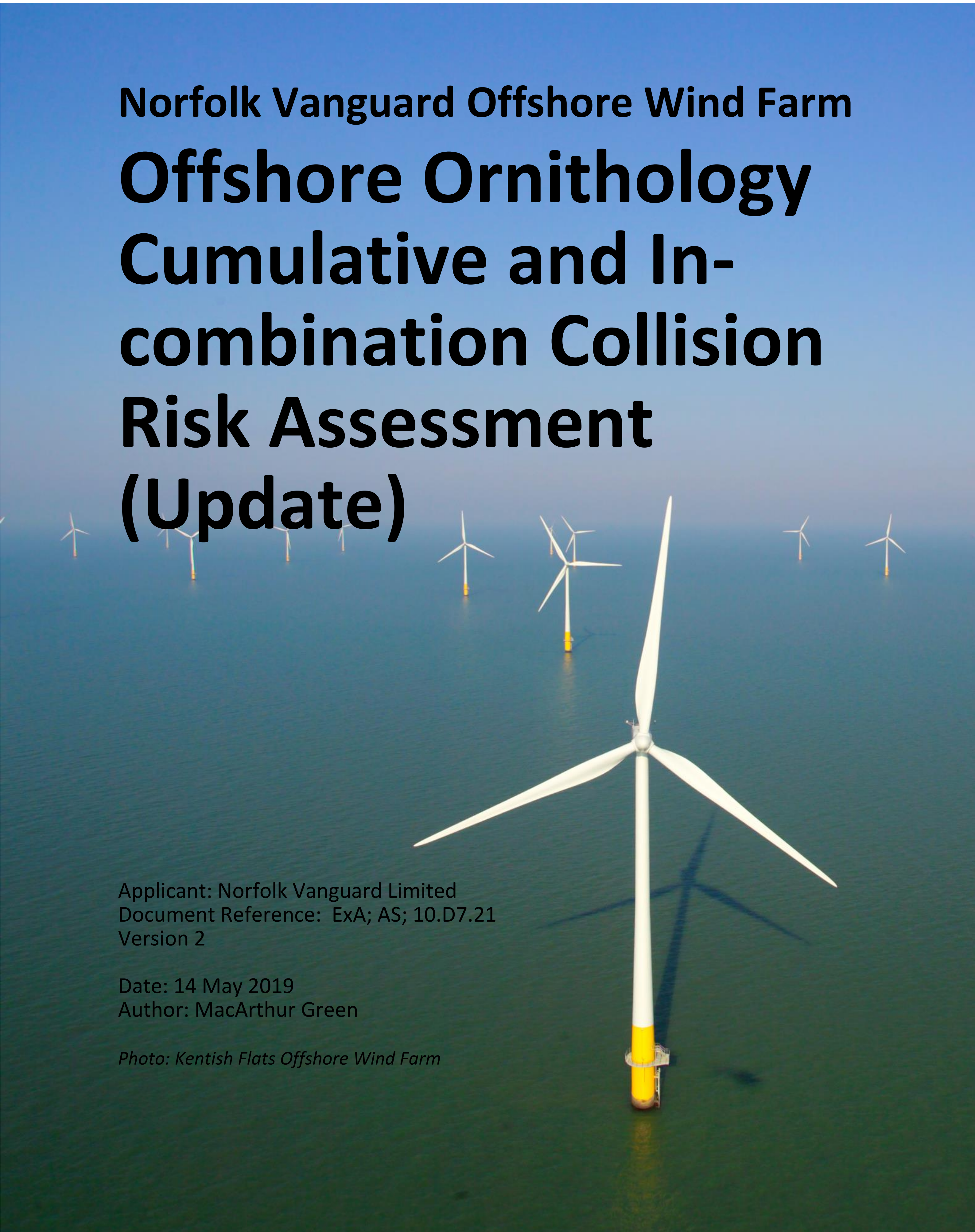

Norfolk Vanguard Offshore Wind Farm

Offshore Ornithology Cumulative and In-combination Collision Risk Assessment (Update)

Applicant: Norfolk Vanguard Limited
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Executive Summary

This note presents an update to the cumulative and in-combination seabird collision risk estimates for the Norfolk Vanguard Offshore Wind Farm (the Project).

