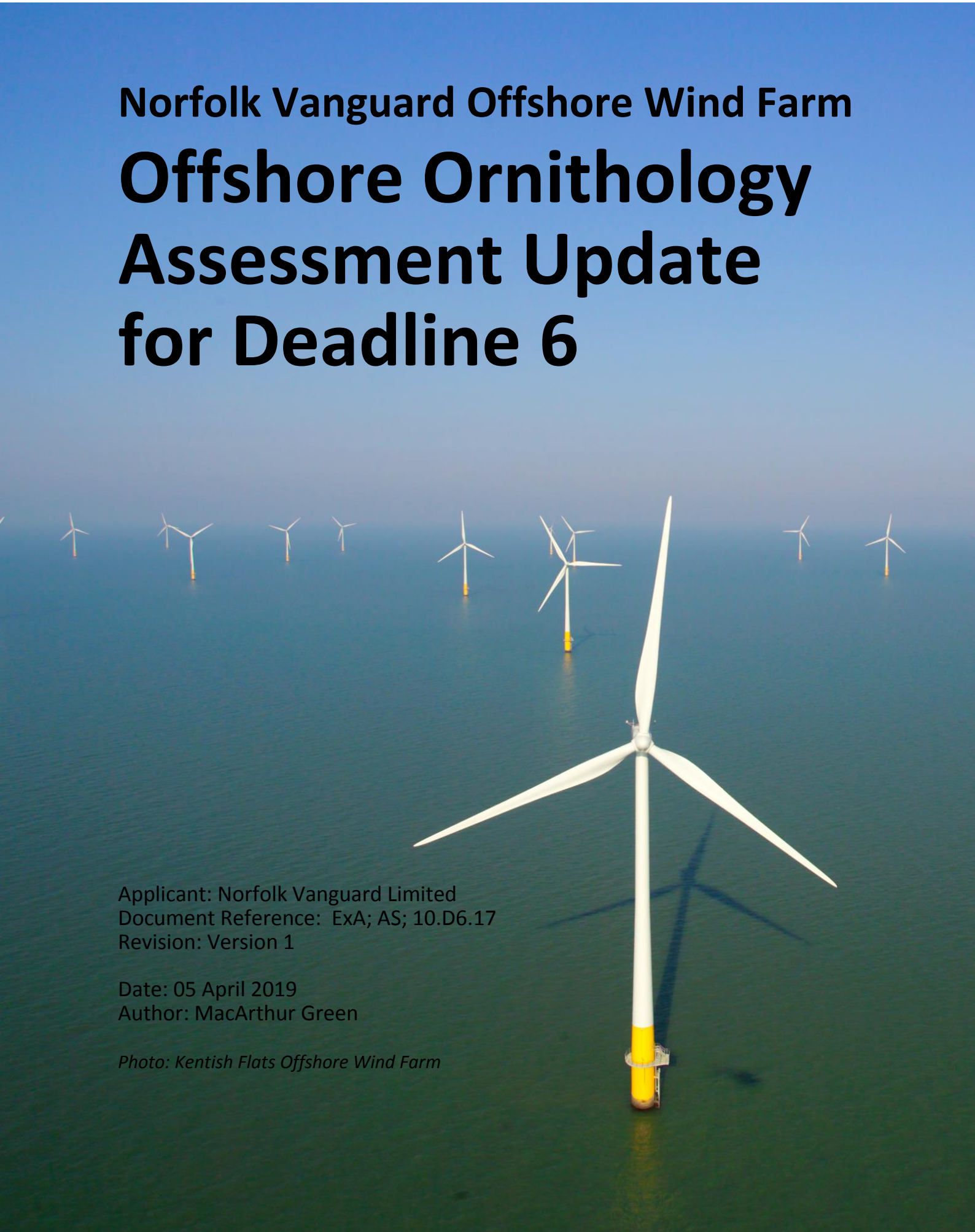
VATTENFALL

Norfolk Vanguard Offshore Wind Farm

Offshore Ornithology Assessment Update for Deadline 6



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Author: MacArthur Green

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Executive Summary

This note provides updated assessments of the potential impacts on ornithological receptors that might arise from the construction, operation and decommissioning of the proposed Norfolk Vanguard project (the Project) covering both the Project alone and cumulatively with other projects, and a Habitats Regulations assessment (HRA) for both the Project alone and in-combination with other relevant plans and projects. The assessment provides predictions using Natural England's preferred precautionary approach and the Applicant's preferred evidence based methods and addresses concerns raised by Natural England and the Royal Society for the Protection of Birds (RSPB) following submission of the Norfolk Vanguard application (Environmental Statement (ES) and HRA).

The conclusions of this updated assessment (based on the evidence based approach) for the Flamborough and Filey Coast Special Area of Protection (SPA) are:

- No adverse effect on integrity due to gannet collisions at Norfolk Vanguard alone or in-combination;
- No adverse effect on integrity due to gannet displacement at Norfolk Vanguard alone or in-combination;
- No adverse effect on integrity due to gannet collisions and displacement together at Norfolk Vanguard alone or in-combination;
- No adverse effect on integrity due to kittiwake collisions at Norfolk Vanguard alone or in-combination;
- No adverse effect on integrity due to puffin displacement at Norfolk Vanguard alone or in-combination;
- No adverse effect on integrity due to razorbill displacement at Norfolk Vanguard alone or in-combination; and
- No adverse effect on integrity due to guillemot displacement at Norfolk Vanguard alone or in-combination.

The conclusion of this updated assessment for the Alde-Ore Estuary SPA is no adverse effect on integrity due to lesser black-backed gull collisions at Norfolk Vanguard alone or in-combination.

The conclusions of this updated assessment for the Greater Wash SPA are:

- No adverse effect on integrity due to red-throated diver displacement during construction (including installation of the export cable) at Norfolk Vanguard alone or in-combination; and
- No adverse effect on integrity due to red-throated diver displacement during operations and maintenance at Norfolk Vanguard alone or in-combination.

The conclusion of this updated assessment for the Outer Thames Estuary SPA is no adverse effect on integrity due to red-throated diver displacement during operations and maintenance at Norfolk Vanguard alone or in-combination.

The conclusions of this updated assessment remain the same as those presented in the ES for the Project alone and cumulatively that there will be no significant impacts (in EIA terms) for any species.

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Glossary

BDMPS	Biologically Defined Minimum Population Scale
CRM	Collision Risk Model
EIA	Environmental Impact Assessment
ES	Environmental Statement
FFC	Flamborough and Filey Coast
GIS	Geographical Information System
HRA	Habitats Regulations Assessment
NE	Natural England
NV	Norfolk Vanguard
PCH	Potential Collision Height
SNH	Scottish Natural Heritage
SOSSMAT	Strategic Ornithological Support Services Migration Assessment Tool
SPA	Special Protection Area

1 INTRODUCTION

1. This note provides updated assessments of the potential impacts on ornithological receptors that might arise from the construction, operation and decommissioning of the proposed Norfolk Vanguard project (the Project) covering both the Project alone (Norfolk Vanguard Wind Farm) and cumulatively with other projects, and a Habitats Regulations Assessment (HRA) for the Project alone and in-combination with other relevant plans and projects in order to address concerns raised by Natural England and the Royal Society for the Protection of Birds (RSPB) following submission of the Norfolk Vanguard application (Environmental Statement (ES) and HRA).

2. The aspects addressed in this note and accompanying documents (references included below) are:

    a. Revised collision risk modelling (CRM) predictions calculated using the deterministic Band (2012) model (with results presented using Natural England guidance, and also using evidence-based parameter values methods (as preferred by the Applicant), as well as updating the assessments to reflect the removal of the 9 MW turbine option from the design envelope for the Project[1]);

    b. A review of SPA apportioning rates for assigning impacts to designated populations. This draws on available data to derive evidence based estimates (as preferred by the Applicant) of connectivity with designated sites in the breeding and nonbreeding seasons, assessed using both the full breeding seasons and migration free breeding seasons;

    c. Revised assessment of collision risk impacts for gannet, kittiwake, herring gull and lesser black-backed gull for the Project alone and cumulatively with other projects for the Environmental Impact Assessment (EIA) and, for gannet, kittiwake and lesser black-backed gull for the Project alone and in-combination for the HRA;

    d. Revised assessment of operational displacement impacts for guillemot, razorbill, puffin, gannet and red-throated diver for the Project alone and cumulatively with other projects for EIA and for the Project alone and in-combination for the HRA; and,

    e. Revised assessment of red-throated diver construction displacement impacts for the Project alone and in-combination for the HRA.

[1] Norfolk Vanguard Offshore Wind Farm Offshore Ornithology: Deterministic Collision Risk Modelling ExA; AS; 10.D6.16

3. It should be noted that based on the advice of Natural England presented at Issue Specific Hearing 4 on 27 March 2019, where cumulative and in-combination assessments have been conducted, the summed total across all wind farms (e.g. of predicted collisions or displacement) is provided both with and without the inclusion of the Hornsea Project Three wind farm. This is to reflect the fact that the baseline seabird density and abundance estimates on which that project's impact assessment is based have not yet been agreed with Natural England and consent has not been awarded.

4. Table 1 provides a summary of the comments provided by Natural England with respect to this analysis and the sections where these have been addressed.

Table 1 Comments provided by Natural England (2018) in their relevant representation with relevance to assessment presented in this report.

Paragraph	Comment	Section where addressed
1.2	**Gannet seasonal definitions** The migration free breeding season has been used by the Applicant in the report of information to inform HRA. We note that considering the full breeding season and adjusting the autumn and spring migration definitions accordingly will alter the number of collisions in each season and hence the overall annual figure apportioned to the Flamborough and Filey Coast (FFC) SPA. Therefore, we would advise that this option of seasonal definitions is also used by the Applicant in the HRA CRM assessment. [note Natural England made a similar comment with respect to month assignments for EIA, but they also concluded this made no difference to the conclusions]	Section 2.1
2.1	**Apportioning of impacts in the non-breeding seasons to relevant SPA colonies** For the apportioning of impacts of species to relevant SPA colonies during the non-breeding seasons, we would recommend that the data presented in the tables in Appendix A of Furness (2015) for the relevant species Biologically Defined Minimum Population Scales (BDMPSs) for each season (e.g. migration, winter etc.) are used. The apportionment of LBBGs to the Alde-Ore Estuary SPA and of kittiwakes to the FFC SPA in the non-breeding seasons has been undertaken using the relevant BDMPS sizes in Furness (2015). However, it is unclear what BDMPS figure has been used in the non-breeding season apportionment of gannets to the FFC SPA. Whether the colony figure in the BDMPS tables used is the adult figure or that for all ages depends on any Population Viability Analysis (PVA) model and outputs to be used. For example, the Applicant has referred to the outputs of existing PVAs done for gannet and kittiwake at FFC SPA at Hornsea 2. The mortality currency of these models is adults, so for example, calculating the proportion that the Flamborough kittiwake number of adults in the relevant seasonal BDMPS represents of the overall total number of kittiwakes of all ages in the relevant season would be acceptable, dependent on the site data used being for birds of all ages. The Applicant has done this for kittiwake, but our understanding is that the gannet apportionment has used a colony figure of birds of all ages (as has also been done for LBBG at the Alde-Ore). Given that the outputs of the existing PVAs tend to be on an adult currency, we also advise that calculations of	Sections 2.1, 2.2, 2.4

Paragraph	Comment	Section where addressed
	baseline mortality used in the HRA are undertaken on an adult currency, therefore using the adult colony figure and the adult mortality rate rather than on all ages.	
2.2	**Apportioning of impacts in the breeding season for LBBG at the Alde-Ore Estuary SPA** Natural England is currently uncertain regarding the evidence base for 25% apportionment of impacts to LBBG during the breeding season used by the Applicant. This is due to a number of reasons/areas of uncertainty: • The figure of 25% used by the Applicant for the breeding season is based on simply summing the totals of counts from LBBG colonies within foraging range of Vanguard (141km mean-maximum range in Thaxter et al. 2012). We note that this approach does not take account of the distance each colony is from Vanguard or segregation, which apportioning approaches should do. If the Alde-Ore is the closest of all the colonies within foraging range, then the apportionment approach may lack precaution (as it may that the birds present at Norfolk Vanguard are biased more towards the Alde-Ore), but if it is the colony located furthest away then the approach may be precautionary. • There may also be some colonies within foraging range that have not been included in the Applicant's summed figure, which should be considered. See our tabulated comments below. • Given the potential for roof nesting urban colonies to be controlled, we are uncertain about the Applicant's approach to doubling the summed urban colonies figure based on the age of data and the Applicant's consideration that these colonies would have significantly increased in the interim. We would therefore suggest that the Applicant provides evidence to justify this decision.	Section 2.4
2.3	**Apportioning of impacts in the breeding season for kittiwake at the FFC SPA** The Applicant has apportioned 16.8% of kittiwake collisions in the breeding season to the FFC SPA and this is considered by the Applicant to be a precautionary estimate. The tracking data for kittiwakes at the FFC SPA up until 2015 suggests low connectivity of the Vanguard site with foraging birds from the colony. This together with the evidence presented by the Applicant for distribution of immature kittiwakes during the breeding season, and in the absence of specific data on the distributions of immatures who will later recruit into a breeding colony to quantify the proportion of pre-breeders present at a site, suggests that the logic presented by the Applicant for arriving at this apportionment figure is reasonable. However, as noted to the Applicant in our response to the draft HRA during the Evidence Plan Process, further tagging of kittiwakes from the FFC SPA colony has been undertaken in 2017 and the results of this does indicate that birds from the FFC SPA do forage within the former Norfolk Zone and within the Vanguard site, particularly Vanguard West. Therefore, we recommend that the Applicant requests this data/reports from the RSPB and then revisits the kittiwake breeding season apportionment following consideration of this data.	Section 2.2
3.3	**RTD mortality/displacement levels (EIA & HRA)** Natural England does not consider the 80% displacement and 5% mortality rate used by the Applicant to be appropriate for assessing disturbance and displacement impacts to RTD from offshore wind farms. We note that this does not follow SNCB guidance (SNCBs 2017). As a result we continue to advise that assessments of operational disturbance and displacement for RTD for offshore wind farm assessments are based on a constant displacement rate across the offshore wind farm site and a 4km	Section 2.9

Paragraph	Comment	Section where addressed
	buffer and suggest that a range of displacement rates up to 100% and a mortality rate of up to 10% are considered. We also consider that the Natural England worst case scenario of 100% displacement and 10% mortality should be used in the assessment of construction disturbance and displacement for RTD for both EIA and for the HRA assessment for RTD at the Greater Wash SPA. However, we note that consideration of this would not alter the EIA level conclusions made by the Applicant in Section 13.7.4.1.2 of the ES Chapter on assessment of offshore cable laying and of the combined impact of construction of both Vanguard East and Vanguard West. [note that Natural England made similar comments with respect to the red-throated diver displacement for EIA. These have been addressed in previously submitted documents ###]	
5.1	**Figures used in cumulative and in-combination assessments of displacement CRM assessments** We welcome the attempt by the Applicant to include figures for Hornsea 3 and Thanet Extension projects in the cumulative and in-combination assessments of displacement and collision risk. We assume that the figures presented in the assessments for these two sites have been obtained from the PEIRs for these projects. We note that Hornsea 3 submitted their application to PINS on 14 May 2018 and this has been accepted by PINS. Thanet Extension submitted their application of 27 June 2018 and has also been accepted by PINS. There are a number of methodological issues and uncertainties identified with the baseline data and assessments completed by Hornsea 3 and some methodological issues identified with the assessments for Thanet Extension. Therefore, at this stage the figures for these projects have not been agreed and therefore this will mean that the cumulative and in-combination assessments will require updating during the process once figures for these projects have been agreed. Whilst we acknowledge that this is beyond the Vanguard Applicant's control, it means that this in addition to the issues/concerns noted above with the Vanguard alone assessments of displacement and CRM mean that we are currently unable to reach any conclusions on the scale of impact of any cumulative or in-combination displacement and CRM impacts.	Throughout
5.3	**Gannet cumulative and in-combination operational displacement assessment** In addition to the overarching comment above regarding the issues/uncertainties around the data included for Vanguard alone and for Hornsea 3 and Thanet Extension, we suggest that a similar approach to that undertaken for the auk cumulative displacement assessments is undertaken for gannet, i.e. to sum the bird abundance estimates for each relevant offshore wind farm and put this total through a displacement matrix, and then assess with a range of displacement of 60-80% and mortality of 1-10%. This also applies to the assessment of LSE for in-combination assessment of gannet displacement from the FFC SPA. Therefore, we advise that once the figures are agreed and the summed figures accurately presented that the assessment and conclusion of the LSE screening for gannet in-combination	Section 2.1.2
5.4	**Auk (puffin, razorbill and guillemot) cumulative and in-combination operational displacement assessments** We note that within the Natural England assessment scenario of 30% displacement and 1% mortality to 70% displacement and 10% mortality, a number of the annual predicted addition auk mortalities equates to greater	Section 2.6.1.2, 2.6.1.4, 2.7.1.2, 2.7.1.4, 2.8.1.2, 2.8.1.4

Paragraph	Comment	Section where addressed
	than 1% of baseline mortality of both the largest BDSMP and the biogeographic populations. This is not insignificant and we advise further consideration be given to this once the figures are agreed. This also applies to the assessment of LSE for in-combination assessment of auk displacement from the FFC SPA. Therefore, we advise that once the figures are agreed and the summed figures accurately presented that the assessment and conclusion of the LSE screening for auk in-combination displacement from FFC SPA is reviewed by the Applicant.	

2 UPDATED ASSESSMENT

2.1 Gannet

2.1.1 Collision risk

2.1.1.1 HRA Project alone

5. The revised collision risks for gannet, calculated using the Band (2012) deterministic model and Natural England's preferred parameter values are provided in Table 2. Further details of the modelling are provided in Vattenfall (2019a).

Table 2. Gannet seasonal and annual collision risk using the migration free (April to August) and full (March to September) breeding seasons.

Site	Breeding season	Spring	Migration free breeding	Autumn	Annual
Norfolk Vanguard East	Migration-free	39.77 (0-86.73)	28.54 (0-83.22)	108.77 (29.43-261.05)	177.08 (29.43-431)
	Full	38.58 (0-81.95)	41.49 (0-116.32)	97.01 (29.43-232.72)	
Norfolk Vanguard West	Migration-free	4.33 (0-17.13)	15.58 (0-50.4)	48.32 (15.38-95.03)	68.23 (15.38-162.56)
	Full	1.88 (0-7.66)	21.08 (0-69.4)	45.26 (15.38-85.49)	

Note: No months are included in more than one season (overlapping months were assigned to the breeding season). Seasons from Furness (2015).

6. The proportion of the total collisions assigned to the Flamborough and Filey Coast SPA in each season by the Applicant in the HRA submitted with the Application (Vattenfall 2018) were 100% (breeding season), 4.2% (autumn) and 5.6% (spring). These rates were derived using the population estimates in Furness (2015) and evidence derived from tracking studies on the migration routes taken by birds from UK colonies (see MacArthur Green 2015 for further details – submitted at Deadline 4: Norfolk Vanguard 2019a).

7. Natural England (2018) advised the Applicant that the nonbreeding season rates should only account for the relative population sizes, with recommended rates calculated by Natural England of 4.8% in autumn and 6.2% in spring (Schedule of Natural England's responses to Examining Authority's second round of written questions, 13 March 2019). Both sets of rates (the Applicant's original set and Natural England's preferred set) have been used to estimate the number of predicted collisions at Norfolk Vanguard which would be attributed to the Flamborough and Filey Coast (FFC) SPA population, using the worst case Norfolk Vanguard East estimates (the worst case assumes all turbines are located in Norfolk Vanguard East) and are presented in Table 3.

Table 3. Gannet seasonal and annual collision risk apportioned to the Flamborough and Filey Coast SPA using the migration free (April to August) and full (March to September) breeding seasons.

Site	Breeding season	Apportioning rates	Spring	Breeding	Autumn	Annual
Norfolk Vanguard East	Migration-free	Applicant	2.2	28.5	4.6	35.3
		Natural England	2.5	28.5	5.2	36.2
	Full	Applicant	2.2	41.5	4.1	47.8
		Natural England	2.4	41.5	4.7	48.6

Note: No months are included in more than one season (overlapping months were assigned to the breeding season). Seasons from Furness (2015). Only the worst case estimates for Norfolk Vanguard East are shown.

8. The maximum predicted mortality for Norfolk Vanguard, using the full breeding season and Natural England's preferred apportioning rates is 48.6 individuals. This is an all age class estimate, of which 55% would be predicted to be adults (from Furness 2015), corresponding to 27 adults from Flamborough and Filey Coast SPA.

