1	Humber Gateway	0.4	1.1	1.5	3
1	Westermost Rough	0.1	0.0	0.1	1
3	Beatrice	49.4	197.4	246.8	4
3	Blyth Demonstration Project	0.5	2.2	2.7	5
3	Dogger Bank Creyke Beck Projects A and B	0.0		0.0	NA
3	Dudgeon	0.0		0.0	1
3	East Anglia ONE	0.0	18.0	18.0	11
3	EOWDC	4.8		4.8	1
3	Firth of Forth Alpha and Bravo	10.0	21.0	31.0	6
3	Galloper	27.2		27.2	1
3	Hornsea Project One	2.9	11.6	14.5	1
3	Inch Cape	0.0	13.5	13.5	7
3	Moray Firth (EDA)	52.0		52.0	8
3	Neart na Gaoithe	5.0	12.5	17.5	9
3	Race Bank	0.0		0.0	1
3	Rampion	155.0		155.0	10
3	Dogger Bank Teesside Projects A and B	0.0		0.0	1
4	Triton Knoll	0.0		0.0	1
4	Hornsea Project Two	23.8		23.8	2
4	East Anglia THREE	23.0		23.0	11
	TOTAL	368.0	333.1	701.1	

*Data sources:

1. SmartWind (2014)
2. SmartWind (2015b)
3. Institute of Estuarine and Coastal Studies (2007)
4. Beatrice Offshore Windfarm Ltd. (2013)
5. Engena (2007)
6. Seagreen (2012)
7. RPS (2013)
8. Natural Power (2013)
9. Bureau Wardenburg (2013)
10. E.ON (2013b)
11. Current document

Appendix 3 – East Anglia ONE updated collision risk estimates for 150 turbines

Table A3.1. Seabird collision mortality at East Anglia ONE using Band Option 1. Monthly and annual values calculated for the updated wind farm design (Table 2) but using 150 turbines. Bird densities and biometrics from Tables 3 and 4.

Species	Avoidance rate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual total
Gannet	98.7	1	0	2	0	0	0	0	4	6	27	122	5	**167**
	98.9	1	0	1	0	0	0	0	3	5	23	104	4	**141**
	99.1	1	0	1	0	0	0	0	3	4	19	84	3	**115**
Kittiwake	98.7	23	13	19	0	0	0	1	0	0	2	108	79	**246**
	98.9	20	11	16	0	0	0	1	0	0	2	91	67	**209**
	99.1	16	9	13	0	0	0	1	0	0	1	75	55	**171**
Lesser black-backed gull	99.4	10	1	1	0	1	0	6	0	3	9	17	0	**48**
	99.5	9	1	1	0	1	0	5	0	3	8	14	0	**40**
	99.6	7	1	1	0	1	0	4	0	2	7	11	0	**32**
Herring gull	99.4	2	2	1	0	1	0	0	0	1	0	20	5	**32**
	99.5	2	2	1	0	1	0	0	0	1	0	17	5	**28**
	99.6	1	1	1	0	1	0	0	0	1	0	13	3	**21**
Great black-backed gull	99.4	0	1	4	0	0	1	0	0	1	0	48	1	**56**
	99.5	0	1	3	0	0	1	0	0	1	0	40	1	**46**
	99.6	0	1	3	0	0	1	0	0	1	0	32	1	**38**

ScottishPower Renewables
Offshore Wind Development
Address: 4th Floor, 1 Atlantic Quay, Glasgow, G2 8JB

Eastangliathree@ScottishPower.com

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