Following requests from the Examining Authority (ExA), Natural England and the Royal Society for the Protection of Birds to explore options to mitigate potential seabird impacts from the Project, additional mitigation has been applied through a revision of the wind turbine layout within the offshore sites and an increase in turbine draught height of 5m, from 22m to 27m, to further minimise collision risks.

The revised project design comprises an amendment to the maximum proportion of turbines to be installed across Norfolk Vanguard East and Norfolk Vanguard West. The layout of the wind turbines will be based on the following maxima:

- No more than two-thirds of the turbines will be installed in Norfolk Vanguard West; and
- No more than half of the turbines in Norfolk Vanguard East (with the remainder installed in the other site in each case).

These replace the previous worst case assumption that all of the turbines would be installed in either the Norfolk Vanguard East or Norfolk Vanguard West sites.

The worst case collision prediction for each species for the revised layouts for the Project alone were provided ahead of Issue Specific Hearing 6 in ExA; CRM; 10.D.6.5.1. The average reduction in collision mortality resulting from the revised layouts was 34%, which was in addition to the approximate 10% reduction resulting from the removal of the 9MW turbine from the design envelope. This note provides further updated estimates with additional reduction in collisions obtained through an increase in the turbine draught height (i.e. the gap between the lower rotor tip and the sea surface at Mean High Water Springs) of 5m, from 22m to 27m.

The average collision risk (across species) for the project, accounting for all the design revisions offered as mitigation by the Applicant (i.e. removal of 9MW turbine, revised layout and turbine draught height increase) has been reduced by 65% in comparison to the Environmental Statement as submitted with the Draft Consent Order application in June 2018. The Applicant considers that this represents a significant step forward in considerably reducing the potential collision impacts associated with the Project.

This note provides a summary of the EIA (Environmental Impact Assessment) project alone assessment as provided in ExA; CRM; 10.D.6.5.1 and updated cumulative assessments with the revised Norfolk Vanguard predictions for gannet, kittiwake, lesser black-backed gull, herring gull, great black-backed gull and little gull, and updated HRA (Habitats Regulations

Assessment) in-combination assessments for gannet, kittiwake, lesser black-backed gull and little gull.

The updated assessment concludes that there will be no significant impacts for any species due to cumulative collisions (EIA) and no Adverse Effects on the Integrity of any Special Protection Areas (SPAs) due to collisions for the Project alone or in-combination with other projects (HRA).

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Glossary

BDMPS	Biologically Defined Minimum Population Scale
CPGR	Counterfactual of Population Growth Rate
CPS	Counterfactual of Population Size
CRM	Collision Risk Model
EIA	Environmental Impact Assessment
ES	Environmental Statement
FFC	Flamborough and Filey Coast
HRA	Habitats Regulations Assessment
JNCC	Joint Nature Conservation Committee
NE	Natural England
MHWS	Mean High Water Springs
NV	Norfolk Vanguard
PCH	Potential Collision Height
PVA	Population Viability Analysis
RSPB	Royal Society for the Protection of Birds
SCM	Seabird Colony Monitoring
SNH	Scottish Natural Heritage
SPA	Special Protection Area

1 INTRODUCTION

1. In the Norfolk Vanguard Deadline 6.5 submission (ExA; CRM; 10.D6.5.1), revised collision estimates were presented for the Project alone to account for the revised project layouts, offered as mitigation for collision risks. This note provides a further update to the collision risk figures following an increase in turbine draught height of 5m (from 22m to 27m). The assessment below includes revised project alone figures and an assessment of the potential collision impacts on seabirds at the proposed Norfolk Vanguard Offshore Wind Farm (the project) alone, cumulatively (Environmental Impact Assessment (EIA)) and in-combination with other projects (Habitat Regulations Assessment (HRA)).

2. Chapter 5 Project Description of the Environmental Statement (ES) provides information on the project design envelope for the wind turbine layout as included in the application. This chapter notes that the detailed design of the layout will be completed during the post-consent phase of the project, however worst case scenarios were assumed for assessments. The worst case scenario in the ES assumed the following maxima:

- 1,800MW in NV East, 0MW in NV West; or
- 0MW in NV East, 1,800MW in NV West.