9. The SPA population at designation was 11,061 pairs (22,122 individuals, although this had increased to 13,391 pairs by 2017). These equate to total population sizes of approximately 40,222 and 48,700 (designated and 2017 count respectively; calculated as individuals divided by the adult proportion of 0.55 from Furness 2015). At an average natural mortality rate of 0.191 (derived as a weighted average across all age classes, see Norfolk Vanguard ES Chapter 13 Offshore Ornithology for details), the natural annual mortality of the population is 7,682 (designated) to 9,300 (2017 count). The addition of 48.6 individuals would therefore increase the mortality rate by 0.63% (designated) and 0.52% (2017 count). Increases in mortality of less than 1% are considered to be undetectable against natural variation and therefore not considered further.

10. Furthermore, the collision prediction used for this assessment combines several sources of precaution:

- Use of a nocturnal activity rate of 25% (Furness et al. 2018 found this should be 8% in the breeding season and 4% in the nonbreeding season);
- Assignment of all collisions between March and September (the full breeding season) to the SPA makes no allowance for the presence of immature birds from a wide range of other colonies which are likely to be present at this time, or for the presence of late and early migrants, and;
- Bowgen and Cook (2018) recently estimated a gannet collision avoidance rate from an empirical study of 99.5%, which would more than halve the estimates above calculated using 98.9%.

11. Therefore, the conclusion of the above assessment, which includes considerable precaution, is that there will be no adverse effect on the integrity of the

Flamborough and Filey Coast SPA as a result of gannet collisions at the proposed Norfolk Vanguard project alone.

2.1.1.2 HRA In-combination

12. Natural England advised that the in-combination collision assessment should include estimates for three additional Scottish wind farms (Hywind, Kincardine and Moray West) and that there is uncertainty regarding the appropriate values to use for the Hornsea Project Three and Thanet Extension wind farms as these are also currently in examination and therefore there is potential for variation. Following Natural England advice, values for Thanet Extension were obtained from the Thanet Extension submission at Deadline 3 (Appendix 39) and estimates for Hornsea Project Three have been taken from the project's ES. As set out above, in accordance with Natural England's advice, cumulative totals without Hornsea Project THREE are also provided. Table 4 presents the full in-combination predictions.

Table 4. Gannet collision mortality for all wind farms with potential connectivity to the Flamborough and Filey Coast SPA

Tier	Wind farm	Spring		Breeding		Autumn		Annual	
		Total	FFC SPA	Total	FFC SPA	Total	FFC SPA	Total	FFC SPA
1	Beatrice Demonstrator	0.7	0.05	0.6	0.0	0.9	0.04	2.2	0.1
1	Greater Gabbard	4.8	0.30	14.0	0.0	8.8	0.42	27.6	0.7
1	Gunfleet Sands	0.0	0.00	0.0	0.0	0.0	0.00	0.0	0.0
1	Kentish Flats	1.1	0.07	1.4	0.0	0.8	0.04	3.3	0.1
1	Lincs	1.7	0.10	2.1	2.1	1.3	0.06	5.1	2.3
1	London Array	1.8	0.11	2.3	0.0	1.4	0.07	5.5	0.2
1	Lynn and Inner Dowsing	0.2	0.01	0.2	0.2	0.1	0.01	0.5	0.2
1	Scroby Sands	0.0	0.00	0.0	0.0	0.0	0.00	0.0	0.0
1	Sheringham Shoal	0.0	0.00	14.1	14.1	3.5	0.17	17.6	14.3
1	Teesside	0.0	0.00	4.9	2.4	1.7	0.08	6.6	2.5
1	Thanet	0.0	0.00	1.1	0.0	0.0	0.00	1.1	0.0
1	Humber Gateway	1.5	0.09	1.9	1.9	1.1	0.05	4.5	2.0
1	Westermost Rough	0.2	0.01	0.2	0.2	0.1	0.01	0.5	0.2
1	Hywind	0.8	0.05	5.6	0.0	0.8	0.04	7.2	0.1
2	Kincardine	0.0	0.00	3.0	0.0	0.0	0.00	3.0	0.0
2	Beatrice	9.5	0.59	37.4	0.0	48.8	2.34	95.7	2.9
2	Dudgeon	19.1	1.18	22.3	22.3	38.9	1.87	80.3	25.4
2	Galloper	12.6	0.78	18.1	0.0	30.9	1.48	61.6	2.3
2	Race Bank	4.1	0.25	33.7	33.7	11.7	0.56	49.5	34.5
2	Rampion	2.1	0.13	36.2	0.0	63.5	3.05	101.8	3.2
2	Hornsea Project One	22.5	1.40	11.5	11.5	32.0	1.54	66.0	14.4
3	Blyth Demonstration Project	2.8	0.17	3.5	0.0	2.1	0.10	8.4	0.3
3	Dogger Bank Creyke Beck Projects A and B	4.3	0.27	5.6	2.8	6.6	0.32	16.5	3.4
3	East Anglia ONE	6.3	0.39	3.4	3.4	131.0	6.29	140.7	10.1
3	European Offshore Wind	0.1	0.00	4.2	0.0	5.1	0.25	9.3	0.3

Tier	Wind farm	Spring		Breeding		Autumn		Annual	
		Total	FFC SPA	Total	FFC SPA	Total	FFC SPA	Total	FFC SPA
	Deployment Centre								
3	Firth of Forth Alpha and Bravo	65.8	4.08	800.8	0.0	49.3	2.37	915.9	6.5
3	Inch Cape	5.2	0.32	336.9	0.0	29.2	1.40	371.3	1.7
3	Moray Firth (EDA)	8.9	0.55	80.6	0.0	35.4	1.70	124.9	2.3
3	Neart na Gaoithe	23.0	1.43	143.0	0.0	47.0	2.26	213.0	3.7
3	Dogger Bank Teesside Projects A and B	10.8	0.67	14.8	7.4	10.1	0.49	35.7	8.6
3	Triton Knoll	30.1	1.87	26.8	26.8	64.1	3.08	121.0	31.8
3	Hornsea Project Two	6.0	0.37	7.0	7.0	14.0	0.67	27.0	8.0
4	East Anglia THREE	9.6	0.60	6.1	6.1	33.3	1.60	49.0	8.3
5	Hornsea Project Three	8.0	0.45	18.0	18.0	12.0	0.5	38.0	19.0
5	Thanet Extension	22.9	1.42	0.0	0.0	11.1	0.53	34.0	2.0
5	Moray West	1.0	0.06	10.0	0.0	2.0	0.10	13.0	0.2
5	Norfolk Vanguard East*	38.6	2.39	41.5	41.5	97.0	4.66	177.1	48.5
	Total (inc. Hornsea Project Three)	**326**	**20.2**	**1713**	**201.4**	**795.6**	**38.1**	**2834**	**259.7**
	Total (exc. Hornea Project Three)	**318**	**19.7**	**1695**	**184.3**	**783.6**	**37.6**	**2796**	**240.7**

* Only the worst case estimates for Norfolk Vanguard East are shown.

13. The in-combination total, all age class, annual gannet collision estimate is 259.7, of which Norfolk Vanguard contributes 48.5 (although it should be noted that this is considered to be an over-estimate due to the precautionary assumptions noted above). The in-combination total annual gannet collision estimate, without Hornsea Project Three, is 240.7.

14. The increase in the background mortality due to this in-combination collision risk using Natural England's preferred precautionary approach (and including Hornsea Project Three) is between 3.4% (designated population) and 2.8% (2017 count). Without Hornsea Project Three these increases are 3.1% and 2.6%, respectively.

15. Outputs from a Population Viability Analysis (PVA) model for this population were presented for Hornsea Project Three (MacArthur Green 2018). This model was an update of similar models produced for Hornsea Project Two, with the addition of a matched-run approach for calculating counterfactual outputs and an extended simulation period (up to 35 years). Simulations were conducted with and without density dependence and were summarised as the counterfactual of population size and population growth rate. The outputs from this model were presented as additional adult mortality, therefore the total FFC SPA estimates have been converted to adults by multiplying by the adult proportion (55%). Thus, the all age class estimate including Hornsea Project Three of 259.7 comprises 142.8 adults, and without Hornsea Project Three the all age total of 240.7 comprises 132.4 adults.

The outputs from these models for adult mortality levels of 125 and 150 (the values which most closely correspond to the above estimates) are provided in Table 5.

Table 5. Gannet FFC SPA population modelling results from MacArthur Green (2018).

Model	Mortality	Counterfactual metric (after 30 years)		Source table (MacArthur Green 2018)
		Growth rate	Population size	
Rate set 1, density independent	125	0.994	0.848	Table A2 1.1 & 1.3
	150	0.993	0.821	
Rate set 1, density dependent	125	0.997	0.895	Table A2 2.1 & 2.3
	150	0.997	0.874	
Rate set 2, density independent	125	0.994	0.848	Table A2 3.1 & 3.3
	150	0.993	0.821	
Rate set 2, density dependent	125	0.997	0.915	Table A2 4.1 & 4.3
	150	0.996	0.894	

16. The maximum reduction in the population growth rate, at an adult mortality of 150, using the more precautionary density independent model was 0.7% (0.993). Using the more realistic density dependent model the maximum reduction in growth rate was 0.4% (0.996).

17. These compare to the observed rate at which this population has grown over the last 25 years, which has been at least 10% per year. A reduction of less than 1% in this case represents a negligible risk for the population.

18. The gannet breeding numbers at the Flamborough and Filey Coast SPA have continued to increase in all counts conducted to date and the gannet population is therefore clearly in favourable conservation status. The relevant conservation objective is to maintain favourable conservation status of the gannet population, subject to natural change.

19. On the basis of the population model predictions the number of predicted in-combination gannet collisions attributed to the Flamborough & Filey Coast SPA is not at a level which would trigger a risk of population decline, but would only result in a slight reduction in the growth rate currently seen at this colony, and so would not have an adverse effect on integrity of the SPA.

20. These totals also include several sources of precaution, including over-estimated nocturnal activity for existing projects and the use of consented collision estimates for projects which have since been constructed to designs with much lower collision risks.

21. Therefore, it can be concluded that there will be no adverse effect on the integrity of Flamborough & Filey Coast SPA from collision impacts on gannet due to the proposed Norfolk Vanguard project in-combination with other plans and projects.

2.1.2 Displacement

22. Natural England advised the Applicant that a cumulative and in-combination assessment of displacement risk for gannet should be presented. To the Applicant's knowledge this has not been requested for previous wind farm applications, and furthermore gannet has not been consistently included in displacement assessments. Following a review of wind farm assessments gannet abundance data were obtained for all but 8 out of 41 wind farms (Table 6).

Table 6. Gannet in-combination abundance using the full breeding season and with apportioned values for FFC SPA.

Wind farm	Buffer width (km)	Total			FFC SPA		
		Spring	Breeding	Autumn	Spring	Breeding	Autumn
Greater Gabbard	0	105	252	69	7	0	3
Gunfleet Sands	No data	9	0	12	1	0	1
Kentish Flats	No data available						
Kentish Flats Extension	2	0	0	13	0	0	1
Lincs	No data available						
London Array	No data available						
Lynn and Inner Dowsing	No data available						
Scroby Sands	No data available						
Sheringham Shoal	No data	2	47	31	0	47	1
Teesside	No data	0	1	0	0	1	0
Thanet	No data available						
Humber Gateway	No data available						
Westermost Rough	No data available						
Hywind	1	4	10	0	0	0	0
Kincardine	1	0	120	0	0	0	0
Beatrice	0.5	0	151	0	0	0	0
Dudgeon	1	11	53	25	1	53	1
Galloper	4	276	360	907	17	0	44
Race Bank	1	29	92	32	2	92	2
Rampion	No data	0	0	590	0	0	28
Hornsea Project One	4	250	671	694	15	671	33
Blyth Demonstration Project	No data	0	0	0	0	0	0
Dogger Bank Creyke Beck	2	176	518	916	11	518	44

Wind farm	Buffer width (km)	Total			FFC SPA		
		Spring	Breeding	Autumn	Spring	Breeding	Autumn
A							
Dogger Bank Creyke Beck B	2	218	637	1132	14	637	54
East Anglia ONE	4	76	161	3638	5	161	175
European Offshore Wind Deployment Centre	2	0	35	5	0	0	0
Seagreen Alpha	0	138	1716	296	9	0	14
Seagreen Bravo	0	194	1240	368	12	0	18
Inch Cape	4	212	2398	703	13	0	34
Moray Firth (EDA)	4	27	564	292	2	0	14
Neart na Gaoithe	2	281	1987	552	17	0	26
Dogger Bank Teesside A	2	226	968	379	14	968	18
Dogger Bank Teesside B	2	238	1282	508	15	1282	24
Triton Knoll	1	24	211	15	1	211	1
Hornsea Project Two	4	124	457	1140	8	457	55
East Anglia THREE	4	524	412	1269	32	412	61
Hornsea Project Three	4	1099	1203	1494	68	1203	72
Thanet Extension	4	384	27	324	24	0	16
Moray West	4	144	2827	439	9	0	21
Norfolk Vanguard East	2	419	176	1630	26	176	78
Norfolk Vanguard West	2	18	95	823	1	95	40
Seasonal total (ex. Hornsea Project Three)	-	4109	17648	16802	256	5781	807
Seasonal total (inc. Hornsea Project Three)	-	5208	18671	18296	324	6984	879
Annual (ex. Hornsea Project three)				38379			6844
Annual (inc. Hornsea Project Three)				42175			8187

23. Natural England advises presentation of a range of displacement rates of between 60% and 80% displacement and 1% mortality. Predictions using these rates are presented in Table 7.

Table 7. Gannet seasonal and annual displacement at Norfolk Vanguard East and West alone, combined and cumulatively (EIA) across all North Sea wind farms and apportioned to Flamborough and Filey coast SPA (HRA) using the full breeding season.

Site	Season	Total population at risk of displacement	Total impact, displacement & mortality rates:		Population apportioned to FFC SPA	FFC SPA impact, displacement & mortality rates:	
			60% - 1%	80% - 1%		30% - 1%	50% - 1%
Norfolk Vanguard	Spring	419	2.5	3.4	26	0.2	0.2
	Breeding	176	1.1	1.4	176	1.1	1.4

Site	Season	Total population at risk of displacement	Total impact, displacement & mortality rates:		Population apportioned to FFC SPA	FFC SPA impact, displacement & mortality rates:	
			60% - 1%	80% - 1%		30% - 1%	50% - 1%
East	Autumn	1,630	9.8	13.0	78	0.5	0.6
	Annual	2,225	13.4	17.8	280	1.7	2.2
Norfolk Vanguard West	Spring	18	0.1	0.1	1	0.0	0.0
	Breeding	95	0.6	0.8	95	0.6	0.8
	Autumn	823	4.9	6.6	40	0.2	0.3
	Annual	936	5.6	7.5	136	0.8	1.1
Norfolk Vanguard East and West Combined	Spring	437	2.6	3.5	27	0.2	0.2
	Breeding	271	1.6	2.2	271	1.6	2.2
	Autumn	2,453	14.7	19.6	118	0.7	0.9
	Annual	3,161	18.9	25.3	416	2.5	3.3
UK North Sea and Channel wind farms	Spring	5208	31.2	41.7	324	1.9	2.6
	Breeding	18671	112.0	149.4	6984	41.9	55.9
	Autumn	18296	109.8	146.4	879	5.3	7.0
	Annual	42175	253.1	337.4	8187	49.1	65.5

2.1.2.1 EIA Project alone

24. Displacement mortality, estimated at 60% to 80% displaced and 1% mortality (as per Natural England guidance) for Norfolk Vanguard, summed across both East and West, was estimated to be between 18.9 and 25.3.

25. Assessing the total annual displacement against the largest Biologically Defined Minimum Population Scale (BDMPS) population (456,298) and the biogeographic population (1,180,000), the percentage increases in background mortality are between 0.02% and 0.03% (BDMPS) and between 0.008% and 0.01% (biogeographic). These increases are below the 1% threshold of detectability, and are of negligible magnitude and negligible significance in EIA terms.

2.1.2.2 EIA Cumulative

26. The total abundance across all wind farms including Hornsea Project Three was 42,175, of which 8,187 are considered to be part of Flamborough and Filey coast SPA. Without Hornsea Project three these totals were 38,379 and 6,844 respectively (Table 6).

27. Assessing the total annual displacement against the largest BDMPS population (456,298) and the biogeographic population (1,180,000), the percentage increases in background mortality are between 0.29% and 0.38% (BDMPS) and 0.11% and 0.15% (biogeographic). These increases are below the 1% threshold of detectability, are of negligible magnitude and minor significance in EIA terms.

2.1.2.3 HRA Project alone

28. Apportioning the Norfolk Vanguard gannet displacement mortality to the FFC SPA on the basis of 100% connectivity in the breeding season and Natural England's preferred rates in spring and autumn (4.8% and 6.2% respectively) the worst case mortality due to Norfolk Vanguard was estimated to be between 2.5 and 3.3 (Table 7).

29. The SPA population at designation was 11,061 pairs (22,122 individuals, although this had increased to 13,391 pairs by 2017). These equate to total population sizes of approximately 40,222 and 48,700 (designated and 2017 count respectively; calculated as individuals divided by the adult proportion of 0.55 from Furness 2015). At an average natural mortality rate of 0.191 (derived as a weighted average across all age classes, see Norfolk Vanguard ES Chapter 13 Offshore Ornithology for details), the natural annual mortality of the population is 7,682 (designated) to 9,300 (2017 count). The addition of up to 3.3 individuals would therefore increase the mortality rate by a maximum of 0.04% (designated population). Increases in mortality of less than 1% are considered to be undetectable against natural variation and therefore there is no risk of an Adverse Effect on the Integrity of the SPA population due to displacement from the Norfolk Vanguard project alone.

2.1.2.4 HRA In-combination

30. Of the total annual displacement, the number apportioned to the Flamborough and Filey Coast SPA was between 49.1 and 65.5 (Table 7). The percentage increase in background mortality of the FFC SPA all age class population (40,222 for the designated population and 48,700 for the 2017 population) is between 0.64% and 0.85% (designated) and between 0.53% and 0.70% (2017 population). These increases are below the 1% threshold of detectability and therefore no Adverse Effect on Integrity is predicted for the FFC SPA gannet population due to in-combination displacement mortality.

2.1.3 Combined displacement and collision risk

2.1.3.1 HRA In-combination

31. Adding the in-combination annual gannet collision estimate of 245 (estimated using Natural England's preferred precautionary methods and including Hornsea Project Three) to the in-combination annual displacement prediction of 49.1 to 65.5 (using Natural England's preferred precautionary rates and including Hornsea Project Three), gives a combined SPA mortality estimate of 294.1 to 310.5. It is important to note that, on top of the precaution in the individual collision and displacement assessments, summing these two impacts adds another layer of precaution, since it implies that individuals can both be displaced (and suffer increased mortality as a consequence) and also be at risk of collision mortality.

32. However, the above over-precaution notwithstanding, the increase in the background mortality of the SPA population due to this combined in-combination collision and displacement risk was between 3.8% and 4.0% (designated population) and 3.2% and 3.3% (2017 count).

33. Outputs from a PVA model for this population were presented for the Hornsea Project Three wind farm (MacArthur Green 2018). This model was an update of similar models produced for Hornsea Project Two, with the addition of a matched-run approach for calculating counterfactual outputs and an extended simulation period (up to 35 years). Simulations were conducted with and without density dependence and were summarised as the counterfactual of population size and population growth rate. The outputs from these models for mortality levels of 275, 300 and 325 (the nearest values to these impact predictions) are provided in Table 8.

Table 8. Gannet FFC SPA population modelling results from MacArthur Green (2018).

Model	Mortality	Counterfactual metric (after 30 years)		Source table (MacArthur Green 2018)
		Growth rate	Population size	
Rate set 1, density independent	275	0.988	0.699	Table A2 1.1 & 1.3
	300	0.986	0.673	
	325	0.985	0.651	
Rate set 1, density dependent	275	0.992	0.776	Table A2 2.1 & 2.3
	300	0.991	0.757	
	325	0.991	0.739	
Rate set 2, density independent	275	0.988	0.696	Table A2 3.1 & 3.3
	300	0.986	0.673	
	325	0.985	0.651	
Rate set 2, density dependent	275	0.992	0.776	Table A2 4.1 & 4.3
	300	0.991	0.757	
	325	0.990	0.738	

34. The maximum reduction in the population growth rate, at a mortality of 325, using the more precautionary density independent model was 1.5% (0.985). Using the more realistic density dependent model the maximum reduction in growth rate was 0.9% (0.991).

35. On the basis of the observed rate at which this population has grown over the last 25 years, which has been at least 10% per year, a maximum reduction of 1.5% to this rate represents a negligible risk for the population.

36. The gannet breeding numbers at the Flamborough and Filey Coast SPA have continued to increase in all counts conducted to date (most recent 2017) and the gannet population is therefore clearly in favourable conservation status. The

relevant conservation objective is to maintain favourable conservation status of the gannet population, subject to natural change.

37. On the basis of the population model predictions the number of predicted in-combination gannet collisions and mortality due to displacement attributed to the Flamborough & Filey Coast SPA is not at a level which would trigger a risk of population decline, but would only result in a slight reduction in the growth rate currently seen at this colony, and so would not have an adverse effect on integrity of the SPA.

38. These totals also include several sources of precaution, including over-estimated nocturnal activity for existing projects and the use of consented collision estimates for projects which have since been constructed to designs with much lower collision risks.

39. Therefore, it can be concluded that there will be no adverse effect on the integrity of Flamborough & Filey Coast SPA from impacts on gannet due to the proposed Norfolk Vanguard project in-combination with other plans and projects.

2.2 Kittiwake

2.2.1 Collision risk

2.2.1.1 HRA Project alone

40. The revised collision risks for kittiwake, calculated using the Band (2012) deterministic model and Natural England's preferred parameter values are provided in Table 9. Further details of the modelling are provided in Vattenfall (2019a).

Table 9. Kittiwake seasonal and annual collision risk using the migration free (April to August) and full (March to September) breeding seasons.

Site	Breeding season	Spring	Breeding	Autumn	Annual
Norfolk Vanguard East	Migration-free	202.8 (25.83-551.15)	29.03 (2.01-82.93)	85.96 (6.68-203.91)	317.79 (34.52-837.99)
	Full	127.08 (25.83-313.57)	106.07 (2.01-328.54)	84.63 (6.68-195.87)	
Norfolk Vanguard West	Migration-free	22.77 (1.7-58.56)	28.12 (3.74-69.65)	36.82 (2.98-89.96)	87.71 (8.42-218.17)
	Full	9.03 (0-20.69)	47.68 (5.44-120.3)	31 (2.98-77.17)	

Note: No months are included in more than one season (overlapping months were assigned to the breeding season). Seasons from Furness (2015).

41. The proportion of the total collisions assigned to the Flamborough and Filey Coast SPA in each season by the Applicant in the original HRA (Vattenfall 2018) were 16.8% (breeding season), 5.4% (autumn) and 7.2% (spring). These rates were derived using

the population estimates in Furness (2015; see MacArthur Green 2015 for further details – submitted at Deadline 4: Norfolk Vanguard, 2019b).

42. Natural England advised the Applicant (Natural England 2018) that the breeding season rate should take account of more recent tracing studies (Wischnewski 2018) which had found evidence to indicate that the previously accepted foraging range for this species may have been an underestimate.

43. The study authors (the RSPB) provided the tracking data on request in order to enable analysis to estimate an alternative breeding season apportioning rate.

44. In the 2017 breeding season this project successfully tracked 18 kittiwakes for periods of up to 29 days in June and July. A summary of the relevant foraging distances recorded by this study is provided below. Of relevance to this analysis are the distances from the SPA to the Norfolk Vanguard sites (205 km to Norfolk Vanguard West and 233 km to Norfolk Vanguard East):

- In June, 12 of 17 birds tracked (in this month) had maximum foraging ranges less than 205 km and 16 had ranges less than 233 km.
- In July, 5 of 11 birds tracked (in this month) had maximum foraging ranges less than 205 km and 7 had ranges less than 233 km.

45. These data indicate that earlier in the season (June) very few birds travelled as far as Norfolk Vanguard and that, even later in the season, foraging trips extending as far as Norfolk Vanguard were only undertaken by around half the tagged birds.

46. It is important that these results are not over-interpreted, since they represent a single season and only a small number of individuals. Nevertheless, they suggest that there is likely to be connectivity between the SPA and Norfolk Vanguard in the breeding season, albeit this connectivity is probably quite low.

47. While some birds recorded on Norfolk Vanguard in the breeding season are therefore likely to have come from Flamborough and Filey Coast SPA, there remains the question of the likely origin of other birds on the site. Immature kittiwakes tend to remain in overwintering areas longer into the breeding season and to move more slowly back towards their natal colonies, both within years and also as they approach maturity (Coulson 2011). Thus, one approach to estimating the kittiwake population size in the North Sea in the breeding season is to consider the spring season immature population in this region, on the basis that these birds are more likely to remain in this area.

48. The UK North Sea spring migration BDMPS immature population is 252,001 (Furness 2015). If this is assumed to represent the UK North Sea population of nonbreeding birds during the breeding season , then this suggests that the Flamborough and Filey Coast SPA adult population (89,040) would make up 26.1% of the birds that could be

recorded on Norfolk Vanguard (89040/(252,001+89040)). While it is likely that not all of these immatures would be present in the southern North Sea throughout the breeding season, this figure (252,001) does not include any immature birds from the very large Russian and Norwegian populations. If these birds (1,830,400 immatures) are added to the potential North Sea population the percentage attributed to the SPA is reduced to 4.1% (89040/(89040+252001+1,830,400)). This provides a lower value to balance against what is likely to be an upper estimate of 26.1% calculated without these birds. It is acknowledged that this almost certainly over estimates the number of Russian and Norwegian immatures present in the North Sea, but it does indicate that these immature birds will make up a very large proportion of the population present in the southern North Sea.

49. Furthermore, immature birds tend to be less competitive than breeding adults, therefore as distance from colonies increases, the likelihood that birds encountered are sub-dominant immature individuals increases. Hence the range 4.1% to 26.1% is considered to provide a realistic range of the apportioning rates for FFC SPA birds on Norfolk Vanguard, covering the uncertainty in this calculation. Taking a precautionary approach, it has been assumed that the upper value (26.1%) is applicable to Norfolk Vanguard.

50. This estimated rate was presented to Natural England and the RSPB and discussed during a call on the 2nd April 2019. Natural England advised the Applicant that they should give consideration to a wider range of possible breeding season connectivity percentages, including up to 100% (i.e. all birds on Norfolk Vanguard during the breeding season should be treated as breeding adults from the SPA, although Natural England acknowledged this figure was highly precautionary). The Applicant considers such an approach is extremely precautionary and gives undue weight to the single tagging study conducted in 2017. Further consideration of the kittiwake data has been undertaken and is presented in the following paragraphs.

51. Table 10 provides monthly and seasonal kittiwake collision estimates on Norfolk Vanguard West and East, for both the migration free and full breeding seasons.

Table 10. Kittiwake monthly collision risks on Norfolk Vanguard East and West with migration free (May to July) and full (March to August) breeding seasons indicated.

Month	Monthly		Seasonal total			
			Migration free		Full breeding	
	NV West	NV East	NV West	NV East	NV West	NV East
Jan	5.4	89.2	22.8	202.7	9.1	127.0
Feb	3.7	37.8				
Mar	10.1	50.4			47.7	106.0
Apr	3.6	25.3				
May	4.8	22.5	28.2	29		
Jun	16.7	4.3				

Month	Monthly		Seasonal total			
			Migration free		Full breeding	
	NV West	NV East	NV West	NV East	NV West	NV East
Jul	6.7	2.2				
Aug	5.8	1.3	37.0	85.9		
Sep	3.6	1.4			31.2	84.6
Oct	6.5	4.3				
Nov	20.1	45.8				
Dec	1	33.1				
Total	**87.8**	**317.8**	**87.8**	**317.8**	**87.8**	**317.8**

52. There are several aspects of the trends in these data which argue against undertaking an assessment as precautionary as that proposed by Natural England. Of the two sites (East and West), the higher density of kittiwakes, and thus higher annual collision risks, were recorded on Norfolk Vanguard East and therefore this site represents the worst case for collisions overall (by more than three times). However, this site is almost 30 km further away from FFC SPA (minimum distance 235km) than Norfolk Vanguard West (minimum distance 205km), and therefore it would be expected that the abundance of kittiwakes in the breeding season would be higher on Norfolk Vanguard West. This observation is thus at odds with the suggested levels of connectivity (the opposite pattern would be expected). Furthermore, in the key breeding months of June and July (but also August) the densities on Norfolk Vanguard East were at their lowest. Densities were also higher on Norfolk Vanguard East in the early months of the full breeding season (March and April) which are those also identified as migration months in Furness (2015). Furness (2015) states that:

Peak spring migration occurs in January-April in Belgium (Vanermen et al. 2013), in March-April generally in Europe (Cramp et al. 1977-94; Forrester et al. 2007). Peak numbers observed in spring at Trektellen seawatching UK sites (predominantly in south and east England) occurred in March.

53. Taken together, these observations have a poor correspondence with the suggestion that breeding adults from FFC SPA make up the majority (if not all) of the kittiwakes present on Norfolk Vanguard.

54. Thus, given the locations of Norfolk Vanguard East and West, and the pattern of observations across the two sites, including March and April as breeding months for FFC SPA birds, this almost certainly over-estimates the number of collisions assigned to this population since there will be large numbers of migrants still passing through at this time. Across the two years, the surveys in March were conducted around the middle of March (12-14th) and early to middle April (4th and 5th and 13th and 15th).

These dates are clearly consistent with the migration period (i.e. not conducted at the ends of the period) and further highlight the high degree of precaution in the request from Natural England that FFC SPA birds should be considered to be the only birds present between March and August (i.e. 100% of collisions in those months should be assigned to the SPA).

55. As noted above, the FFC SPA apportioning estimate of 26.1% calculated above is considered precautionary, since it only incorporates UK immature birds and does not include consideration of the potentially very large number of birds from the Russian and Norwegian populations, of which an unknown, but likely very large, proportion will be present in the North Sea during migration and the breeding season.

56. The estimated seasonally apportioned collision estimates are provided in Table 11.

Table 11. Kittiwake seasonal and annual collision risk after application of apportioning rates (7.2% in spring, 26.1% in breeding and 5.4% in autumn) to the Flamborough and Filey Coast SPA using the migration free (May to July) and full (March to August) breeding seasons.

Site	Breeding season	Spring	Breeding	Autumn	Annual
Norfolk Vanguard East	Migration-free	14.6	7.6	4.6	26.8
	Full	9.2	27.7	4.6	41.5
Norfolk Vanguard West	Migration-free	1.6	7.4	2.0	11.0
	Full	0.7	12.4	1.7	14.8

Note: No months are included in more than one season (overlapping months were assigned to the breeding season). Seasons from Furness (2015).

57. The maximum predicted collision mortality for Norfolk Vanguard East, using the full breeding season is 41.5 individuals. However, as discussed above, apportioning mortality at the more distant Norfolk Vanguard East to the SPA using these seasonal definitions is considered highly precautionary. Indeed, the tracking evidence provides very little evidence for connectivity to Norfolk Vanguard East at all.

58. However, there is more evidence for connectivity with the slightly closer Norfolk Vanguard West site, although even here the migration free season is considered more appropriate for assigning collisions to the SPA. Nonetheless, consideration for the full breeding season for Norfolk Vanguard West is also presented.

59. Although FFC SPA is much the largest kittiwake breeding colony in the southern North Sea, there are other, closer kittiwake colonies to Norfolk Vanguard West. The most recent population estimates for these have been extracted from the JNCC Seabird Monitoring Programme website (http://jncc.defra.gov.uk/smp/). These have been used to calculate the relative proportions from each colony which could be present on Norfolk Vanguard West (Table 12). It is important to note that this only provides an estimate of the relative proportions of breeding adults within that at sea population, and not the proportion of all birds present (i.e. including immature birds).

Table 12. Colonies of kittiwake between Humberside and Suffolk and estimated proportions of adults from each colony present on the Norfolk Vanguard site based (calculated using SNH tool[2]).

Colony	Minimum distance from Norfolk Vanguard West (km)	Approximate no. of breeding pairs (year)	Colony weighting (population size / distance[2)]	Colony proportion (colony weight / ∑ colony weights)
FFC SPA	205	45,504 (2017)	1.083	0.864
Lowestoft	57	325 (2016)	0.100	0.079
Sizewell	85	502 (2008)	0.069	0.055

60. The apportioning indicates that of the adults present, up to 86% are potentially from FFC SPA. On this basis, 22.6% of the total birds on the wind farm (86% of 26.1%) could originate from FFC in the breeding season. This is further evidence that the value of 26.1% (as calculated above) is precautionary.

61. Therefore, in summary:

    a. There is very little evidence for connectivity between the FFC SPA and Norfolk Vanguard East site, with no tracking connectivity, and monthly trends in abundance which are much more compatible with migration movements than breeding movements. Therefore, since Norfolk Vanguard West is closer to FFC SPA and there is more compelling evidence for connectivity on this site the HRA for Norfolk Vanguard is based on the collisions at this site.

    b. Since monthly patterns of abundance (on both sites) more closely correspond to migration movements, the migration free breeding season is considered more appropriate (although the full season is also presented);

    c. The proportion of the birds on Norfolk Vanguard West in the breeding season predicted to originate from the FFC SPA has been calculated using a precautionary rate of 26.1%. This is precautionary because it does not allow for the presence of breeding adults from closer colonies, nor that of Russian and Norwegian immatures.

62. The Norfolk Vanguard West annual collisions apportioned to the FFC SPA using the migration free breeding season is 11.0 and using the full breeding season is 14.8.

63. Furthermore, the collision prediction used for this combines several sources of precaution:

[2] https://www.nature.scot/sites/default/files/2017-07/A2176850%20-%20Interim%20Guidance%20on%20Apportioning%20Impacts%20from%20Marine%20Renewable%20Developments%20to%20breeding%20seabird%20populations%20in%20special%20Protection%20Areas%20-%2021%20Dec%202016.pdf

- Use of a nocturnal activity rate of 50% (Furness et al. in prep. Indicates that a value less than 20% is more appropriate for this species); and
- Bowgen and Cook (2018) recently estimated a kittiwake collision avoidance rate from an empirical study of 99%, which would reduce collisions by around 10% compared with the current predictions using 98.9%.

64. These are all age class estimates, of which 53% would be predicted to be adults (from Furness 2015), corresponding to 6 and 8 adults from Flamborough and Filey Coast SPA respectively.

65. The SPA population at designation was 44,520 pairs (89,040 individuals). This equates to a total population size of approximately 168,000 (calculated as individuals divided by the adult proportion of 0.53 from Furness 2015). At an average natural mortality rate of 0.156 (derived as a weighted average across all age classes, see Norfolk Vanguard ES Chapter 13 Offshore Ornithology for details), the natural annual mortality of the population is 26,208. The addition of up to 14.8 individuals would therefore increase the mortality rate by 0.05%. Increases in mortality of less than 1% are considered to be undetectable against natural variation and therefore, the conclusion is that there will be no adverse effect on the integrity of the Flamborough and Filey Coast SPA as a result of kittiwake collisions at the proposed Norfolk Vanguard project.

2.2.1.2 HRA In-combination

66. Natural England advised that the in-combination collision assessment should include estimates for three additional Scottish wind farms (Hywind, Kincardine and Moray West) and that there is uncertainty regarding the appropriate values to use for the Hornsea Project Three and Thanet Extension wind farms as these are also currently in examination and therefore there is potential for variation. Following Natural England advice, estimates for Hornsea Project Three have been taken from that project's ES and for Thanet Extension from that project's submission at Deadline 3 (Vattenfall 2019b). Natural England also advised that for other wind farms with potential connectivity to the FFC SPA during the breeding season, the apportioning rates presented for the East Anglia THREE wind farm, labelled as 'NE Method' should be used. These were: 100% for Lincs, Humber Gateway, Westermost Rough, Dudgeon, Race Bank and Triton Knoll; 83% for Hornsea Projects One and Two (NB,for Project One this was given as 66.6%, but NE advises that the higher rate for Project Two should be used) and 19.3% for the Dogger Bank Projects. In addition, for Hornsea Project Three a value of 94% was advised. These advised percentages have been used together with the value of 26.1% estimated for Norfolk Vanguard.

Table 13. Kittiwake collision mortality for all wind farms with potential connectivity to the Flamborough and Filey Coast SPA

Tier	Wind farm	Spring		Breeding		Autumn		Annual	
		Total	FFC SPA	Total	FFC SPA	Total	FFC SPA	Total	FFC SPA
1	Beatrice Demonstrator	1.7	0.1	0.0	0.0	2.1	0.1	3.8	0.2
1	Greater Gabbard	11.4	0.8	1.1	0.0	15.0	0.8	27.5	1.6
1	Gunfleet Sands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	Kentish Flats	0.7	0.1	0.0	0.0	0.9	0.0	1.6	0.1
1	Lincs	0.7	0.0	0.7	0.7	1.2	0.1	2.6	0.8
1	London Array	1.8	0.1	1.4	0.0	2.3	0.1	5.5	0.3
1	Lynn and Inner Dowsing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	Scroby Sands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	Sheringham Shoal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	Teesside	2.5	0.2	38.4	0.0	24.0	1.3	64.9	1.5
1	Thanet	0.4	0.0	0.3	0.0	0.5	0.0	1.2	0.1
1	Humber Gateway	1.9	0.1	1.9	1.9	3.2	0.2	7.0	2.2
1	Westermost Rough	0.1	0.0	0.1	0.1	0.2	0.0	0.5	0.1
1	Hywind	0.9	0.1	16.6	0.0	0.9	0.0	18.3	0.1
2	Kincardine	1.0	0.1	22.0	0.0	9.0	0.5	32.0	0.6
2	Beatrice	39.8	2.9	94.7	0.0	10.7	0.6	145.2	3.4
2	Dudgeon	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Galloper	31.8	2.3	6.3	0.0	27.8	1.5	65.9	3.8
2	Race Bank	5.6	0.4	1.9	1.9	23.9	1.3	31.4	3.6
2	Rampion	29.7	2.1	54.4	0.0	37.4	2.0	121.5	4.2
2	Hornsea Project One	20.9	1.5	44.0	36.5	55.9	3.0	120.8	41.0
3	Blyth Demonstration Project	1.4	0.1	1.4	0.0	2.3	0.1	5.1	0.2
3	Dogger Bank Creyke Beck Projects A and B	295.0	21.2	288.0	55.6	135.0	7.3	718.0	84.1
3	East Anglia ONE	46.7	3.4	1.5	0.0	161.0	8.7	209.2	12.1
3	European Offshore Wind Deployment Centre	1.1	0.1	11.8	0.0	5.8	0.3	18.7	0.4
3	Firth of Forth Alpha and Bravo	247.6	17.8	153.1	0.0	313.1	16.9	713.8	34.7
3	Inch Cape	63.5	4.6	13.1	0.0	224.8	12.1	301.4	16.7
3	Moray Firth (EDA)	19.3	1.4	43.6	0.0	2.0	0.1	64.9	1.5
3	Neart na Gaoithe	4.4	0.3	32.9	0.0	56.1	3.0	93.4	3.3
3	Dogger Bank Teesside Projects A and B	216.9	15.6	136.9	26.4	90.7	4.9	444.5	46.9
3	Triton Knoll	45.4	3.3	24.6	24.6	139.0	7.5	209.0	35.4
3	Hornsea Project Two	3.0	0.2	16.0	13.3	9.0	0.5	28.0	14.0
4	East Anglia THREE	37.6	2.7	6.1	0.0	69.0	3.7	112.7	6.4
5	Hornsea Project Three*	11.4	0.8	165.3	153.7	61.3	3.3	238.0	157.9
5	Thanet Extension	15.3	1.1	2.3	0.0	5.3	0.3	23.0	1.4
5	Moray West	7.0	0.5	79.0	0.0	24.0	1.3	110.0	1.8
5	Norfolk Vanguard West (full breeding season)	9.1	0.7	47.7	12.4	31.2	1.7	88.0	14.8
	Total (inc. Hornsea Project Three)	**1176**	**85**	**1307**	**327**	**1545**	**83**	**4257.1**	**495.2**

Tier	Wind farm	Spring		Breeding		Autumn		Annual	
		Total	FFC SPA	Total	FFC SPA	Total	FFC SPA	Total	FFC SPA
	Total (exc. Hornsea Project Three)	**1164**	**84**	**1142**	**173**	**1483**	**80**	**4019.0**	**337.4**

67. The in-combination all age class total annual kittiwake collision estimate is 495.2, of which Norfolk Vanguard contributes 14.8 (although it should be noted that this is considered to be an over-estimate due to the precautionary assumptions noted above). Without Hornsea Project Three this total is 337.4.

68. The increase in the background mortality due to this in-combination collision risk using Natural England's preferred precautionary approach (and the inclusion of Hornsea Project Three) is 1.8% and 1.3% without Hornsea Project Three.

69. A population model was produced for this population for the Hornsea Project Three wind farm (MacArthur Green 2018). This model was an update of similar models produced for Hornsea Project Two, with the addition of a matched-run approach for calculating counterfactual outputs and an extended simulation period (35 years). Simulations were conducted with and without density dependence and were summarised as the counterfactual of population size and population growth rate. The outputs from this model were presented as additional adult mortality, therefore the total FFC SPA estimates have been converted to adults by multiplying by the adult proportion (53%). Thus, the all age class estimate including Hornsea Project Three of 495.2 comprises 262.4 adults, and without Hornsea Project Three the all age total of 337.4 comprises 178.8 adults. The outputs from these models for adult mortality levels of 200 and 300 (the closest upper values to these totals) are provided in Table 14.