3. Previous modelling (as presented in ES Chapter 13 Offshore Ornithology and subsequent updates submitted during the examination) presented worst case mortalities estimated in line with these scenarios.

4. During the examination for the project, requests have been made by Natural England and the Royal Society for the Protection of Birds (RSPB) to explore options to mitigate potential seabird impacts from the Project, and these requests have specifically advised that consideration should be given to increasing the turbine draught height.

5. In order to provide additional mitigation with the aim of further minimising collision risk (in accordance with National Policy Statement EN-3 para 2.6.108), the smallest (9MW) turbine was removed from the design envelope, with the 10MW now the smallest under consideration, and subsequently the turbine layout within the site was reviewed. The wind turbine layout is now based between the following maximum proportion of turbines which could be installed in either site with two alternative scenarios, (a) and (b):

    a. The maximum proportion of turbines in NV West would be two-thirds (with one-third in NV East); or

b. The maximum proportion of turbines in NV East would be half (with the other half in NV West).

6. The above updates were presented in the Deadline 6.5 submission (ExA; CRM; 10.D6.5.1) for the project alone for both scenario (a) and (b) for each species in order to clearly identify the species-specific worst case design, which reflect differences in the densities of a particular species across NV East and NV West. The higher estimate in each case represents the worst case for assessment.

7. In response to Natural England's comments received at Deadline 7, further mitigation to reduce collision risk has been adopted by the Applicant through an increase in the turbine draught height of 5m (from 22m to 27m). Since the density of seabirds in flight decreases with increasing altitude (i.e. most seabirds fly close to the sea), increasing the distance between the rotors and the sea surface reduces collision risk. This reduces the Project collision risk over and above the previous design revisions by 41%.

8. Consequently, in response to requests from Natural England and the RSPB to minimise the project's potential impacts, and in accordance with National Policy Statement EN-3, the Project collision risk has been reduced by 65% since the DCO submission (including the removal of the 9MW turbine, the revised layout and the 5m turbine draught height increase).

9. Natural England provided interim comments on the Applicant's submissions at Deadline 6, some of which are of relevance to this cumulative and in-combination assessment. These are provided in Table 1 and the sections where these have been addressed are identified.

Table 1 Comments provided by Natural England (2019) on the Applicant's Deadline 6 submissions where these are relevant to the current cumulative and in-combination assessment presented in this report.

Comment	Response and section where addressed (if appropriate)
We note that the CRM predictions in the HRA assessments have been adjusted to adult only currency by using the proportion of adults based on the age structure model in BDMPS report (Furness 2015) that was created in order to assess the numbers of immature birds that are associated with breeding populations. We are uncertain as to the appropriateness of assuming that the proportion of adults from this model will be representative of the proportion of adults recorded in the Vanguard areas. As noted in our pre-meeting at the last ISH, we recommend that this would be better undertaken based on the proportion of adults recorded in the baseline survey data for each season from Vanguard, should this be available.	The survey derived age ratios have been reviewed and for all relevant species (gannet, kittiwake and lesser black-backed gull) these are in excess of 93%. The Applicant does not consider these to provide a reliable guide for use in the assessment. Further consideration of the evidence for at sea age ratios will be provided in a subsequent submission.
Baseline mortality rates for HRA assessments have been based on using an all ages colony count and all ages survival/mortality rate to calculate baseline mortality. We note that in our Relevant	Additional assessment is provided in this note which considers the proportion of total collisions

Comment	Response and section where addressed (if appropriate)
Representations, which is actually repeated by the Applicant here in Table 1 of this document that: 'Given that the outputs of the existing PVAs tend to be on an adult currency, we also advise that calculations of 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.' Therefore, we advise again that assessments should be done using baseline mortality calculations using the adult colony figures and adult mortality rates.	assigned to adults (using the Furness 2015 age ratios) assessed against the SPA populations using the adult mortality rates. The Applicant would note that the assessments against background mortality are also supplemented with assessment using PVA (Population Viability Analysis), and consideration of these results is the primary basis for conclusions reached.
We welcome that in-combination assessments have been undertaken including Hornsea Three and excluding Hornsea Three. As previously noted, the latest figures available from the Thanet Extension and Hornsea Project Three examinations should be presented in the in-combination assessment, and the significant lack of confidence regarding the Hornsea Project Three figures should be discussed.	The cumulative and in-combination assessments in this note use figures for Hornsea Project Three (from the Environmental Statement, ES) and Thanet Extension (from that Project's Deadline 3 submission, Appendix 39), based on the advice received from Natural England. This was on the basis that Natural England could not advise on which alternative assessment values submitted during each project's examination were appropriate. The current assessment therefore also presents the ES values for these projects.
We welcome that the in-combination assessments for gannet and kittiwake at the FFC SPA now include figures for the Hywind, Kincardine and Moray West offshore wind farms (OWFs). We also note that the CRM figures included in the in-combination assessments for East Anglia One are the figures for the 150 turbine option (which is the legally secured design). However, we note that the in-combination assessment for LBBG at the Alde-Ore Estuary SPA still does not include figures for the Hywind and Kincardine OWFs. We will review the in-combination assessments for the other species regarding these other OWFs for Deadline 7.	The Applicant acknowledges that collision estimates for lesser black-backed gull at Hywind and Kinkardine wind farms were omitted from the assessment. These have now been included within this note, although it should be noted that no collisions were predicted for this species at either wind farm.
We note that there are no updated assessments of EIA cumulative gannet, kittiwake and LBBG CRM presented in the relevant assessment sections for these species. Whilst the updated cumulative CRM figures are presented in Table 4 for gannet and Table 13 for kittiwake, the cumulative totals and hence the significance of cumulative CRM impacts have not yet been agreed and therefore the Applicant should also present the updated assessment of what these cumulative figures equate to of baseline mortality of the largest BDMPS and biogeographic populations. Updated cumulative CRM assessments should be presented for all of the five key species (gannet, kittiwake, LBBG, herring gull and great black-backed gull).	These have been provided in this note: gannet cumulative (section 3.1.1.3), kittiwake cumulative (section 3.2.1.3), lesser black-backed gull cumulative (section 3.4.1.4), herring gull cumulative (section 3.3.1.2) and great black-backed gull cumulative (section 3.5.1.2).
We note that no updated assessment is provided for great black-backed gull (GBBG) – we advise that as no agreements have yet been made regarding GBBG cumulative CRM, that an updated	This is provided in this note (section 3.5.1.2).

Comment	Response and section where addressed (if appropriate)
assessment should also be provided that takes account of the updated figures for Vanguard, Thanet Extension and Hornsea Three, and also includes figures for Hywind, Kincardine and Moray West OWFs.	

10. Natural England's responses submitted at Deadline 7 included a request to investigate the potential for further reducing collision mortality through raising rotor blade heights. This note, together with ExA; As; D7.5.2, provides updated collision risk modelling results and assessment of impacts which directly address this request.

2 OVER PRECAUTION

11. In the following assessment, it is considered that many sources of precaution have been applied. These are highlighted by the Applicant within the relevant species specific sections. It should also be noted that as the number of wind farms included in cumulative and in-combination assessments increases, the total predicted impacts also increase. The various sources of precaution which have become accepted components of ornithological assessments are therefore highlighted. Under the current methodologies, the Applicant considers that there is a very real risk that future wind farms may face a conclusion of adverse effect on integrity being reached, not because they represent unacceptable ecological impacts at a project alone or in-combination level, but because the assessment process does not account for the need to present and manage uncertainty in a proportionate manner.

12. The sources of precaution in ornithological impact assessments include reduced collision risks for built wind farms compared with their consented designs which are considered in the assessments, the use of upper confidence limits and overly precautionary parameter estimates in collision risk modelling and displacement assessments and a preference for density independent population models, despite the fact that these are self-evidently flawed for predictive purposes. The combined result of these and other precautionary assumptions means that cumulative impact estimates are almost certainly overinflated, possibly by several orders of magnitude.