Table 14. Kittiwake FFC SPA population modelling results from MacArthur Green (2018).

Model	Mortality	Counterfactual metric (after 30 years)		Source table (MacArthur Green 2018)
		Growth rate	Population size	
Rate set 1, density independent	200	0.998	0.937	Table A2 5.1 & 5.3
	300	0.997	0.906	
Rate set 1, density dependent	200	1.000	0.981	Table A2 6.1 & 6.3
	300	0.999	0.976	
Rate set 2, density independent	200	0.998	0.937	Table A2 7.1 & 7.3
	300	0.997	0.907	
Rate set 2, density dependent	200	1.000	0.980	Table A2 8.1 & 8.3
	300	0.999	0.971	

70. The maximum reduction in the population growth rate, at a mortality of 300, using the more precautionary density independent model was 0.3% (0.997) and without Hornsea Project Three this was 0.2%. Using the more realistic density dependent model these maximum reductions in growth rate were 0.1% (0.999) and 0% (1.0) respectively.

71. This growth rate reduction represents a very small risk to the population's conservation status.

72. The kittiwake breeding numbers at the Flamborough and Filey Coast SPA have remained relatively stable around an average of approximately 40,000 pairs over the last 20 years. The RSPB reported that since 2000 the population has grown by 7% which would equate to 0.4% annual growth rate (RSPB unpublished report). Therefore, the kittiwake population appears to be in favourable conservation status and the relevant conservation objective is to maintain this status, subject to natural change.

73. On the basis of the population model predictions the number of predicted in-combination kittiwake collisions attributed to the Flamborough & Filey Coast SPA is not at a level which would trigger a risk of population decline, but may result in a slight reduction in the growth rate currently seen at this colony.

74. These totals also include several sources of precaution, including over-estimated nocturnal activity for existing projects and the use of consented collision estimates for projects which have since been constructed to designs with much lower collision risks.

75. Therefore, it can be concluded that there will be no adverse effect on the integrity of Flamborough & Filey Coast SPA from impacts on kittiwake due to the proposed Norfolk Vanguard project in-combination with other projects.

2.3 Herring gull

2.3.1 Collision risk

2.3.1.1 EIA Cumulative

76. Natural England requested the inclusion of a cumulative assessment of herring gull collision risk.

77. The cumulative herring gull collision risk prediction is presented in Table 15. This collates collision predictions from other wind farms which may contribute to the cumulative total. This table takes the wind farm assessment for East Anglia THREE as its starting point and adds more recent wind farm predictions.

78. The collision values presented in Table 15 include totals for breeding, nonbreeding and annual periods. However, not all projects provide a seasonal breakdown of collision impacts, therefore it is not possible to extract data from these periods for cumulative assessment. Natural England has previously noted that an 80:20 split between the nonbreeding and breeding seasons is appropriate for lesser black-backed gull in terms of collision estimates (Natural England, 2013), and this has been used for herring gull. Therefore, for those sites where a seasonal split was not presented the annual numbers in Table 15 have been multiplied by 0.8 to estimate the nonbreeding component and 0.2 to estimate the breeding component.

Table 15. Herring gull cumulative collision risk.

Tier	Wind farm	Breeding	Nonbreeding	Annual
1	Beatrice Demonstrator	0.0		0.0
1	Greater Gabbard	0.0		0.0
1	Gunfleet Sands	0.0		0.0
1	Kentish Flats	0.5	1.7	2.2
1	Lincs	0.0		0.0
1	London Array	0.0		0.0
1	Lynn and Inner Dowsing	0.0		0.0
1	Scroby Sands	0.0		0.0
1	Sheringham Shoal	0.0		0.0
1	Teesside	8.7	34.5	43.2
1	Thanet	4.9	19.6	24.5
1	Humber Gateway	0.4	1.1	1.5
1	Westermost Rough	0.1	0.0	0.1
1	Hywind	0.6	7.8	8.4
2	Kincardine	1.0	0.0	1.0
2	Beatrice	49.4	197.4	246.8
2	Dudgeon	0.0		0.0
2	Galloper	27.2		27.2
2	Race Bank	0.0		0.0
2	Rampion	155.0		155.0
2	Hornsea Project One	2.9	11.6	14.5
3	Blyth Demonstration Project	0.5	2.2	2.7
3	Dogger Bank Creyke Beck Projects A and B	0.0		0.0
3	East Anglia ONE	0.0	28.0	28.0
3	European Offshore Wind Deployment Centre	4.8		4.8
3	Firth of Forth Alpha and Bravo	10.0	21.0	31.0
3	Inch Cape	0.0	13.5	13.5
3	Moray Firth (EDA)	52.0		52.0
3	Neart na Gaoithe	5.0	12.5	17.5
3	Dogger Bank Teesside Projects A and B	0.0		0.0
3	Triton Knoll	0.0		0.0
3	Hornsea Project Two	23.8		23.8
4	East Anglia THREE	0.0	23.0	23.0
5	Hornsea Project Three*	1.0	7.0	8.0

Tier	Wind farm	Breeding	Nonbreeding	Annual
5	Thanet Extension	10.0	4.0	14.0
5	Moray West	12.0	1.0	13.0
5	Norfolk Vanguard East*	0.0	37.4	37.4
	Total (inc. Hornsea Project Three)	**369.6**	**423.3**	**792.9**
	Total (exc. Hornsea Project Three)	**368.6**	**416.3**	**784.9**

*Only the worst case estimates for Norfolk Vanguard East are shown.

79. On the basis of the worst case Norfolk Vanguard East collision estimates the annual cumulative total including Hornsea Project Three is 792.9 and without this project is 784.9.

80. The background mortality for the largest BDMPS population (466,511) at an all age class average mortality rate of 0.174 (Appendix 3.2, document reference ExA; WQApp3.2; 10.D1.3) is 81,173. The addition of 793 to this increases the rate by 0.97%, and without Hornsea Project Three this would be 0.96%. These are below the 1% threshold of detectability.

81. This total also includes several sources of precaution, including over-estimated nocturnal activity for projects and the use of consented collision estimates for projects which have since been constructed to designs with much lower collision risks.

82. Nonetheless, even including these additional sources of precaution the cumulative herring gull collision risk results in an impact of minor magnitude and a minor significant impact.

2.4 Lesser black-backed gull

2.4.1 Collision risk

2.4.1.1 Apportioning to the Alde Ore Estuary SPA

83. Alde-Ore Estuary SPA is located 92 km from the closest point of the Norfolk Vanguard OWF sites. The lesser black-backed gull is estimated to have a mean breeding season foraging range of 72 km from colonies, a mean maximum foraging range of 141 km, and a maximum recorded foraging range of 181 km (Thaxter et al. 2012). Therefore, breeding adults from Alde-Ore Estuary SPA may forage over an area that includes the Norfolk Vanguard site, although the site is further from the colony than most likely foraging activity of this population. Other breeding lesser black-backed gull SPAs in Britain are located more than 181km from the Norfolk Vanguard site. The Alde-Ore Estuary SPA is therefore the only British lesser black-backed gull SPA colony that is within maximum foraging range.

84. During a call to discuss apportioning rates (2nd April 2019), Natural England advised the Applicant that consideration should be given to presentation of a range of

percentages for the proportion of birds on the Norfolk Vanguard site which may originate from this SPA, with an upper limit of 100%. The following sections present a detailed review of the evidence relating to lesser black-backed gull behaviour, foraging ecology and the regional population, in order to arrive at appropriate rates for this assessment. A key aspect of this review was the need to identify an appropriate balance between uncertainty and precaution.

85. As well as the Alde-Ore Estuary SPA, there are non-SPA colonies of lesser black-backed gulls located within foraging range of Norfolk Vanguard, including rooftop nesting gulls in several towns in Suffolk and Norfolk. As there is a high likelihood that birds from these populations will also be present on Norfolk Vanguard it is appropriate to consider the relative population sizes and potential for connectivity. This is discussed in detail below.

86. The national census of seabirds breeding in Britain and Ireland in 1985-86 found 37 pairs of lesser black-backed gulls breeding in Norfolk and fewer than 43 pairs in Suffolk at sites outside the Alde-Ore Estuary SPA (Lloyd et al. 1991). There were at least 5,000 pairs nesting at Orfordness in the Alde-Ore Estuary SPA and 2 or 3 pairs at Havergate (Lloyd et al. 1991 and JNCC Seabird Monitoring Programme (SMP) database), so the Alde-Ore Estuary SPA held 98% of the lesser black-backed gulls breeding in East Anglia in 1985-86. The national census of seabirds breeding in Britain and Ireland in 1998-2002 found 1,605 pairs of lesser black-backed gulls breeding in Norfolk and 1,166 pairs in Suffolk at sites outside the Alde-Ore Estuary SPA (Mitchell et al. 2004), so 2,771 pairs were found nesting at sites in East Anglia away from the Alde-Ore Estuary SPA. The JNCC SCM (Site Condition Monitoring) database shows a huge drop in breeding numbers at Orfordness and Havergate at that time after many years of colony growth (Plate 2.1). According to JNCC, this was apparently caused by foxes which were entering the colony to kill adults and chicks and take gull eggs (Mavor et al. 2001). Numbers have declined further since 2001 (Plate 2.1), as the problem of depredations by foxes has apparently continued.

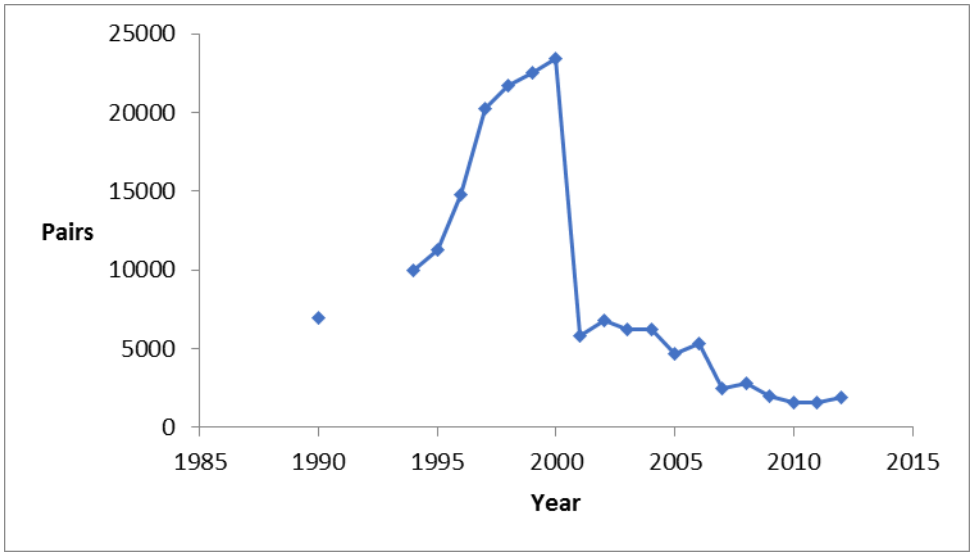

Plate 2.1 Number of breeding pairs of lesser black-backed gulls in the Alde-Ore Estuary SPA; Orfordness plus Havergate (data from JNCC SCM database).

87. There were estimated to be 23,000 pairs at Orfordness and 400 pairs at Havergate in 2000, so an estimated 89% of the lesser black-backed gulls breeding in Norfolk and Suffolk were in the Alde-Ore Estuary SPA in 2000. The colony at Orfordness held 5,500 pairs, and the colony at Havergate held 290 pairs in 2001 (JNCC SMP database). That means that 68% of the breeding population was within the Alde-Ore Estuary SPA in 2001.

88. The Alde-Ore population of lesser black-backed gulls has since decreased considerably, the most recent published counts being 640 pairs at Orfordness in 2012 and 1,668 pairs at Havergate in 2016. It is unclear why no counts have been entered into the JNCC SMP database for Orfordness since 2012 and that limits understanding of any changes that have occurred since 2012.

89. By comparison, numbers breeding elsewhere in East Anglia have increased. There were 743 pairs at urban colonies in Great Yarmouth in 2012, 467 pairs at Southtown/Gorleston in 2012, probably about 2,000-3,000 pairs at Lowestoft in 2008-2011, and a few hundred pairs at other sites in Norfolk and Suffolk (Piotrowski 2013). These urban colonies have only been censused a few times, and counts are not very accurate because many rooftops are impossible to view, so the numbers are likely to be underestimates (Ross et al. 2016). Furthermore, the 2012 census of urban breeding gulls in Suffolk was carried out after adverse conditions resulted in considerable breeding failure of many gulls (Piotrowski 2013) so is also likely to have underestimated numbers at urban sites. However, despite the relatively incomplete census data, it is clear that urban colonies have been growing very fast, as seen at Lowestoft (Plate 2.2), and Great Yarmouth (Plate 2.3).

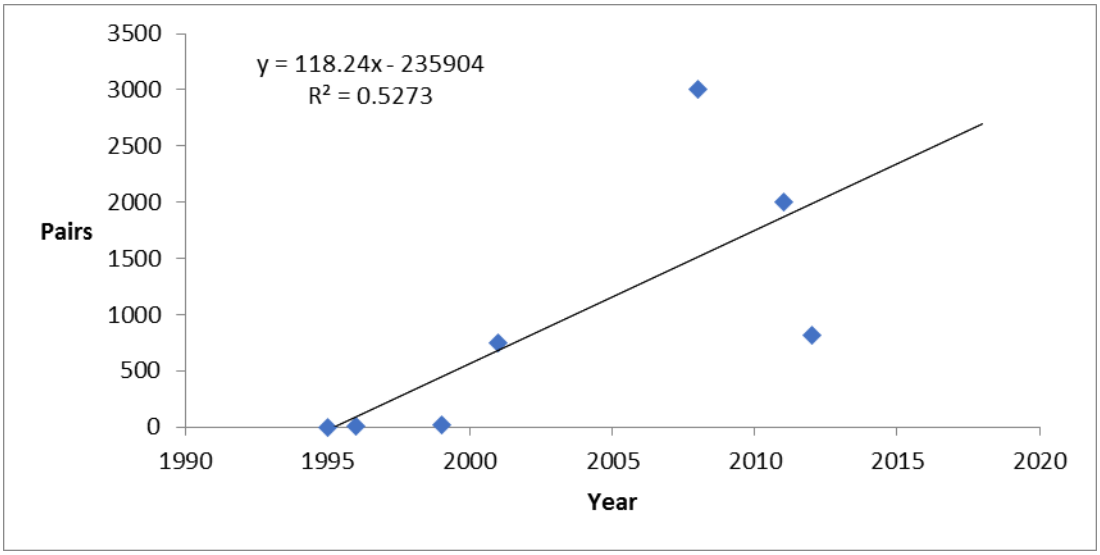

Plate 2.2 Number of breeding pairs of lesser black-backed gulls in Lowestoft (data from JNCC SCM database and Piotrowski 2013).

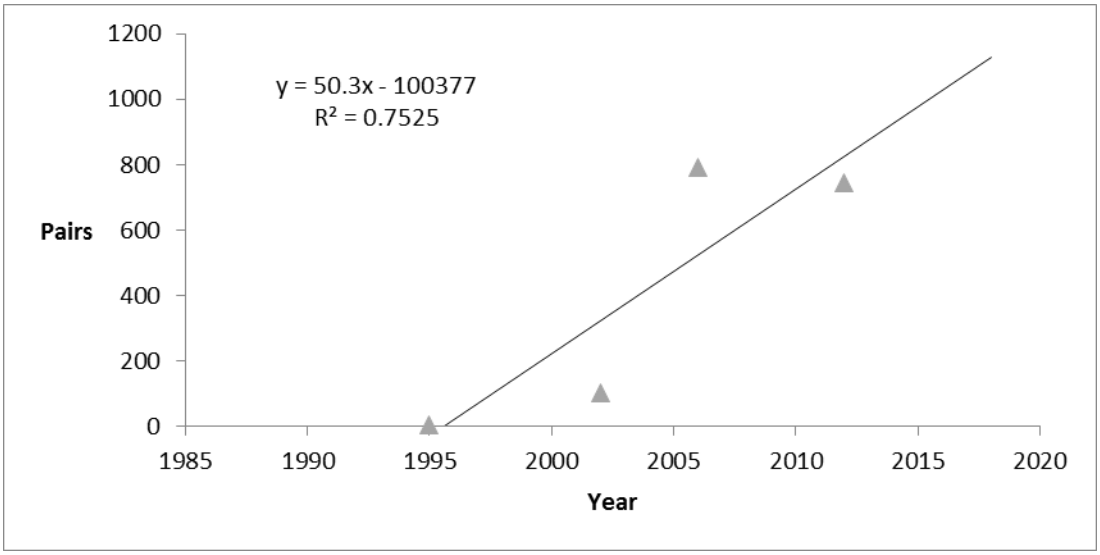

Plate 2.3 Number of breeding pairs of lesser black-backed gulls in Great Yarmouth (data from JNCC SCM database and Piotrowski 2013).

90. In addition, breeding numbers have increased at Felixstowe (1,401 pairs in 2013; Plate 2.4) and Ipswich (99 pairs in 2001, 262 pairs in 2012), which are also urban colonies, and at Outer Trial Bank (1,704 pairs in 2006, 1,457 pairs in 2009 and 1,294 pairs in 2018) (JNCC SCM database).

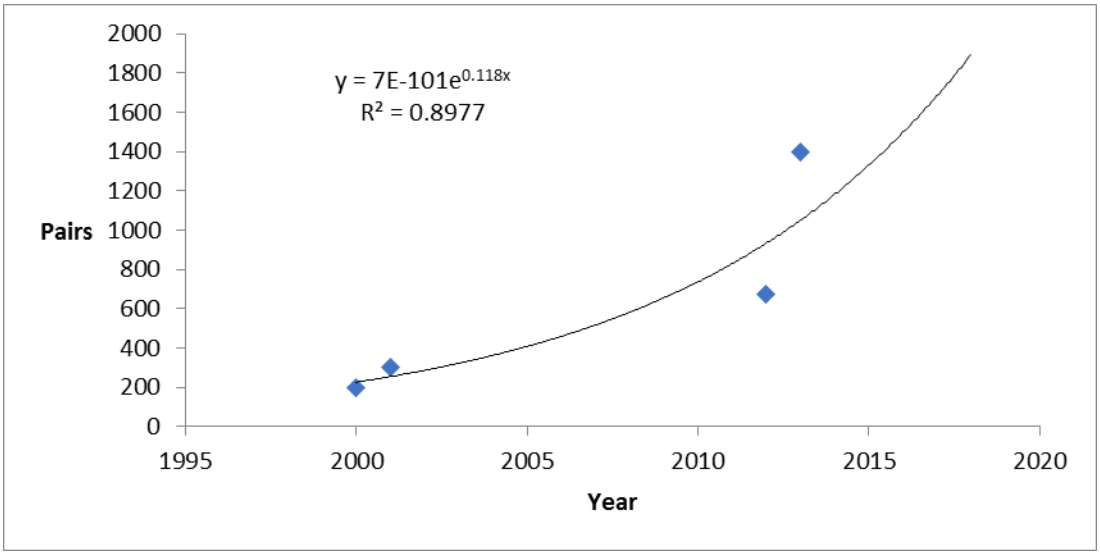

Plate 2.4 Numbers of breeding pairs of lesser black-backed gulls at Felixstowe (data from JNCC SCM database). For this colony an exponential growth curve is a better fit than a linear increase.

91. The numbers at Alde-Ore Estuary SPA colonies in 2012-2016 (ca. 2,300 pairs) compare with ca. 5,100 pairs at sites in Norfolk and Suffolk outside the SPA. This suggests that the percentage of Norfolk and Suffolk lesser black-backed gulls breeding within the SPA had fallen to about 31% of the population.

92. Concerted efforts to make urban areas 'gull-proof' can sometimes result in a reduction in breeding numbers of urban gulls of as much as 25% (Coulson and Coulson 2009) though such reductions may possibly only be temporary until gulls find other urban nest sites where they are tolerated. In general, urban nesting by gulls has increased throughout the UK much faster than total populations of gulls (Raven and Coulson 1997, Nager and O'Hanlon 2016) because the breeding success of gulls tends to be higher at urban sites than in rural colonies (chicks on rooftops are not exposed to predators such as foxes and are less at risk of disturbance or conflict with other gulls; Monaghan 1979, Monaghan and Coulson 1977), and survival of adults at urban colonies is at least as high, and probably higher, than at rural sites (Rock and Vaughan 2013, O'Hanlon and Nager 2018). Piotrowski (pers. comm. who carried out the census of breeding numbers at urban sites in Suffolk in 2012) stated that efforts to deter urban nesting gulls in Suffolk have largely been ineffective and do not seem to have resulted in significant reductions in the population in urban sites overall.