3 UPDATED ASSESSMENT

3.1 Gannet

3.1.1 Collision risk

3.1.1.1 EIA Project alone

13. The revised collision risk estimates for gannet for the 10MW turbine, along with the revised Project layout (ExA; CRM 10.D6.5.1) and 5m turbine draught height increase (ExA;AS;10.D7.5.2), calculated using the Band (2012) deterministic model and Natural England's preferred parameter values, are provided in Table 2.

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

Breeding season	Spring	Migration free breeding	Autumn	Annual
Migration-free	11.88 (6.64-19.04)	11.98 (2.3-25.21)	42.45 (28.27-59.2)	66.31 (37.21-103.44)
Full	10.89 (6.64-16.51)	16.98 (3.8-35.15)	38.43 (26.77-51.77)	

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

14. In the submission at Deadline 6.5 (ExA; CRM 10.D6.5.1, Table 2) it was concluded that a higher annual mortality of 112 (prior to the turbine draught height increase) would not increase the background rate by more than 1% and therefore it was concluded that Norfolk Vanguard Offshore Wind Farm alone would have no significant impact at the EIA scale. This conclusion is further supported by the lower revised annual estimate of 66 (a reduction of 41% for the turbine draught height increase alone), and therefore the conclusion of no significant impact at the EIA scale remains valid.

3.1.1.2 HRA Project alone

15. The proportion of the total collisions assigned to the Flamborough and Filey Coast (FFC) SPA in each season by the Applicant in the Information to Support HRA submitted with the Application (document reference 5.03) 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 Norfolk Vanguard 2019a).

16. 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 SPA population (Table 3), using the revised worst case Norfolk Vanguard estimates (the worst case for gannet assumes 50% of the turbines are located in Norfolk Vanguard East and 50% are located in Norfolk Vanguard West) and the reduction due to the 5m turbine draught height increase.

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.

Breeding season	Apportioning rates	Spring	Breeding	Autumn	Annual
Migration-free	Applicant	0.5	12.0	2.4	14.9
	Natural England	0.6	12.0	2.6	15.2
Full	Applicant	0.5	17.0	2.2	19.6
	Natural England	0.5	17.0	2.4	19.9

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.

17. The maximum predicted mortality of Flamborough and Filey coast SPA gannets at Norfolk Vanguard, using the full breeding season and Natural England's preferred apportioning rates is 19.9 adults (95% confidence intervals 5.8-39.2).

18. The SPA population at designation was 11,061 pairs (22,122 individuals, although this had increased to 13,391 pairs by 2017). At an average natural adult mortality rate of 0.081, the natural annual mortality of the population is 1,792 (designated) to 2,169 (2017 count). The addition of 19.9 individuals would therefore increase the mortality rate by 1.1% (designated) and 0.9% (2017 count). If the upper 95% confidence estimate (39.2) is used, these increases would be between 2.2% and 1.8%, respectively. While if the lower 95% confidence estimates are used (5.8) these rates are 0.3% and 0.3%.

19. While the mean prediction using the designated population is slightly above the 1% threshold for detection, with the consequent need to undertake additional assessment, it is important to note that this collision prediction combines several sources of precaution:

- Use of a nocturnal activity rate of 25% (Furness et al. 2018 recommended 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%.

20. Outputs from a 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. Outputs from this model were presented as additional adult mortality at increments of 25, thus the results for additional adult mortality of 25 and 50, the closest values to the current predictions of 5.8, 19.9 and 39.2 are provided in Table 4.

Table 4. 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	25	0.999	0.968	Table A2 1.1 & 1.3
	50	0.998	0.937	
Rate set 1, density dependent	25	0.999	0.978	Table A2 2.1 & 2.3
	50	0.999	0.957	
Rate set 2, density independent	25	0.999	0.968	Table A2 3.1 & 3.3
	50	0.998	0.936	
Rate set 2, density dependent	25	0.999	0.978	Table A2 4.1 & 4.3
	50	0.999	0.957	

21. The maximum reduction in the population growth rate, at an adult mortality of 50, using the most precautionary combination of assumptions (95% confidence estimate, all mortality assigned to adults, assessed using the density independent model) was 0.2% (0.998). Using the more realistic density dependent model the maximum reduction in growth rate was 0.1% (0.999).

22. 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 no more than 0.2% (and that for a considerably higher mortality than even the most precautionary assumption using the upper 95% confidence estimate) in this growth rate represents a negligible risk for the population.

23. 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.

24. On the basis of the population model predictions the number of predicted project alone 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.

25. 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 alone.

3.1.1.3 EIA cumulative and HRA In-combination

26. Natural England advised that the cumulative and 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 the Applicant’s understanding from discussions with Natural England, 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 5 presents the full updated cumulative and in-combination predictions.

Table 5. Gannet collision mortality for all wind farms, and with collisions apportioned to the Flamborough and Filey Coast SPA

Wind farm	Spring		Breeding		Autumn		Annual	
	Total	FFC SPA	Total	FFC SPA	Total	FFC SPA	Total	FFC SPA
Beatrice Demonstrator	0.7	0.05	0.6	0.0	0.9	0.04	2.2	0.1
Greater Gabbard	4.8	0.30	14.0	0.0	8.8	0.42	27.5	0.7
Gunfleet Sands	0.0	0.00	0.0	0.0	0.0	0.00	0.0	0.0
Kentish Flats	1.1	0.07	1.4	0.0	0.8	0.04	3.3	0.1
Lincs	1.7	0.10	2.1	2.1	1.3	0.06	5.0	2.3
London Array	1.8	0.11	2.3	0.0	1.4	0.07	5.5	0.2
Lynn and Inner Dowsing	0.2	0.01	0.2	0.2	0.1	0.01	0.5	0.2
Scroby Sands	0.0	0.00	0.0	0.0	0.0	0.00	0.0	0.0
Sheringham Shoal	0.0	0.00	14.1	14.1	3.5	0.17	17.6	14.3

Wind farm	Spring		Breeding		Autumn		Annual	
	Total	FFC SPA	Total	FFC SPA	Total	FFC SPA	Total	FFC SPA
Teesside	0.0	0.00	4.9	2.4	1.7	0.08	6.7	2.5
Thanet	0.0	0.00	1.1	0.0	0.0	0.00	1.1	0.0
Humber Gateway	1.5	0.09	1.9	1.9	1.1	0.05	4.5	2.0
Westermost Rough	0.2	0.01	0.2	0.2	0.1	0.01	0.5	0.2
Hywind	0.8	0.05	5.6	0.0	0.8	0.04	7.2	0.1
Kincardine	0.0	0.00	3.0	0.0	0.0	0.00	3.0	0.0
Beatrice	9.5	0.59	37.4	0.0	48.8	2.34	95.7	2.9
Dudgeon	19.1	1.18	22.3	22.3	38.9	1.87	80.3	25.3
Galloper	12.6	0.78	18.1	0.0	30.9	1.48	61.6	2.3
Race Bank	4.1	0.25	33.7	33.7	11.7	0.56	49.5	34.5
Rampion	2.1	0.13	36.2	0.0	63.5	3.05	101.8	3.2
Hornsea Project One	22.5	1.40	11.5	11.5	32.0	1.54	66.0	14.4
Blyth Demonstration Project	2.8	0.17	3.5	0.0	2.1	0.10	8.4	0.3
Dogger Bank Creyke Beck Projects A and B	4.3	0.27	5.6	2.8	6.6	0.32	16.5	3.4
East Anglia ONE	6.3	0.39	3.4	3.4	131.0	6.29	140.7	10.1
European Offshore Wind Deployment Centre	0.1	0.00	4.2	0.0	5.1	0.25	9.3	0.3
Firth of Forth Alpha and Bravo	65.8	4.08	800.8	0.0	49.3	2.37	915.9	6.4
Inch Cape	5.2	0.32	336.9	0.0	29.2	1.40	371.3	1.7
Moray Firth (EDA)	8.9	0.55	80.6	0.0	35.4	1.70	124.9	2.3
Neart na Gaoithe	23.0	1.43	143.0	0.0	47.0	2.26	213.0	3.7
Dogger Bank Teesside Projects A and B	10.8	0.67	14.8	7.4	10.1	0.49	35.7	8.5
Triton Knoll	30.1	1.87	26.8	26.8	64.1	3.08	121.0	31.7
Hornsea Project Two	6.0	0.37	7.0	7.0	14.0	0.67	27.0	8.0
East Anglia THREE	9.6	0.60	6.1	6.1	33.3	1.60	49.0	8.3
Hornsea Project Three	8.0	0.45	18.0	18.0	12.0	0.5	38.0	19.0
Thanet Extension	22.9	1.42	0.0	0.0	11.1	0.53	34.0	2.0
Moray West	1.0	0.06	10.0	0.0	2.0	0.10	13.0	0.2
Norfolk Vanguard	10.9	0.5	16.9	16.9	38.4	2.4	66.3	19.9
Total (inc. Hornsea Project Three)	**298.4**	**18.27**	**1688.2**	**176.8**	**737**	**35.89**	**2723.5**	**231.1**
Total (exc. Hornea Project Three)	**290.4**	**17.82**	**1670.2**	**158.8**	**725**	**35.39**	**2685.5**	**212.1**