93. Urban nesting lesser black-backed gull numbers in Suffolk increased by over 1000% between 1995 and 2012 (Piotrowski 2013) at a period when numbers breeding in the Alde-Ore Estuary SPA decreased by about 70%. If this trend has continued then the proportion of lesser black-backed gulls at Norfolk Vanguard that originate from Alde-

Ore Estuary SPA may be decreasing further below 31% since 2012, but this is uncertain. At a qualitative level, the picture shown quantitatively in 2012 appears not to be much changed since then. However, a repeat census of breeding gull numbers would be helpful to check on that and may be carried out as part of the current national census of breeding seabirds and could be made more accurate by use of drones to photograph inaccessible rooftops (Ross et al. 2016, Rush et al. 2018).

94. The available data show that the Alde-Ore Estuary SPA held about 98% of the East Anglia breeding population of lesser black-backed gulls in 1985-86, 89% of the East Anglia breeding population of lesser black-backed gulls in 2000, 68% in 2001 and about 31% in 2012-2016 (Plate 2.5). Since numbers at urban colonies in particular have been on an upward trend, it seems likely that the percentage of the population within the Alde-Ore Estuary SPA will have decreased further since 2012-2016.

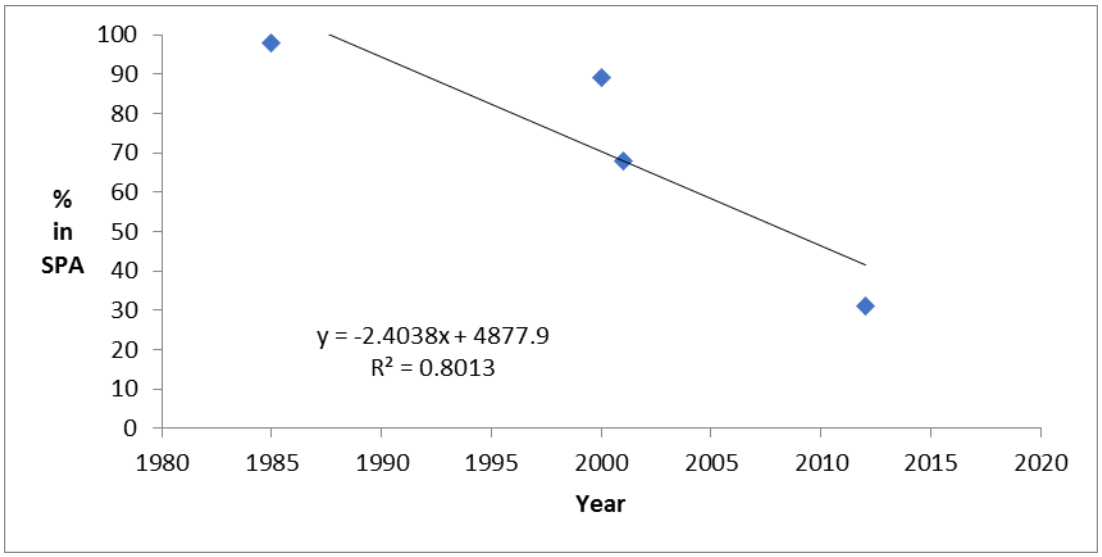

Plate 2.5 The percentage of lesser black-backed gulls breeding in East Anglia that were breeding within the Alde-Ore Estuary SPA in different survey years (based on JNCC SCM database and Piotrowski 2013).

95. It is likely that breeding adult lesser black-backed gulls visiting the Norfolk Vanguard site will tend to come from colonies within foraging range, and within that sample, may come more from colonies closer to the site than from colonies further away. In that context, it is worth noting that the SPA population at Alde-Ore Estuary is in the middle of the range of distances of East Anglian lesser black-backed gull colonies from Norfolk Vanguard (Table 16). Application of the simple population size – distance colony apportioning approach developed jointly by SNH (Scottish Natural Heritage) and MacArthur Green indicates that around 17% of the birds recorded on the Norfolk Vanguard site would be expected to originate from the Alde Ore Estuary SPA (Table 16).

Table 16. Colonies of lesser black-backed gulls in East Anglia ranked according to the minimum distance from Norfolk Vanguard (noting the maximum foraging range of breeding lesser black-backed gulls is reported by Thaxter et al. (2012) as 181 km and estimated proportions of each present on the Norfolk Vanguard site based (calculated using SNH tool[3]).

Colony	Minimum distance from Norfolk Vanguard (km)	Approximate no. of breeding pairs in period 2008-2015	Colony weighting (population size / distance[2)]	Colony proportion (colony weight / ∑ colony weights)
Great Yarmouth	51	750	0.288	0.21
Southtown	55	450	0.149	0.11
Lowestoft	60	2000	0.556	0.41
Alde-Ore Estuary SPA	92	2000	0.236	0.17
Felixstowe	120	700	0.049	0.04
Ipswich	120	250	0.017	0.01
Outer Trial Bank	140	1300	0.066	0.05

96. On the basis of the population sizes and distances, of all the breeding adults present on Norfolk Vanguard in the breeding season, 17% are expected to be breeding adults from Alde Ore Estuary SPA. However, since adults comprise around 58% of the total population (Furness 2015), and since immature birds are more likely to visit areas distant from the main foraging areas, with locations close to colonies used by breeding adults (Wakefield et al. 2017), the overall proportion of birds at Norfolk Vanguard during the breeding season that are breeding adults is likely to be at most 58%, and possibly much less. Therefore, the proportion of birds at Norfolk Vanguard that are breeding adults from the Alde-Ore Estuary SPA is likely to be 17% of, at most, 58% of the total (i.e. approximately 10% overall). However, tracking data from adults breeding at the Alde-Ore Estuary SPA provide a better approach to estimating numbers at Norfolk Vanguard originating from that SPA and so tracking data are considered below.

97. It is likely that the amount of foraging within the marine environment varies among colonies and among years, depending on the relative availability of different feeding opportunities. Lesser black-backed gulls are generalist feeders, able to exploit a wide range of foods from urban waste food to earthworms on rural pasture land to small mammals and insects in grassland to intertidal animals, marine fish caught at sea and fisheries waste (discards and offal) made available behind fishing boats. However, there is evidence from diet studies and from tracking studies, that breeding adult lesser black-backed gulls tend to switch to feeding on marine fish when rearing chicks. This is thought to be at least in part a strategy to provide chicks

[3] https://www.nature.scot/sites/default/files/2017-07/A2176850%20-%20Interim%20Guidance%20on%20Apportioning%20Impacts%20from%20Marine%20Renewable%20Developments%20to%20breeding%20seabird%20populations%20in%20special%20Protection%20Areas%20-%2021%20Dec%202016.pdf

with nutritionally better food to support chick growth and development. That switch would, therefore, be just as appropriate for urban nesting gulls as for rural nesting gulls.

98. Tracking data (Hayley Douglas, pers. comm.) and diet data (Steve Piotrowski, pers. comm.) for urban nesting lesser black-backed gulls do indeed suggest that those birds feed to an extent in marine habitat, especially when rearing chicks, and do not suggest that urban nesting gulls are significantly less marine than those nesting in rural colonies (based on evidence reviewed below). Lesser black-backed gulls nesting in urban colonies in East Anglia include marine fish in their breeding season diet as well as earthworms, small mammals and urban food waste (Steve Piotrowski, pers. comm.). Those birds clearly forage at sea to some extent, just as some rural nesting gulls do.

99. Some rural nesting lesser black-backed gulls do not seem to feed at sea while breeding. Clewley et al. (2017) reported on tracking data from adult lesser black-backed gulls breeding at Bowland Fells SPA. Two individuals from this rural inland colony spent a small minority of their foraging time in the marine environment but less than 10 km from the coast, whereas 14 others were never tracked over marine habitat (although three spent a small amount of time in estuarine habitat). Scragg et al. (2016) tracked ten adult lesser black-backed gulls breeding at the Ribble and Alt Estuary SPA and found that even for this coastal population, over 90% of their position fixes away from the colony occurred inland, with less than 0.5% occurring in marine habitat. Those studies indicate that rural nesting lesser black-backed gulls can have very low connectivity with marine habitat, even when the colony is at the coast.

100. Tracking of urban nesting gulls has only begun very recently (Rock et al. 2016), is based on small sample sizes, and is mostly not yet published. The ‘tag-n-track’ project has deployed GPS tags on lesser black-backed gulls breeding on rooftops in Strathclyde (Scotland). The data show that different individuals tend to have particular individual habits (as often found in gulls; Navarro et al. 2017), often returning regularly to the same location. However, birds nesting on rooftops include individuals that forage in the Clyde Estuary and Clyde Sea (Hayley Douglas, pers. comm.). Tracking of a small sample of breeding lesser black-backed gulls nesting in Bristol indicates that those birds do not forage in marine habitat, presumably because the sea is too distant and there are adequate foraging opportunities within closer range (Anouk Spelt, pers. comm.). Coulson and Coulson (2008) found that lesser black-backed gulls nesting in Dumfries did not forage in marine habitat, but fed mainly on agricultural land, especially on earthworms. Thaxter et al. (2017) estimated that up to 41 birds would need to be tracked for about 145 days in order to describe 95% of area use by the population. On that basis, no clear conclusions

can be reached about the relative importance of marine versus terrestrial habitat use from tracking studies based on deployment of very few tags for short periods of time, but the studies mentioned above do indicate that some urban nesting lesser black-backed gulls will forage at sea, and also indicate that birds from some rural colonies will forage almost exclusively inland. There is no evidence that urban nesting lesser black-backed gulls show lower connectivity with marine foraging habitat than rural nesting lesser black-backed gulls, although that possibility cannot be ruled out.

101. Tracking data (Thaxter et al. 2015) indicate very low connectivity between breeding lesser black-backed gulls at Orfordness (Alde-Ore Estuary SPA) and the Norfolk Vanguard site. Connectivity appears to vary between zero and very low across the years studied, presumably depending on variations in food availability in different years. Tracking data show a time budget overlap with the former East Anglia Zone of 3.7% in 2010, 1.1% in 2011 and 0.2% in 2012 (Thaxter et al. 2015 Supplementary material Appendix A). The Norfolk Vanguard site forms a small part of the former East Anglia Zone. The tracking data indicate that much less than 0.5% of the foraging time of lesser black-backed gulls is spent within the Norfolk Vanguard site plus 2km buffer. For the population of about 2,000 breeding pairs at Alde-Ore Estuary SPA that would represent considerably fewer than 10 birds (0.5% of the total number of pairs) at any point in time (assuming that under normal circumstances one adult is at the nest site while the other is away on a foraging trip). Given that there were on average about 300 lesser black-backed gulls in the Norfolk Vanguard site during the breeding season (April to August), fewer than 10 birds during the chick-rearing period from the Alde-Ore would represent less than 3% of the lesser black-backed gulls present. This finding is consistent with the fact that the Alde-Ore Estuary SPA population (c. 2,000) represents only about 25% of the population of adult lesser black-backed gulls breeding in East Anglia (c. 7,500, although this total is likely to be incomplete and therefore an underestimate). It also corresponds with the observation that Norfolk Vanguard is located towards the upper limit of lesser black-backed foraging range from most breeding colonies and is therefore likely to be used more by nonbreeders than by breeding adults.

102. Tracking data are for chick-rearing periods, so do not necessarily apply at other times during the breeding season. However, lesser black-backed gulls show more marine foraging behaviour during chick-rearing and more terrestrial foraging behaviour earlier in the breeding season, so the overlap with Norfolk Vanguard is likely to be highest during the latter part of the breeding season when birds have chicks to provision and is probably lower than this during the early breeding season.

103. Given the low numbers indicated by tracking this raises the question of where birds observed on Norfolk Vanguard come from, if not Alde-Ore SPA. To be precautionary

in relation to the SPA population of Alde-Ore Estuary, we have assumed that no breeding adults from the populations in the Netherlands visit the Norfolk Vanguard site because tracking data from birds in the Netherlands strongly indicate that connectivity for these birds is extremely low (Camphuysen 1995, 2013; Camphuysen et al. 2015). However, it is known that there are large numbers of immature lesser black-backed gulls in the populations (Furness 2015 estimated from demographic data that about 40% of the population will be immature birds and 60% will be breeding age adults). While younger immature birds may remain in the wintering area year round, during spring and summer older immatures move towards breeding areas and may form a significant part of the population at sea in areas such as Norfolk Vanguard. Consequently, a substantial part of the birds present at Norfolk Vanguard is likely to be immature birds from a variety of populations drawn from a much larger area than just East Anglia. The birds present may also include breeding adults from non-SPA colonies in East Anglia, especially those closer to Norfolk Boreas than is the Alde-Ore Estuary SPA (such as Great Yarmouth, Southtown, and Lowestoft).

104. To conclude, during the breeding season, on the basis of relative population sizes and colony distance, combined with age ratios, the breeding adults from Alde-Ore Estuary SPA would comprise less than 17% of the on-site birds, while tracking data suggest this percentage would most likely be less than 3%. Both of these values have been used in the assessment for the breeding season and represent upper and lower limits on apportioning rates, derived from the available evidence.

105. During migration, lesser black-backed gulls of all age classes will pass through the southern North Sea, with a small proportion of these passing through the Norfolk Vanguard site. Therefore, during migration, birds from many different local populations within the region may be at risk of collision mortality and the Alde-Ore Estuary SPA population represents only a very small fraction of the regional population potentially at risk. The lesser black-backed gull Biologically Defined Minimum Population Scales (BDMPS) population in UK North Sea and Channel waters in autumn (August-October) is estimated to be 209,000 birds, while the spring (March-April) population is estimated to be 197,000 birds (Furness 2015). The total Alde-Ore SPA lesser black-backed gull population has been estimated at around 6,700 individuals (assuming adults comprise 60% of the population, Furness 2015). This indicates that birds associated with the Alde-Ore SPA represent about 3.3% of these BDMPS populations. Therefore, it is likely that about 3.3% of the estimated collision mortality during the autumn and spring migration periods would affect birds associated with the Alde-Ore SPA population, of which around 60% would be breeding adults (i.e. 2% of the total collision mortality would be breeding adults from Alde-Ore Estuary SPA). This percentage applies both for estimated mortality due to

the proposed Norfolk Vanguard project alone, and to in-combination effects within the region.

106. During winter, lesser black-backed gulls are present in UK waters in smaller numbers than during migration; the estimated BDMPS winter population of lesser black-backed gulls in the UK North Sea and Channel waters is about 39,000 birds (Furness 2015). Adults from the Alde-Ore SPA lesser black-backed gull breeding population may represent a higher proportion of the winter BDMPS than they do during the migration seasons BDMPS populations because a higher proportion of the overwintering birds are likely to be adults (most immatures migrate further south). Furness (2015) considered that around 50% of breeding adults from the SPA remain in the region (a precautionary assumption), hence the proportion of birds from the Alde-Ore SPA will be approximately 5% (Furness 2015). Hence, no more than 5% of the estimated collision mortality on the lesser black-backed gull population during winter would be apportioned to the Alde-Ore SPA breeding population, either for estimated mortality due to the proposed Norfolk Vanguard project alone, or in-combination for the region. The true percentage is an unknown amount below 5%, but is likely to be greater than the 3.3% estimated during migration seasons.

2.4.1.2 HRA Project alone

107. No works for the proposed Norfolk Vanguard project will take place within the Alde-Ore Estuary SPA site boundary. The main potential impact for lesser black-backed gull is therefore in relation to collision risk when birds are outside of the SPA site boundary; these gulls fly partly within the height range where they may encounter rotating turbine blades.

108. The predicted monthly numbers of lesser black-backed gull collision mortalities based on Band Option 2 (Band 2012), with an avoidance rate of 99.5% (the avoidance rate as agreed with Natural England for use in Band model Option 1 or 2 collision risk modelling) for the proposed Norfolk Vanguard project, are shown in Table 17.

Table 17. Predicted monthly numbers collision estimates for lesser black-backed gull at the Norfolk Vanguard site calculated using Band Option 2 (generic flight heights) for the worst case turbine option (10MW). Months in bold indicate the full breeding months (note that the migration free breeding season has also considered in the assessment).

Month	Deterministic collision mortality (mean density and 95% c.i.)	Monthly proportions (assumed 17% breeding season, 3.3% migration periods and 5% in mid-winter; see section 2.4.1.1)
January	0 (0-0)	0 (0-0)
February	0 (0-0)	0 (0-0)
March	0.87 (0-5.3)	0.03 (0-0.17)
April	**0.84 (0-5.4)**	**0.14 (0-0.92)**

Month	Deterministic collision mortality (mean density and 95% c.i.)	Monthly proportions (assumed 17% breeding season, 3.3% migration periods and 5% in mid-winter; see section 2.4.1.1)
May	**0 (0-0)**	**0 (0-0)**
June	**7.01 (0-17.6)**	**1.19 (0-2.99)**
July	**8.77 (0-23.3)**	**1.49 (0-3.96)**
August	**12.58 (1.9-27.9)**	**2.14 (0.32-4.74)**
September	3.52 (0-14.0)	0.12 (0-0.46)
October	6.04 (0-17.1)	0.2 (0-0.56)
November	0 (0-0)	0 (0-0)
December	0 (0-0)	0 (0-0)
Total	39.62 (1.91-110.47)	5.31 (0.3-13.8)

109. The majority of collisions are predicted during the second half of the breeding season and early autumn (June to August). This indicates wider movements of failed and nonbreeding individuals and birds on migration through the southern North Sea.

110. During the migration-free breeding season (May to July) the total number of predicted collisions was 15.8, while for the full breeding season this figure was 29. On the basis of the seasonal percentages of Alde-Ore SPA birds predicted to be on the Norfolk Vanguard site (figures derived above), using the migration-free breeding season the attributable mortality would be up to 3 birds and using the full breeding season would be up to 5 birds (Table 18).

Table 18. Estimated Alde-Ore lesser black-backed gull collision risk at Norfolk Vanguard calculated using deterministic collision estimates and seasonal percentages as detailed in the text.

Month	Migration free breeding season		Full breeding season	
	Total	Alde-Ore	Total	Alde-Ore
Spring (3.3%)	1.7	0.06	0.9	0.03
Breeding season (3% -17%)	15.8	0.5-2.7	29.2	1.0-5.0
Autumn (3.3%)	22.1	0.7	9.5	0.32
Winter (5%)	0	0	0	0
Total	**39.6**	**1.3-3.5**	**39.6**	**1.3-5.3**

111. Natural mortality for the SPA population (assuming approximately 6,666 birds of all ages) would be around 940 individuals at an average all age class mortality rate of 14.10% (using immature and adult survival rates from Horswill and Robinson 2015). A total additional worst case mortality of up to 5 birds (using the full breeding season) due to collisions at the Norfolk Vanguard site would increase the mortality

rate by 0.5% (from 0.141 to 0.1417). Following SNCB recommendations, an increase in mortality of less than 1% is considered to be undetectable against the range of background variation. Therefore, since the increased mortality predicted as a result of Norfolk Vanguard is below the agreed threshold at which increases in mortality are detectable, this means that no significant impact can be attributed to this level of impact arising from the proposed Norfolk Vanguard project alone.

112. It is therefore also reasonable to conclude that there will be no adverse effect on the integrity of the Alde-Ore Estuary SPA as a result of lesser black-backed gull collisions at the proposed Norfolk Vanguard project alone.

2.4.1.3 HRA In-combination

113. The cumulative lesser black-backed gull collision risk prediction has been calculated using a tiered approach for all wind farms in the North Sea (Table 19).

Table 19. Lesser black-backed gull collision mortality for all wind farms (nonbreeding) and those with potential connectivity during the breeding season with the Alde-Ore SPA.

Tier	Wind farm	Predicted collisions (@ 99.5% avoidance rate, Band Model option 2)			
		Annual	Nonbreeding	Breeding (Annual minus nonbreeding)	Projects within 141km of Alde Ore SPA
1	Beatrice Demonstrator	0.0	0.0	0.0	0
1	Greater Gabbard	62.0	49.6	12.4	12.4
1	Gunfleet Sands	1.0	0.0	1.0	1.0
1	Kentish Flats	1.6	1.3	0.3	0.3
1	Lincs	8.5	6.8	1.7	0
1	London Array	0.0	0.0	0.0	0
1	Lynn and Inner Dowsing	0.0	0.0	0.0	0
1	Scroby Sands	0.0	0.0	0.0	0
1	Sheringham Shoal	8.3	6.6	1.7	1.7
1	Teesside	0.0	0.0	0.0	0
1	Thanet	16.0	12.8	3.2	3.2
1	Humber Gateway	1.3	1.1	0.3	0
1	Westermost Rough	0.3	0.3	0.1	0
2	Beatrice	0.0	0.0	0.0	0
2	Dudgeon	38.3	30.6	7.7	7.7
2	Galloper	138.8	111.0	27.8	27.8
2	Race Bank	54.0	10.8	43.2	0
2	Rampion	7.9	6.3	1.6	0
2	Hornsea Project One	21.8	17.4	4.4	0
3	Blyth Demonstration Project	0.0	0.0	0.0	0
3	Dogger Bank Creyke Beck Projects A and B	13.0	10.4	2.6	0
3	East Anglia ONE	39.7	33.8	5.9	5.9
3	European Offshore Wind Deployment Centre	0.0	0.0	0.0	0

Tier	Wind farm	Predicted collisions (@ 99.5% avoidance rate, Band Model option 2)			
		Annual	Nonbreeding	Breeding (Annual minus nonbreeding)	Projects within 141km of Alde Ore SPA
3	Firth of Forth Alpha and Bravo	10.5	8.4	2.1	0
3	Inch Cape	0.0	0.0	0.0	0
3	Moray Firth (EDA)	0.0	0.0	0.0	0
3	Neart na Gaoithe	1.5	1.2	0.3	0
3	Dogger Bank Teesside Projects A and B	12.0	9.6	2.4	0
3	Triton Knoll	37.0	29.6	7.4	0
3	Hornsea Project Two	4.0	2.0	2.0	0
4	East Anglia THREE	10.0	8.2	1.8	1.8
5	Hornsea Project Three	17.3	0	17.3	0
5	Thanet Extension	2.3	0.8	1.5	1.5
5	Moray West	0	0	0	0
5	Norfolk Vanguard (apportioned as Table 18)	39.6	10.4	29.2	5.0
	Total (inc. Hornsea Project Three)	**546.7**	**369.2**	**177.9**	**68.2**
	Total (exc. Hornsea Project Three)	**529.4**	**369.2**	**160.6**	**68.2**

114. It should be noted that it was not possible to estimate mortality for each of the three non-breeding seasons (autumn, winter, spring) as defined by Furness (2015) because the required breakdown of estimates by month is not available for this species for most wind farms. Hence, it was necessary to define mortality as either annual or non-breeding season and from these calculate the breeding season mortality. Cumulative lesser black-backed gull non-breeding season mortality is estimated at 369.2 birds (of all age classes), of which the proposed Norfolk Vanguard project contributes 10.4 birds. Cumulative breeding season mortality has been estimated as 177.9, of which Norfolk Vanguard was estimated to contribute 29.2.

115. Given that tracking studies have revealed low connectivity for the Alde-Ore SPA population with the Norfolk Vanguard site (Thaxter et al. 2012b, 2015), it is questionable both whether the proposed Norfolk Vanguard project would contribute to an in-combination total during the breeding season, and also if all of the wind farms within 141 km should be considered. However, as a precautionary assessment with respect to the Alde-Ore SPA population, wind farms within 141 km of the Alde-Ore SPA have been considered during the breeding season, on the grounds that only these wind farms have the potential to contribute to mortality on the SPA population at this time of year. Hence the breeding season mortality has been summed for Greater Gabbard, Gunfleet Sands, Kentish Flats, London Array, Scroby Sands, Sheringham Shoal, Thanet, Thanet Extension, Dudgeon, East Anglia ONE, Galloper and East Anglia THREE. The total breeding season mortality for these wind

farms is 63.3, to which Norfolk Vanguard adds 5. However, it is more likely that the breeding season total should be based on wind farms within the mean foraging range of 72 km (Greater Gabbard, East Anglia ONE, Galloper, London Array) which indicate a total breeding season mortality estimate of 45 collisions.

116. Allowing for the relative size of the Alde Ore Estuary SPA population compared with that in Norfolk and Suffolk as a whole within 141 km of the SPA (the SPA is estimated to represent 30% of the total Norfolk and Suffolk lesser black-backed gull population, as discussed above), the breeding season total was estimated to be 24.0 (30% of the other wind farm total of 63.3 plus 5.0 at Norfolk Vanguard).

117. In the nonbreeding season, as discussed above, given the large geographical area from which lesser black-backed gulls migrating through the Norfolk Vanguard site originate, it is only possible to apportion mortality to the Alde-Ore SPA population on the basis of its size relative to the wider lesser black-backed gull population. Across all age classes the Alde-Ore Estuary SPA represents approximately 3.3% of the BDMPS autumn population, about 3.3% of the BDMPS spring population and a maximum of 5% of the BDMPS winter population. As noted above, for many wind farms there is insufficient information to determine in which months nonbreeding season collisions occur. Therefore, on the basis of the whole period a weighted Alde-Ore Estuary SPA percentage of 4% has been calculated (5 months at 3.3% and 4 months at 5%). This indicates that up to 15 birds (369 x 4%) could die from the Alde-Ore Estuary SPA population during the nonbreeding season (of which 0.35 are attributed to Norfolk Vanguard).

118. The annual mortality of lesser black-backed gulls from the Alde-Ore SPA is therefore 15 during the nonbreeding season and 24.0 during the breeding season, 39.0 in total (of which Norfolk Vanguard contributes up to 5.3).

119. In-combination mortality of up to 39 birds, using Natural England's preferred precautionary approach, attributable to the Alde-Ore SPA population of lesser black-backed gulls compares with estimated natural mortality of about 940 birds per year. Thus, the additional in-combination mortality would increase this to 979 which represents an increase in mortality rate of 4.1%.

120. Recent work has highlighted the reduction in collisions which results from updating consented assessments to reflect as-built wind farm designs in comparison to the original full consent envelopes (MacArthur Green 2017, unpublished report). For the wind farms within foraging range of Alde Ore Estuary SPA where this has been undertaken updating from the consented design to the as-built design reduces predicted mortality by an average of 33% (MacArthur Green 2017 unpublished report), which would reduce the in-combination mortality prediction for existing wind farms from 19 (63.3 x 0.3, accounting for the SPA proportion of birds present)

to around 12.7 (19 x 0.67, accounting for headroom reduction), to which the Norfolk Vanguard project adds 5.3 (17.7 in total) which would result in an increase in background mortality of 1.9%.

121. To provide context for these estimates, it is worth noting that the in-combination collision total predicted for the Galloper Wind Farm was 85 when this wind farm was consented (using the methods recommended at that time but updated to the 99.5% avoidance rate to ensure comparability), which is more than double the more precautionary estimate of 39 above, and more than four times the more likely prediction of 17.7.

122. It is also worth noting, the comments made by the Secretary of State in relation to the East Anglia ONE assessment. Despite the much lower avoidance rate applied at the time of that assessment (98%), it was concluded by the Secretary of State in relation to East Anglia ONE (DECC 2014), that the mortality from offshore wind farms is insignificant compared to other factors affecting the population of the lesser black-backed gull, and with planned improvements to the SPA (such as excluding predatory mammals from gull colonies), immigration from other colonies is likely, and would boost numbers, should favourable breeding conditions be created.

123. To summarise the above calculations, the all age class, annual, in-combination mortality predictions are:

- 39 (based on 141 km foraging range) comprising:
  - 15 nonbreeding (0.35 at Norfolk Vanguard),
  - 24 breeding (63.3 x 0.3 for other wind farms within 141km plus 5 at Norfolk Vanguard);
- 30 (based on 72 km foraging range) comprising:
  - 15 nonbreeding (0.35 at Norfolk Vanguard),
  - 15 breeding if wind farms within 72km are included in the breeding season (45 x 30% accounting for the Alde Ore Estuary SPA percentage of the Norfolk and Suffolk population with potential connectivity; 0 at Norfolk Vanguard);
- 28 (based on 141 km foraging range and consent vs. built reduction) comprising:
  - 10 nonbreeding (15 x 67%; 0.35 at Norfolk Vanguard),
  - 18 breeding (63.3 x 0.3 x 0.67 of the existing wind farm total plus 5 at Norfolk Vanguard).

124. These were converted to adult mortalities by multiplying by 0.58, giving in-combination totals of between 16 and 23.

125. A population model was developed to provide further interpretation of these potential in-combination impacts (MacArthur Green 2019). This model was developed following current NE guidance, utilising a matched-run approach to generate counterfactuals of population size (CPS) and counterfactuals of population growth rate (CPGR) and run for a simulated period of 30 years. Summary results are provided in Table 20.

Table 20. Lesser black-backed gull Alde Ore Estuary SPA population modelling results (see MacArthur Green 2019 for details).

Model	Adult mortality	Counterfactual metric (after 30 years)		Source table (Appendix 1)
		Growth rate	Population size	
Density independent	15	0.995	0.898	Tables A.1 & A.2
	25	0.991	0.834	
Density dependent	15	0.998	0.971	Tables A.3 & A.4
	25	0.998	0.951	

126. Taking the modelled adult mortality of 25 (as the worst case), the population growth rate was predicted to be 0.9% lower (0.991) than the baseline using the density independent model, and 0.2% lower (0.998) using the density dependent model. At the lower modelled adult mortality of 15, the reduction in growth rate was 0.5% for the density independent model and 0.2% for the density dependent model.

127. These reductions in growth rate, which are all less than 1%, even for the more precautionary density independent model and the higher precautionary collision predictions, are small and therefore are not considered likely to result in a population decline. The more realistic collision estimates, accounting for the reduced impacts from built wind farms compared with the consented designs, predict a growth rate reduction of no more than 0.5% (density independent), which further reduces any concerns about the impact on the SPA population.

2.4.1.4 Conclusion

128. The relevant conservation objective is to restore breeding numbers of lesser black-backed gulls from the present level of about 2,000 pairs back to the population size at designation which was about 14,000 pairs. The annual number of predicted lesser black-backed gull collisions at the Norfolk Vanguard site, including the precautionary assumption of an extended breeding season, which can be attributed to the Alde Ore SPA is very small (no more than 5.3) and therefore not considered to materially alter the natural mortality rate for this population. Therefore, no adverse effect on the integrity of the Alde-Ore SPA lesser black-backed gull population is predicted as a result of the proposed Norfolk Vanguard project alone.

129. Given the degree of precaution in collision assessments, including the use of the much higher mortality predictions estimated for consented wind farm designs rather than for the as built wind farm designs, it is considered that an adverse effect on integrity due to in-combination collisions can also be ruled out.

130. Furthermore, the context for the status of this population is relevant to the significance of potential collision mortality. The breeding success, and hence the population trend, of lesser black-backed gulls in the Alde-Ore SPA population appears to be mainly determined by the amount of predation, disturbance and flooding occurring at this site (Department of Energy and Climate Change 2013a, Thaxter et al. 2015). Increased predation and disturbance by foxes has been considered the main factor causing reductions in breeding numbers. Management measures to reduce access by foxes has resulted in some recovery of numbers of gulls. The main driver of gull numbers in this SPA therefore appears to be suitable management at the colonies to protect gulls from predators (Department of Energy and Climate Change 2013a). It seems apparent that further efforts in this regard could readily offset the in-combination collision mortality and improve this population's conservation status.

2.5 Auk displacement

131. Sections 2.6 to 2.8 of this report provides an updated cumulative and in-combination assessment of potential displacement impacts on guillemot, razorbill and puffin. This has been produced to address comments and concerns raised by Natural England.

132. An updated displacement assessment for auks was provided in appendix 3.3 at Deadline 1 (Appendix 3.3, document reference ExA; WQApp3.3; 10.D1.3). Natural England reviewed it and agreed that the Project alone displacement impacts (from an EIA point of view) for puffin and guillemot were not significant, while that for razorbill was also not expected to be significant, but due to minor summing errors this required revision before Natural England could confirm this (Natural England 2019). Other comments made by Natural England which are addressed in this note are provided in Table 21.

Table 21. Natural England (2019) comments on the auk assessment and the Applicant's response.

Comment	Section where addressed
The midwinter (razorbill) peak for Norfolk Vanguard East was reported as 279 (November) rather than the higher December value (491).	This has been amended in the assessment below, section 2.7
The figures used for the Thanet Extension wind farm were taken from the project's Environmental Statement (ES) tables which applied a 0.5 km buffer, rather than the Statutory Natural Conservation Bodies (SNCBs) advise width of 2 km.	These have now been replaced in the assessment below (sections 2.6, 2.7 and 2.8) with values from the project's technical reports, summed for the wind farm and 2 km buffer
The figures for the Seagreen Alpha and Bravo projects used	The Applicant has reviewed the available

Comment	Section where addressed
values obtained from the project's 2018 submission. Natural England requested that the figures used should be those which correspond to the 2012 consented project.	document for the earlier, 2012 submission, and has been unable to find population estimates which include the wind farms and 2km buffers, whereas these estimates (inc. the buffers) are available in the 2018 submission. Furthermore, the 2018 values include the data used for the 2012 application, with the addition of data from the 2017 (May to October) surveys. Therefore, the Applicant considers the 2018 submission estimates to be robust for the purposes of the current cumulative assessment.
Natural England requested the inclusion of figures for the Moray West wind farm.	These have been added in the assessment below (sections 2.6, 2.7 and 2.8).
The puffin estimate for Norfolk Vanguard East in the breeding season in the cumulative table was mistakenly reported as 0, rather than 67.	This has been corrected in the assessment below (section 2.6). It should be noted that the project alone estimate for Norfolk Vanguard East in Appendix 3.3, document reference ExA; WQApp3.3; 10.D1.3 used the correct value.
Natural England initially questioned the reference BDMPS (biologically defined minimum population scale) populations used for assessing guillemot and puffin (Natural England's comments on Appendix 3.3 – Operational Auk and Gannet Displacement: update and clarification [REP1-008]). However, Natural England subsequently agreed these populations are appropriate for assessing annual impacts (Natural England's comments on responses by all other parties to the Examining Authority's second written questions. 20 March 2019).	No update required.
Natural England advise that the relevant biogeographic populations should also be used for assessment.	These have now been included in the assessment below (sections 2.6, 2.7 and 2.8).
Natural England advised that assessment should include consideration of the full range of their advised displacement (30-70%) and mortality (1-10%) rates.	These were all presented in the auk note (Appendix 3.3, document reference ExA; WQApp3.3; 10.D1.3), with the Applicant's evidence based rates of 50% displacement and 1% mortality used for consideration of impacts. Additional discussion is provided which considers the NE advised range. These are also presented in the assessment below (sections 2.6, 2.7 and 2.8).

2.6 Puffin

133. Norfolk Vanguard East and Norfolk Vanguard West are located 205 km and 233 km respectively from Flamborough and Filey Coast SPA, which is beyond the puffin mean maximum foraging range of 105 km (Thaxter et al. 2012). Therefore, it is appropriate to assume there is no breeding season connectivity with Norfolk Vanguard. Outside the breeding season, puffins disperse from their breeding sites.

Large numbers are found throughout the North Sea in the nonbreeding season (defined as August to February).

134. Table 22 presents the abundance of puffins in all wind farms included in the cumulative assessment, including Norfolk Vanguard. The abundance peaked on Norfolk Vanguard during the nonbreeding season with a mean maximum of 112 individuals. The total population at risk on North Sea wind farms and also apportioned to the Flamborough and Filey Coast SPA are presented in Table 22. During the breeding season, for wind farms within the mean maximum foraging range (105 km; Thaxter et al. 2012) a precautionary assumption has been made that 100% percent of the birds present originate from the SPA, and 0% for all other sites (i.e. those beyond 105 km). To calculate the proportion of birds from the Flamborough and Filey Coast SPA on each wind farm during the nonbreeding season, the SPA population (adjusted for all age classes by dividing by 0.55, Furness 2015) was divided by the UK North Sea and Channel BDMPS population (3484/231,956 = 1.5%) and this was multiplied by the nonbreeding population estimates.

Table 22. Cumulative and in-combination puffin numbers on wind farms in the North Sea.

Project	Total		Apportioned to the FFC SPA	
	Breeding season	Non-breeding season	Breeding season	Non-breeding season
Aberdeen	42.0	81.7	0	1.2
Beatrice	2858.0	2434.8	0	36.6
Blyth Demonstration	235.0	122.8	0	1.8
Dogger Bank Creyke Beck A	37.0	295.2	0	4.4
Dogger Bank Creyke Beck B	102.0	742.9	0	11.2
Dogger Bank Teesside A	34.0	273.0	0	4.1
Dogger Bank Teesside B	35.0	328.7	0	4.9
Dudgeon	1.0	3.2	0	0.0
East Anglia ONE	16.0	32.0	0	0.5
East Anglia THREE	181.0	307.0	0	4.6
Galloper	0.0	0.8	0	0.0
Greater Gabbard	0.0	0.9	0	0.0
Hornsea Project One	1070.0	1257.0	1070.0	18.9
Hornsea Project Two	468.0	2039.0	468.0	30.6
Hornsea Project Three	253.0	127.0	0	1.9
Humber Gateway	15.0	9.6	15.0	0.1
Hywind	119.0	85.0	0	1.3
Inch Cape	2956.0	2688.0	0	40.4
Kincardine	19.0	0	0	0.0
Lincs and LID6	3.0	6.0	3.0	0.1
London Array I & II	0.0	0.6	0	0.0
Moray East	2795.0	656.4	0	9.9
Moray West	1115	3966	0	59.6
Neart na Gaoithe	2562.0	2103.4	0	31.6
Race Bank	1.0	9.6	1.0	0.1

Project	Total Breeding season	Non-breeding season	Apportioned to the FFC SPA Breeding season	Non-breeding season
Seagreen A	2572.0	1526.0	0	22.9
Seagreen B	3582.0	3863.0	0	58.0
Sheringham Shoal	4.0	25.8	0	0.4
Teesside	35.0	18.0	0	0.3
Thanet	0.0	0.1	0	0.0
Thanet Extension	0.0	0.0	0	0.0
Triton Knoll	23.0	70.7	23.0	1.1
Westermost Rough	61.0	35.0	61.0	0.5
Seasonal Total (Ex. NV)	**21194**	**23109**	**1641**	**347**
Annual Total (Ex. NV)		**443030**		**1988**
Norfolk Vanguard East	67	112	0	1.7
Norfolk Vanguard West	0	0	0	0
Seasonal Total (Inc. NV)	**21261**	**23221**	**1641**	**348.7**
Annual Total (Inc. Hornsea Project Three)		**44482**		**1989.7**
Annual Total (ex. Hornsea Project Three)		**441020**		**1987.8**

135. Natural England does not consider a single combination of displacement and mortality in their assessment of impact, instead advising presentation of a range from 30% to 70% displaced and 1% to 10% mortality. However, evidence in support of the use of a precautionary displacement rate of 50% within the wind farm, 30% within the 1 km buffer and 0% thereafter, combined with a 1% mortality rate for guillemot and razorbill (1st WQ Appendix 3.3) is also considered appropriate for puffin (although it should be noted this assessment has not applied the variable rate but rather 50% across the wind farm and 2 km buffer). Table 23 provides estimates of the displacement mortality at Norfolk Vanguard and all UK North Sea wind farms included in the cumulative assessment and also apportioned to the Flamborough and Filey Coast SPA.

Table 23. Puffin abundance estimates on Norfolk Vanguard and summed across all UK North Sea and Channel wind farms, and number apportioned to Flamborough and Filey Coast SPA and estimates of displacement mortality.

Site	Season	Total population at risk of displacement	Total impact, displacement & mortality rates: 30% - 1%	50% - 1%	70%-10%	Population apportioned to FFC SPA	FFC SPA impact, displacement & mortality rates: 30% - 1%	50% - 1%	70%-10%
Norfolk Vanguard East	Breeding	67	0.2	0.3	4.7	0	0	0	0
	Nonbreeding	112	0.3	0.6	7.8	1.7	<0.01	<0.01	0.12
	Annual	179	0.5	0.9	12.5	1.7	<0.01	<0.01	0.12
Norfolk Vanguard	Breeding	0	0	0	0	0	0	0	0
	Nonbreeding	-	0	0	0	0	0	0	0

Site	Season	Total population at risk of displacement	Total impact, displacement & mortality rates: 30% - 1%	50% - 1%	70%-10%	Population apportioned to FFC SPA	FFC SPA impact, displacement & mortality rates: 30% - 1%	50% - 1%	70%-10%
West	Annual	0	0	0	0	0	0	0	0
All North Sea wind farms East & West	Breeding	21261	64	106	1488	1641	5	8	115
	Nonbreeding	23221	70	116	1625	348.7	1.0	1.7	24
	Annual	44482	133	222	3114	1989.7	6	9.7	139

2.6.1.1 EIA Project alone

136. Annual mortality of puffins displaced from Norfolk Vanguard East was estimated to be in the range 0.5 to 12.5 and 0 for Norfolk Vanguard West. Assessed against the largest BDMPS (868,689), with a baseline mortality rate of 0.167, the addition of the worst case displacement mortality of 12.5 to this would increase the mortality rate by <0.01%, while assessed against the biogeographic population (11,840,000) this would result in an increase in mortality by <0.001%. Therefore the worst case displacement mortality would have a negligible magnitude and result in an impact of negligible significance.

2.6.1.2 EIA Cumulative

137. The total number of puffins considered to be at risk of displacement from UK North Sea and Channel wind farms (including Hornsea Project Three) in the breeding season including Norfolk Vanguard was estimated to be 21,261 (67 on Norfolk Vanguard) and in the nonbreeding season 23,221 (112 on Norfolk Vanguard).

138. The cumulative total annual mortality across all UK North Sea and Channel wind farms was estimated to be in the range 133 to 3,114. Assessed against the largest BDMPS (868,689), with a baseline mortality rate of 0.167, the addition of the worst case displacement mortality (at 70% displaced and 10% mortality) of 3,114 to this, would increase the mortality rate by 2.1%, while assessed against the biogeographic population this would result in an increase in mortality of 0.16%. Using the evidence based annual mortality of 222 (assessed at 50% displaced and 1% mortality) the increase in mortality rate for the BDMPS population would be 0.15% and against the biogeographic population would be 0.01%.

139. Therefore, using the most precautionary rates preferred by Natural England (70% displaced and 10% mortality) this suggests that a significant cumulative displacement impact cannot be ruled out for the worst case prediction when assessed against the BDMPS population (an increase in mortality of 2.1%). However, it should be noted that the contribution to this total from Norfolk Vanguard is less than 0.4% which

corresponds to only 12.5 individuals. Therefore, Norfolk Vanguard's addition to this cumulative impact is negligible.

140. However, using the evidence based rates (50% displaced and 1% mortality) this increase in mortality is 0.15% which is below the threshold considered detectable (1%) and less than 1 mortality would be attributed to Norfolk Vanguard . On this basis the displacement mortality would have a negligible magnitude and result in an impact of negligible significance.

2.6.1.3 HRA Project alone

141. Of the puffins recorded on Norfolk Vanguard, 1.7 were apportioned to the Flamborough and Filey Coast SPA population, and at the worst case displacement rates this was estimated to result in 0.12 additional mortalities. This would increase the background mortality rate by 0.02%, which is much lower (50x) than the threshold for detectable effects, defined as a 1% increase. Therefore, there is no risk of an adverse effect on the integrity of the SPA due to this extremely small effect at Norfolk Vanguard.

2.6.1.4 HRA in-combination

142. The number of puffins apportioned to the Flamborough and Filey Coast SPA population at risk of displacement on North Sea wind farms was estimated to be 1,641 in the breeding season (of which over 1,500, 94%, were recorded on the Hornsea Projects 1 and 2 wind farms and none on Norfolk Vanguard) and 349 in the nonbreeding season (of which 1.7 were recorded on Norfolk Vanguard). Overall, of the 1,989.7 puffins (including Hornsea Project Three) at risk of displacement annually, 0.08% were birds on Norfolk Vanguard. Without Hornsea Project Three this total is reduced to 1987.8.

143. Therefore, irrespective of the potential for an in-combination effect on the SPA population, it is evident that Norfolk Vanguard's contribution to this will make no difference. Given this extremely small contribution, it is therefore arguable that there is no requirement for the Applicant to undertake an in-combination assessment.

144. It is important to note that puffins are extremely difficult to census because they nest in burrows, the back of holes in cliffs and under boulders. The number of puffins visible at colonies fluctuates from hour to hour and day to day (Furness 2015). As a consequence, it is highly probable that the Flamborough and Filey Coast SPA population is significantly underestimated, since this site is largely inaccessible and extremely challenging to census. It is therefore very likely that the magnitude of effect calculated above is also over-estimated.

145. It should also be noted that the HRA for the Hornsea Project Two concluded: "The Secretary of State recognises the methodological disagreements between the parties. He has considered the representations made by the Applicant, NE and the RSPB and the recommendation as made by the ExA. The Secretary of State agrees with the recommendations of the ExA, NE and the Applicant and is satisfied that the potential increased auk species displacement mortality as a result of the Project in-combination would not represent an adverse effect upon the integrity of the FFC pSPA. For this conclusion he places particular weight on the advice of NE that predicted mortalities for the Project in-combination would not exceed a level whereby the growth rate of the populations would be reduced by more than 0.4% p.a. for guillemot, 0.5% p.a. for razorbill, and 0.25% p.a. for puffin."

146. On the basis of the precautionary assumptions, the Secretary of State's conclusion in relation to Hornsea Project Two, and that of the 1,989.7 puffins at risk of displacement annually the additional projects since Hornsea Project Two was consented only contribute an additional 3.47 % to the total, it can be concluded that there will be no adverse effect on the integrity of the FFC SPA from impacts on puffin due to the proposed Norfolk Vanguard project in-combination with other plans and projects.

2.7 Razorbill

147. Norfolk Vanguard East and Norfolk Vanguard West are located 205 km and 233 km respectively from Flamborough and Filey Coast SPA (the nearest breeding colony), which is beyond the razorbill mean maximum foraging range of 48.5km (Thaxter et al. 2012). Therefore, it is appropriate to assume there is no breeding season connectivity with Norfolk Vanguard. Outside the breeding season, razorbills migrate from their breeding sites. Large numbers are found throughout the North Sea in the nonbreeding seasons (covering the period from August to March).

148. Table 24 presents the abundance of razorbills in all wind farms included in the cumulative assessment, including Norfolk Vanguard. The annual total of razorbills at risk of displacement on the Norfolk Vanguard site (combined across the breeding season and all the nonbreeding seasons and both Norfolk Vanguard East and West) was a mean maximum of 3,508 individuals (Table 24).

149. The totals at risk on other North Sea wind farms and apportioned to the Flamborough and Filey Coast SPA are also presented in Table 24. During the breeding season, for wind farms within the mean maximum foraging range (48.5 km; Thaxter et al. 2012) a precautionary assumption of 100% percent of the individuals have been considered to originate from the SPA, and 0% for all other sites (i.e. those beyond 48.5km). During the nonbreeding seasons the SPA population (37,088, adjusted for all age classes by dividing by 0.57, Furness 2015) has been divided by

the respective seasonal UK North Sea and Channel BDMPS populations (591,874 in spring and autumn and 218,622 in winter).

Table 24. Cumulative and in-combination razorbill numbers on wind farms in the North Sea.

	Total				Apportioned to the FFC SPA			
Project	Spring	Breeding	Autumn	Winter	Spring	Breeding	Autumn	Winter
Aberdeen	161.0	64.4	7.3	25.7	0.0	4	1	2
Beatrice	873.0	833.0	555.3	833.0	0.0	52	94	52
Blyth Demonstration	121.0	90.9	60.6	90.9	0.0	6	10	6
Dogger Bank Creyke Beck A	1250.0	1576.0	1728.0	4149.0	0.0	99	293	260
Dogger Bank Creyke Beck B	1538.0	2097.0	2143.0	5118.7	0.0	131	364	321
Dogger Bank Teesside A	834.0	310.3	958.5	1919.0	0.0	19	163	120
Dogger Bank Teesside B	1153.0	592.3	1426.0	2953.3	0.0	37	242	185
Dudgeon	256.0	346.1	745.4	346.1	0.0	22	126	22
East Anglia ONE	16.0	26.0	154.5	336.0	0.0	2	26	21
East Anglia THREE	1807.0	1122.0	1499.0	1524.0	0.0	70	254	95
Galloper	44.0	43.0	105.5	394.0	0.0	3	18	25
Greater Gabbard	0.0	0.0	387.3	83.8	0.0	0	66	5
Hornsea Project One	1109.0	4812.3	1517.5	1802.8	0.0	302	257	113
Hornsea Project Two	2511.0	4220.5	719.5	1668.0	0.0	264	122	105
Hornsea Project Three	630.0	2020.0	3649.0	1236.0	0.0	127	619	77
Humber Gateway	27.0	20.0	13.4	20.0	0.0	1	2	1
Hywind	30.0	719.0	10.0		0.0	45	2	0
Inch Cape	1436.0	2870.0	651.0		0.0	180	110	0
Kincardine	22.0				0.0	0	0	0
Lincs and LID6	45.0	33.5	22.3	33.5	0.0	2	4	2
London Array I & II	14.0	20.4	13.6	20.4	0.0	1	2	1
Moray East	2423.0	1102.6	30.2	168.3	0.0	69	5	11
Moray West	2808	3544	184	3585	0.0	222	31	225
Neart na Gaoithe	331.0	5492.4	507.8		0.0	344	86	0
Race Bank	28.0	42.0	28.0	42.0	0.0	3	5	3
Seagreen A	5876.0		1003.0		0.0	0	170	0
Seagreen B	3698.0		1272.0		0.0	0	216	0
Sheringham Shoal	106.0	1343.0	211.3	30.2	0.0	84	36	2
Teesside	16.0	61.5	1.9	20.0	0.0	4	0	1
Thanet	3.0	0.0	13.6	20.9	0.0	0	2	1
Thanet Extension		6.0	56.0	124.0	0.0	0	10	8
Triton Knoll	40.0	253.7	854.5	116.7	0.0	16	145	7
Westermost Rough	91.0	121.3	151.6	90.9	91.0	8	26	6
Seasonal Total (Ex. NV)	**29297**	**33783**	**20681**	**26752**	**91**	**2117**	**3507**	**1677**
Annual Total (Ex. NV)				**110513**				**7392**

Project	Total				Apportioned to the FFC SPA			
	Spring	Breeding	Autumn	Winter	Spring	Breeding	Autumn	Winter
Norfolk Vanguard East	599	491	491	752	0.0	31	83	47
Norfolk Vanguard West	280	375	348	172	0.0	23	59	11
Seasonal Total (Inc. NV)	**30176**	**34649.2**	**21519.6**	**27676.1**	**91.0**	**2171.0**	**3649.0**	**1735.0**
Annual Total (Inc. Hornsea Project Three)				**114021**				**7646.0**
Annual Total (ex. Hornsea Project Three)				**106486**				**6823**

150. Natural England advises presentation of a range of displacement rates of between 30% and 70% displacement and 1% and 10% mortality. However, evidence was presented in support of the use of a precautionary displacement rate of 50% within the wind farm, 30% within the 1 km buffer and 0% thereafter, combined with a 1% mortality rate for guillemot and razorbill (1st WQ Appendix 3.3; although note that the variable buffer has not been applied in this assessment, with the 50% rate applied across both the wind farm and 2km buffer). Predictions using these alternative rates are presented in Table 25.

Table 25. Razorbill abundance estimates on Norfolk Vanguard and summed across all UK North Sea and Channel wind farms, number apportioned to Flamborough and Filey Coast SPA and estimates of displacement mortality.

Site	Season	Total population at risk of displacement	Total impact, displacement & mortality rates:			Population apportioned to FFC SPA	FFC SPA impact, displacement & mortality rates:		
			30% - 1%	50% - 1%	70%-10%		30% - 1%	50% - 1%	70%-10%
Norfolk Vanguard East	Spring	599	1.8	3.0	41.9	0	0.0	0.0	0.0
	Breeding	491	1.5	2.5	34.4	31	0.1	0.2	2.2
	Autumn	491	1.5	2.5	34.4	83	0.2	0.4	5.8
	Midwinter	752	2.3	3.8	52.6	47	0.1	0.2	3.3
	Annual	2333	7.1	11.8	163.3	161	0.4	0.8	11.3
Norfolk Vanguard West	Spring	280	0.8	1.4	19.6	0	0.0	0.0	0.0
	Breeding	375	1.1	1.9	26.3	23	0.1	0.1	1.6
	Autumn	348	1.0	1.7	24.4	59	0.2	0.3	4.1
	Midwinter	172	0.5	0.9	12.0	11	0.0	0.1	0.8
	Annual	1175	3.4	5.9	82.3	93	0.3	0.5	6.5
Norfolk Vanguard East and West	Spring	879	2.6	4.4	61.5	0	0.0	0.0	0.0
	Breeding	866	2.6	4.3	60.6	54	0.2	0.3	3.8
	Autumn	839	2.5	4.2	58.7	142	0.4	0.7	9.9
	Midwinter	924	2.8	4.6	64.7	58	0.2	0.3	4.1

Site	Season	Total population at risk of displacement	Total impact, displacement & mortality rates:			Population apportioned to FFC SPA	FFC SPA impact, displacement & mortality rates:		
			30% - 1%	50% - 1%	70%-10%		30% - 1%	50% - 1%	70%-10%
Combined	Annual	3508	10.5	17.5	245.5	254	0.8	1.3	17.8
UK North Sea and Channel wind farms	Spring	27676	90.5	150.9	2112.3	1735	5.2	8.7	121.5
	Breeding	30176	103.9	173.2	2425.4	91	0.3	0.5	6.4
	Autumn	34649	64.6	107.6	1506.4	2171	6.5	10.9	152.0
	Midwinter	21520	83.0	138.4	1937.3	3649	10.9	18.2	255.4
	Annual	114021	342.1	570.1	7981.5	7646	22.9	38.2	535.2

2.7.1.1 EIA Project alone

151. Annual mortality of razorbills displaced from Norfolk Vanguard was estimated to be in the range 10.5 to 245.5 (summed across both the East and West sites and all seasons). Assessed against the largest BDMPS (591,874), the addition of the worst case displacement mortality of 245.5 to the background mortality of 192,986 would increase the mortality rate by 0.24%, while assessed against the biogeographic population this would increase the baseline mortality rate by 0.08%, which is below the 1% threshold at which impacts are considered undetectable. Therefore, the worst case displacement mortality would have a negligible magnitude and result in an impact of negligible significance.

2.7.1.2 EIA Cumulative

152. The cumulative total annual mortality across all UK North Sea and Channel wind farms was estimated to be in the range 342 to 7,981 with the inclusion of Hornsea Project Three and 292 to 6,826 without this project. Assessed against the largest BDMPS (591,874), with a baseline mortality rate of 0.174, the addition of the worst case displacement mortality of 7,981 (at 70% displaced and 10% mortality) to this would increase the mortality rate by 7.7%, while assessed against the biogeographic population this would result in an increase in mortality of 0.27%. Using the evidence based annual mortality (570) the increase in mortality rate for the BDMPS population would be 0.55% and against the biogeographic population would be 0.02%.

153. Therefore, using the most precautionary rates preferred by Natural England (70% displaced and 10% mortality) this suggests that a significant cumulative displacement impact cannot be ruled out for the worst case prediction when assessed against the BDMPS population (an increase in mortality of 7.7%). However it should be noted that of this, the contribution from Norfolk Vanguard is only just over 3%.

154. However, using the evidence based rates (50% displaced and 1% mortality) this increase in mortality would be a maximum of 0.55% which is below the threshold

considered detectable (1%). On this basis the displacement mortality would have a negligible magnitude and result in an impact of negligible significance.

2.7.1.3 HRA Project alone

155. Natural England considered that a LSE on the razorbill population of the Flamborough and Filey Coast SPA due to displacement from the Norfolk Vanguard wind farm could not be ruled out. Apportioning the Norfolk Vanguard displacement mortality to the SPA on the basis of no connectivity in the breeding season (as the wind farm is located more than four times the mean maximum foraging range for this species) and an even distribution in the nonbreeding season (on the assumption that the SPA population is evenly distributed within the nonbreeding BDMPS population) the worst case mortality due to Norfolk Vanguard was 17.8 individuals. This would increase the baseline mortality (of 6,453, calculated for all ages assuming 57% adults, Furness 2015) by 0.3%, which would be undetectable. Therefore, displacement of razorbill from Norfolk Vanguard would not have an adverse effect on the integrity of the SPA.

2.7.1.4 HRA In-combination

156. Given the extremely small mortality due to Norfolk Vanguard it is clear that the project will make an extremely small contribution to an in-combination impact. Nonetheless, on the basis of the totals in Table 25 the combined displacement mortality across the whole year was estimated to be in the range 23 to 535 individuals. These would increase the baseline mortality rate of the population (all ages) by 0.35% to 8.3%, while assessed using the evidence based displacement and mortality rates, the increase would be 0.6%.

157. On the basis of the most precautionary rates preferred by Natural England, there is potential for an adverse effect on the razorbill population due to in-combination displacement effects. However, using the evidence based prediction, which is below the 1% threshold for detecting increases in mortality, the conclusion would be no adverse effect on the integrity of this SPA for the Project Alone or in-combination with other plans and projects. Furthermore, the contribution to this from Norfolk Vanguard is very small, estimated to comprise 3.4%.

158. Outputs from a PVA model for this population were presented for the Hornsea Project Three wind farm (MacArthur Green 2018). This modelling was an update of similar models produced for Hornsea Project Two, with the addition of a matched-run approach for calculating counterfactual outputs and an extended simulation period (up to 35 years). Simulations were conducted with and without density dependence and were summarised as the counterfactual of population size and population growth rate. The outputs from this model were presented as additional

adult mortality, therefore the total FFC SPA estimates have been converted to adults by multiplying by the adult proportion (57%). Thus, the all age class in-combination estimate of 535 comprises 305 adults, and without Hornsea Project Three the all age total of 434.5 comprises 230 adults. The Norfolk Vanguard project alone estimate of 17.8 comprises 10 individuals. The outputs from these models for mortality levels of 50, 250 and 300 (the nearest values to the project alone and in-combination predictions) are provided in Table 26.

Table 26. Razorbill FFC SPA population modelling results from MacArthur Green (2018).

Model	Mortality	Counterfactual metric (after 30 years)		Source table (MacArthur Green 2018)
		Growth rate	Population size	
Rate set 1, density independent	50	0.998	0.934	Table A2 13.1 & 13.3
	250	0.988	0.708	
	300	0.986	0.660	
Rate set 1, density dependent	50	1.00	0.978	Table A2 14.1 & 14.3
	250	0.998	0.891	
	300	0.997	0.870	
Rate set 2, density independent	50	0.998	0.933	Table A2 15.1 & 15.3
	250	0.988	0.760	
	300	0.986	0.707	
Rate set 2, density dependent	50	0.998	0.949	Table A2 16.1 & 16.3
	250	0.991	0.760	
	300	0.989	0.716	

159. The maximum reduction in the population growth rate, at a mortality of 50 (which is five times the Norfolk Vanguard alone adult displacement mortality of 10 estimates using the worst case displacement and mortality rates), using the more precautionary density independent model was 0.2% (0.998). On the basis of the observed rate at which this population has grown, between 2000 and 2008 (7.2%) and between 2008 and 2017 (7.2%) (RSPB unpubl. Report 2017), a reduction of 0.2% to this rate represents a negligible risk for the population.

160. The maximum reduction in the population growth rate, at a mortality of 300 (which is the nearest modelled value to the in-combination adult total of 305), using the more precautionary density independent model was 1.4% (0.986). On the basis of the observed rate at which this population has grown, between 2000 and 2008 (7.2%) and between 2008 and 2017 (7.2%) (RSPB unpubl. Report 2017), a reduction of 1.4% to this rate, due to the worst case displacement predictions, would still permit population growth at over 5.5% per year.

161. The razorbill breeding numbers at the Flamborough and Filey Coast SPA have shown strong growth over the last 20 years and are continuing to increase so the

population is therefore clearly in favourable conservation status. The relevant conservation objective is to maintain favourable conservation status of the razorbill population, subject to natural change.

162. On the basis of the population model outputs the number of predicted in-combination razorbill displacement mortalities attributed to the Flamborough & Filey Coast SPA is not at a level which would trigger a risk of population decline, but would only result in a small reduction in the growth rate currently seen at this colony, and so would not have an adverse effect on integrity of the SPA.

163. Therefore, it can be concluded that there will be no adverse effect on the integrity of Flamborough & Filey Coast SPA from impacts on razorbill due to the proposed Norfolk Vanguard project in-combination with other plans and projects.

2.8 Guillemot

164. Norfolk Vanguard East and Norfolk Vanguard West are located 205 km and 233 km respectively from Flamborough and Filey Coast SPA (the nearest breeding colony), which is beyond the guillemot mean maximum foraging range of 84.2km (Thaxter et al. 2012). Outside the breeding season, guillemots disperse from their breeding sites. Large numbers are found throughout the North Sea in the nonbreeding season (covering the period from August to February).

165. Table 27 presents the abundance of guillemots in all wind farms included in the cumulative assessment, including Norfolk Vanguard. The annual total of guillemots at risk of displacement on the Norfolk Vanguard site (combined across the breeding season and the nonbreeding season and both Norfolk Vanguard East and West) was a mean maximum of 9,096 individuals (Table 27).

166. The totals at risk on other North Sea wind farms and apportioned to the Flamborough and Filey Coast SPA are also presented in Table 27. During the breeding season, for wind farms within the mean maximum foraging range (84.2 km) a precautionary assumption of 100% percent of the individuals have been considered to originate from the SPA, and 0% for all other sites (i.e. those beyond 84.2km). During the nonbreeding seasons the SPA population (37,088, adjusted for all age classes by dividing by 0.57, Furness 2015) has been divided by the UK North Sea and Channel BDMPS population (1,617,306).

Table 27. Cumulative and in-combination guillemot numbers on wind farms in the North Sea.

	Total		FFC	
Project	Breeding	Nonbreeding	Breeding	Nonbreeding
Aberdeen	547.0	225.0	0.0	12.0
Beatrice	13610.0	2755.0	0.0	142.0
Blyth Demonstration	1220.0	1321.0	0.0	68.0
Dogger Bank Creyke Beck A	5407.0	6142.0	0.0	316.0

	Total		FFC	
Project	**Breeding**	**Nonbreeding**	**Breeding**	**Nonbreeding**
Dogger Bank Creyke Beck B	9479.0	10621.0	0.0	546.0
Dogger Bank Teesside A	3283.0	2268.0	0.0	117.0
Dogger Bank Teesside B	5211.0	3701.0	0.0	190.0
Dudgeon	334.0	542.0	0.0	28.0
East Anglia ONE	274.0	640.0	0.0	33.0
East Anglia THREE	1744.0	2859.0	0.0	147.0
Galloper	305.0	593.0	0.0	31.0
Greater Gabbard	345.0	548.0	0.0	28.0
Hornsea Project One	9836.0	8097.0	0.0	417.0
Hornsea Project Two	7735.0	13164.0	0.0	677.0
Hornsea Project Three	13374.0	17772.0	0.0	914.0
Humber Gateway	99.0	138.0	99.0	7.0
Hywind	249.0	2136.0	0.0	110.0
Inch Cape	4371.0	3177.0	0.0	163.0
Kincardine	632.0		0.0	0.0
Lincs and LID6	582.0	814.0	0.0	42.0
London Array I & II	192.0	377.0	0.0	19.0
Moray East	9820.0	547.0	0.0	28.0
Moray West	24426.0	38174.0	0.0	1964.0
Neart na Gaoithe	1755.0	3761.0	0.0	194.0
Race Bank	361.0	708.0	0.0	36.0
Seagreen A	13606.0	4688.0	0.0	241.0
Seagreen B	11118.0	4112.0	0.0	212.0
Sheringham Shoal	390.0	715.0	0.0	37.0
Teesside	267.0	901.0	0.0	46.0
Thanet	18.0	124.0	0.0	6.0
Thanet Extension	12.0	1105.0	0.0	57.0
Triton Knoll	425.0	746.0	425.0	38.0
Westermost Rough	347.0	486.0	347.0	25.0
Seasonal Total (Ex. NV)	**141374**	**133957**	**871**	**6891**
Annual Total (Ex. NV)		**275331**		**7762**
Norfolk Vanguard East	2931	2197	0	113
Norfolk Vanguard West	1389	2579	0	133
Seasonal Total (Inc. NV)	**145694**	**138733**	**871**	**7137**
Annual Total (inc. Hornsea Project Three)		**284427**		**8008**
Annual Total (ex. Hornsea Project Three)		**253281**		**7094**

167. Natural England advises presentation of a range of displacement rates of between 30% and 70% displacement and 1% and 10% mortality. However, evidence was presented in support of the use of a precautionary displacement rate of 50% within the wind farm, 30% within the 1km buffer and 0% thereafter, combined with a 1% mortality rate for guillemot and razorbill (1st WQ Appendix 3.3; although note that the variable buffer has not been applied in this assessment, with the 50% rate

applied across both the wind farm and 2km buffer). Predictions using these alternative rates are presented in Table 28.

Table 28. Guillemot abundance estimates on Norfolk Vanguard and summed across all UK North Sea and Channel wind farms, number apportioned to Flamborough and Filey Coast SPA and estimates of displacement mortality.

Site	Season	Total population at risk of displacement	Total impact, displacement & mortality rates:			Population apportioned to FFC SPA	FFC SPA impact, displacement & mortality rates:		
			30% - 1%	50% - 1%	70%-10%		30% - 1%	50% - 1%	70%-10%
Norfolk Vanguard East	Breeding	2931	9	15	205	0	0	0	0
	Nonbreeding	2197	7	11	154	113	0	1	8
	Annual	5128	16	26	359	113	0	1	8
Norfolk Vanguard West	Breeding	1389	4	7	97	0	0	0	0
	Nonbreeding	2579	8	13	181	133	0	1	9
	Annual	3968	12	20	278	133	0	1	9
Norfolk Vanguard East and West Combined	Breeding	4320	13	22	302	0	0	0	0
	Nonbreeding	4776	14	24	334	246	1	1	17
	Annual	9096	27	46	636	246	1	1	17
UK North Sea and Channel wind farms	Breeding	145694	437	728	10199	871	3	4	61
	Nonbreeding	138733	416	694	9711	7137	21	36	500
	Annual	284427	853	1422	19910	8008	24	40	561

2.8.1.1 EIA Project alone

168. Annual mortality of guillemot displaced from Norfolk Vanguard was estimated to be in the range 27 to 636 (summed across both the East and West sites and all seasons). Assessed against the largest BDMPS (2,045,078) the worst case displacement mortality (at 70% displaced and 10% mortality) would increase the baseline mortality rate by 0.12%, which is below the 1% threshold at which impacts are considered undetectable. The same would be true in relation to the much larger biogeographic population (4,125,000). Therefore, the worst case displacement mortality would have a negligible magnitude and result in an impact of negligible significance.

2.8.1.2 EIA Cumulative

169. The cumulative total annual mortality across all UK North Sea and Channel wind farms was estimated to be in the range 853 to 19,910 with the inclusion of Hornsea Project Three and 760 to 17,730 without this project. Assessed against the largest BDMPS (2,045,078), with a baseline mortality rate of 0.14, the addition of the worst case displacement mortality of 19,910 (at 70% displaced and 10% mortality) to this would increase the mortality rate by 6.9%, while assessed against the biogeographic population this would result in an increase in mortality of 3.4%. Using the evidence

based rates (50% displaced and 1% mortality) the annual mortality of 1,422 would increase the mortality rate for the BDMPS population by 0.49% and for the biogeographic population the increase would be 0.24%.

170. Therefore, using the most precautionary rates preferred by Natural England (70% displaced and 10% mortality), this suggests that a significant cumulative displacement impact cannot be ruled out when assessed against the BDMPS population (an increase in mortality of 6.9%). It should be noted that the contribution to this total from Norfolk Vanguard is less than 3.2% (0.12% of the increase in background mortality).

171. However, using the evidence based rates (50% displaced and 1% mortality) this increase in mortality is a maximum of 0.49% which is below the threshold considered detectable (1%). On this basis the displacement mortality would have a negligible magnitude and result in an impact of negligible significance.

2.8.1.3 HRA Project alone

172. Natural England considered that a likely significant effect on the guillemot population of the Flamborough and Filey Coast SPA, due to displacement from Norfolk Vanguard, could not be ruled out. Apportioning the Norfolk Vanguard displacement mortality to the SPA on the basis of no connectivity in the breeding season (as the wind farm is located more than four times the mean maximum foraging range for this species) and an even distribution in the nonbreeding season (on the assumption that the SPA population is evenly distributed within the nonbreeding BDMPS population) the worst case mortality due to Norfolk Vanguard was 17 individuals. This would increase the baseline mortality (of 20,438 calculated for all ages assuming 57% adults, Furness 2015) by 0.08%, which would be undetectable. Therefore, displacement of guillemot from Norfolk Vanguard would not have an adverse effect on the integrity of the SPA.

2.8.1.4 HRA In-combination

173. Given the extremely small mortality due to Norfolk Vanguard it is clear that the Project will also make an extremely small contribution to an in-combination impact. Nonetheless, on the basis of the totals presented in Table 28 the combined displacement mortality across the whole year was estimated to be in the range 24 to 561 individuals. These would increase the baseline mortality rate of the population by 0.1% to 2.7%. Assessed using the evidence based displacement and mortality rates, the increase would be 0.2%.

174. On the basis of the most precautionary rates preferred by Natural England, there is potential for an adverse effect on the guillemot population due to in-combination

displacement effects. However, using the evidence based prediction, which is below the 1% threshold for detecting increases in mortality, the conclusion would be no adverse effect on the integrity of this SPA for the Project Alone or in-combination with other plans and projects. Furthermore, the contribution from Norfolk Vanguard is very small, estimated to comprise 3%.

175. Outputs from a PVA model for this population were presented for the Hornsea Project Three wind farm (MacArthur Green 2018). This modelling was an update of similar models produced for Hornsea Project Two, with the addition of a matched-run approach for calculating counterfactual outputs and an extended simulation period (up to 35 years). Simulations were conducted with and without density dependence and were summarised as the counterfactual of population size and population growth rate. The outputs from this model were presented as additional adult mortality, therefore the total FFC SPA estimates have been converted to adults by multiplying by the adult proportion (57%). Thus, the all age class in-combination estimate of 561 comprises 323 adults. The Norfolk Vanguard project alone estimate of 17 comprises 10 individuals. The outputs from these models for mortality levels of 50 and 350 (the nearest values to the project alone and in-combination predictions) are provided in Table 29.

Table 29. Guillemot FFC SPA population modelling results from MacArthur Green (2018).

Model	Mortality	Counterfactual metric (after 30 years)		Source table (MacArthur Green 2018)
		Growth rate	Population size	
Rate set 1, density independent	50	0.999	0.983	Table A2 9.1 & 9.3
	350	0.996	0.885	
Rate set 1, density dependent	50	1.000	0.992	Table A2 10.1 & 10.3
	350	0.998	0.943	
Rate set 2, density independent	50	0.999	0.983	Table A2 11.1 & 11.3
	350	0.996	0.885	
Rate set 2, density dependent	50	1.000	0.991	Table A2 12.1 & 12.3
	350	0.998	0.939	

176. The maximum reduction in the population growth rate, at a mortality of 50 (which is five times the Norfolk Vanguard alone adult displacement mortality), using the more precautionary density independent model was 0.1% (0.999). On the basis that the observed rate at which this population grew between 2000 and 2008 (3.0%) and between 2008 and 2017 (4.0%) (RSPB unpubl. Report 2017), a reduction of 0.1% to this rate represents a negligible risk for the population.

177. The maximum reduction in the population growth rate, at a mortality of 350 (which is the nearest modelled value to the in-combination total of 323), using the more

precautionary density independent model was 0.4% (0.996). On the basis that the observed rate, at which this population has grown between 2000 and 2008 (3.0%) and between 2008 and 2017 (4.0%) (RSPB unpubl. Report 2017), a reduction of 0.4% to this rate represents a negligible risk for the population.

178. The guillemot breeding numbers at the Flamborough and Filey Coast SPA have shown strong growth over the last 20 years and the population is therefore clearly in favourable conservation status. The relevant conservation objective is to maintain favourable conservation status of the guillemot population, subject to natural change.

179. On the basis of population model outputs the number of predicted in-combination guillemot displacement mortalities attributed to the Flamborough & Filey Coast SPA is not at a level which would trigger a risk of population decline, but would only result in a small reduction in the growth rate currently seen at this colony, and so would not have an adverse effect on integrity of the SPA.

180. Therefore, it can be concluded that there will be no adverse effect on the integrity of Flamborough & Filey Coast SPA from impacts on guillemot due to the proposed Norfolk Vanguard project in-combination with other projects.

2.9 Red-throated diver

181. Following the review of the Applicant's Deadline 1 submission which provided additional red-throated diver assessment (Norfolk Vanguard Offshore Wind Farm Offshore Ornithology: Red-throated diver displacement (Appendix 3.1, document reference ExA; WQApp3.1; 10.D1.3) Natural England advised the Applicant to undertake a 'like for like' cumulative assessment similar to that undertaken for the Thanet Extension wind farm (Vattenfall 2019b). Following further discussion on this matter with Natural England (call on the 8th March 2019 and a meeting with Natural England and the RSPB on 27th March 2019) it was agreed the geographical coverage for this assessment is the same for Norfolk Vanguard and Thanet Extension (i.e. the southern North Sea) therefore it would be appropriate for Norfolk Vanguard to make reference to the existing work in the current assessment. This is provided below.

2.9.1.1 EIA Cumulative

182. The red-throated diver operational cumulative assessment provided in Appendix 3.1, (document reference ExA; WQApp3.1; 10.D1.3) included all the wind farms in the red-throated diver BDMPS region (South west North Sea, Furness 2015). However, the project assessments for several of these did not include the necessary level of detail to permit their inclusion in a quantitative cumulative assessment. Natural England's advice on this aspect was to estimate the abundance of red-throated diver in all the wind farms in the cumulative assessment using the SeaMaST spatial dataset

(Bradbury et al. 2014), thereby ensuring that the relative contribution from each project was maintained.

183. As noted above, since this has already been undertaken for the Thanet Extension project, covering the same region, wind farms and red-throated diver population, these results (Vattenfall 2019b) have been used for Norfolk Vanguard.

184. The full details of the methods are included in Vattenfall (2019b). In summary the approach was as follows:

- The GIS data source was the SeaMaST 3x3km grid of density estimates for the North Sea produced by Bradbury et al. (2014);
- Wind farm boundaries for projects in the south-west North Sea were overlaid on the density data to obtain consistent abundance estimates for each site;
- The number of red-throated divers potentially displaced by wind farms in the assessment were presented as the summed totals by development phase (i.e. tiers), split into operational, under construction, consented but not constructed and submitted but not determined. The final category (submitted but not determined) did not include Thanet Extension (as this project was identified separately), and therefore this category only comprised Norfolk Vanguard and Hornsea Project Three; and,
- As well as the summed number of birds at risk of displacement in each tier, the percentage of the total was also provided.

185. The cumulative total displacement as presented in Vattenfall (2019b) is presented in Table 30 (this was Table 2 in Vattenfall 2019b).

Table 30. The relative contribution of Thanet Extension to the cumulative displacement of red-throated diver, assessed for each respective wind farm plus 4 km buffer.

Offshore wind farms in the English North Sea summed by Tier Scenario	Wind farms and 4 km buffers	
	Number of RTD potentially displaced	Relative contribution to RTD potentially displaced
Tier 1: Operational	1,540.8	97.6%
Tier 2: Under construction	3.7	0.2%
Tier 3: Consented but not constructed	6.7	0.4%
Tier 4: Application in process – other than Thanet Extension	1.5	0.1%
Tier 4: Thanet Extension	25.4	1.6%

186. Tier 4 includes Norfolk Vanguard and Hornsea Project Three only. The combined percentage that these projects make to the cumulative total estimated to be displaced was 0.1%. Operational wind farms (Tier 1) accounted for the overwhelming majority of the cumulative impact, with 98% of the total.

187. Assessment was also presented in Vattenfall (2019) for the proportions of the smaller BDMPS (10,177, winter) that the numbers in Table 30 represent. This estimated that the two tier 4 projects (Norfolk Vanguard and Hornsea Project Three) would together displace 0.01% of the BDMPS population. This compares to operational wind farms (tier 1) which were predicted to displace 15.1% of the winter BDMPS population. Thus operational wind farms are predicted to displace more than 1,000 times as many divers as Norfolk Vanguard and Hornsea Project Three combined.

188. With application of the Natural England advised rates of displacement (100%) and mortality (10%) to the totals in Table 30, with a background mortality rate for this species of 0.228 (Vattenfall 2018), the increase in the background mortality rate due to the cumulative total using these rates would be 6.6%, while that from the tier 4 projects would be 0.06%. With application of the evidence based rates of 90% displaced and 1% mortality (Appendix 3.1, document reference ExA; WQApp3.1; 10.D1.3) the cumulative effect would increase the baseline mortality by 0.6% and the tier 4 projects would increase the mortality rate by <0.001%.

189. The conclusion of this cumulative assessment, derived on a like for like basis across wind farms in the south west North Sea, is that when the most precautionary displacement and mortality rates are applied (100% displaced, 10% mortality) to the cumulative total, the background mortality rate increase exceeds the 1% threshold. However, application of the evidence based rates indicates this increase would be below the 1% threshold. In either case, the contribution from the two tier 4 projects (which include Norfolk Vanguard) is extremely small and the Project alone impact is negligible.

2.9.1.2 HRA Project alone: export cable installation

190. The Norfolk Vanguard HRA considered the potential effect on the Greater Wash SPA population of red-throated divers due to disturbance and displacement during installation of the export cable. The assessment determined that if 100% of birds are displaced by 2 km around up to 2 vessels moving very slowly through the SPA and a 5% mortality rate is assumed, between 2 and 4 individuals would be at risk of mortality.

191. Natural England has advised the Applicant that they consider a 5% mortality rate for this impact is insufficiently precautionary and have requested this is assessed using a 10% mortality rate.

192. The original HRA (Vattenfall 2018) provided the following justification for why the 5% rate used was already considered highly precautionary for this impact:

At this level of additional mortality a maximum of between 2 and 4 birds would be expected to die across the entire winter period (September to April) as a result of any potential displacement effects from the offshore cable installation activities. However, owing to the Rochdale envelope approach and the nature of the calculations employed, this almost certainly over-estimates the duration of cable laying by a factor of around 7, since even travelling at the minimum speed of 30m per hour, if a working day lasts for 12 hours the vessel would traverse the SPA in approximately 40 days (assuming the cable route through the SPA is around 15km). From these considerations it is clear that the assumption of 5% mortality is highly precautionary in relation to disturbance by cable laying vessels.

193. Furthermore, the Applicant undertook a detailed evidence review for the potential impact of displacement on this species (Appendix 3.1, document reference ExA; WQApp3.1; 10.D1.3) which concluded that a mortality rate of 1% was both precautionary and more appropriate.

194. Nonetheless, an assessment using Natural England's preferred rates is provided below.

195. The estimated natural mortality for the SPA population (1,511), would be approximately 300 (calculated using a composite all age class mortality rate of 0.2). The addition of a maximum of 4 to 8 (calculated for 100% displacement and 10% mortality from 2 vessels) to this total during a single year would increase the mortality rate in that year by approximately 1.3% to 2.6%.

196. However, as this is based on highly precautionary assumptions about the magnitude and impact of displacement and would only be expected to apply during a single nonbreeding season (and only then if cable laying by two vessels occurs simultaneously within the SPA during the nonbreeding period), it is reasonable to conclude that there will be no adverse effect on the integrity of the Greater Wash SPA as a result of red-throated diver displacement due to cable laying for the proposed Norfolk Vanguard project alone.

2.9.1.3 HRA In-combination: export cable installation

197. Natural England advised that there is potential for the cable installation through the Greater Wash SPA to overlap with that for Hornsea Project Three. It is not clear from Hornsea Project Three's construction timelines how likely such an overlap would be, and given that the actual duration of cable installation through the SPA for Norfolk Vanguard is likely to be no longer than 6 weeks, it would seem that the risk of this occurring simultaneously is in fact very small.

198. The predicted mortality of red-throated diver due to cable installation displacement for Hornsea Project Three was two individuals (estimated at 100% displacement and

10% mortality). The in-combination mortality for Norfolk Vanguard and Hornsea Project Three is therefore between 6 and 10 individuals, although as noted the likelihood of these occurring over the same period is considered to be very small. Assessed using the Applicant's evidence based rates, the in-combination mortality would be between 0.6 and 1 individual.

199. The addition of a maximum of 6 to 10 to the baseline mortality of 300 during a single year would increase the mortality rate in that year by approximately 2% to 3.3%, while at the Applicant's evidence based rates this would be 0.3%

200. However, this assessment is based on a combination of highly precautionary assumptions about the magnitude and impact of displacement and the potential for temporal overlap between the projects. This in-combination effect would only be expected to occur during a single nonbreeding season, if both cable laying vessels planned for Norfolk Vanguard are present at the same time, and this was also at the same time when those for Hornsea Project Three are present, and furthermore that this combination of events occurs within the SPA during the nonbreeding period (which is the least favoured period for such work due to less suitable weather conditions). If any of these conditions is not met, then there would not be an in-combination impact.

201. Thus, an adverse effect on integrity due to in-combination displacement can be seen to be highly improbable since it is contingent on several highly precautionary assumptions. It is therefore reasonable to conclude that there will be no adverse effect on the integrity of the Greater Wash SPA as a result of red-throated diver displacement due to cable laying for the proposed Norfolk Vanguard project in-combination with that for Hornsea Project Three.

2.9.1.4 HRA In-combination: operations and maintenance disturbance

202. Natural England raised a concern with the Applicant that vessels transiting either the Greater Wash SPA or the Outer Thames Estuary SPA between the operations and maintenance port (the location of which is not yet confirmed) and the wind farm sites could cause disturbance to red-throated divers. However, Natural England also stated that their concern would be removed if best practice management measures were put in place to minimise such risks. Natural England's proposed mitigation is:

- To avoid and minimise traffic where possible during the most sensitive time period in January/ February/ March and putting mechanisms in place to control boat traffic;
- Restricting vessel movements where possible to existing navigation routes (to areas where RTD are likely to be lowest);
- Maintaining direct transit routes (to minimise transit distances through areas used by divers);

- Avoidance of over-revving of engines (to minimise noise disturbance); and,
- That the Applicant has a responsibility to make vessel operators aware of:
    - The importance of the species (tool box talk),
    - The need to avoid rafting birds either en route to the wind farm from the operational port and/or within the array (dependent on location) and
    - Where possible avoid disturbance to areas with consistently high diver density.

203. The Applicant has agreed to these mitigation measures which will be included in the next version of the draft Development Consent Order (dDCO). Therefore, following adoption of these measures there will be no adverse effect on the integrity of either the Greater Wash SPA or Outer Thames Estuary SPA due to operation and maintenance vessel traffic.

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