3.1.1.3.1 Cumulative assessment

27. The cumulative total, all age class annual gannet collision mortality is estimated to be 2,723.5 with the inclusion of Hornsea Project Three and 2,685.5 without this project. Note, however that many of the collision estimates for other wind farms were calculated on the basis of consented designs; that is with higher total rotor

swept areas than have been installed (or are planned), which is a key factor in collision risk. For example, the Beatrice wind farm, which is currently under construction, was consented on the basis of up to 125 x 7MW turbines but only 84 x 7MW turbines have been installed, leading to a reduction in mortality risk of 33%. A method for updating collision estimates for changes in wind farm design such as this was presented in Trinder (2017). Updating the collision estimates for the Beatrice wind farm using this approach reduces the predicted annual mortality from 96 to 64. Applying the same method to the other relevant wind farms achieves a reduction in the cumulative annual mortality of around 400. Therefore, the values presented in Table 5, as well as being based on precautionary calculation methods, can be seen to overestimate the total collision risk by around 15% due to the reduced collision risks for projects which undergo design revisions post-consent.

28. Previous gannet collision assessments for the wind farms listed in Table 5 have been made on the basis of Band model Option 1 and a range of avoidance rates between 95% and 99%. The current rate of 98.9% dates from November 2014 (JNCC *et al.,* 2014) and followed the review conducted by Cook *et al.* (2014). Therefore, the decisions for some of the projects consented prior to this date were on the basis of estimated cumulative collision mortality numbers which were higher than the values presented in Table 5. However, given the variation in rates presented in different assessments and the rates used in reaching consent decisions, it is difficult to confidently determine the avoidance rate used for each wind farm consent decision. Nonetheless, it can be stated with a good degree of certainty that none of the previous wind farms have been consented on the basis of an avoidance rate higher than 99%, and many will have been based on assessment at 98%. A reduction in the avoidance rate from 99% to 98% leads to a doubling of the predicted collisions, therefore even though cumulative totals for older wind farms included fewer wind farms this will have been more than offset by the lower avoidance rate used.

29. Therefore, since avoidance rates have such a large effect on predicted mortality levels it therefore follows that the current cumulative total of 2,723.5 is almost certainly lower than those calculated for previous wind farm cumulative assessments (for which consent decisions have been granted).

30. Work conducted at the Greater Gabbard wind farm (APEM, 2014) has also found that gannet avoidance of wind farms during the autumn migration period may be even higher than the current estimate of 98.9%. Of 336 gannets observed during this study, only 8 were recorded within the wind farm, indicating a high degree of wind farm (macro) avoidance. Analysis of their data indicated a macro-avoidance rate in excess of 95% compared with the current guidance value of 64%. When combined with meso- and micro-avoidance this would result in higher overall

avoidance than the current 98.9% and would further reduce the total collision mortality prediction.

31. Furthermore, the collision estimates for most wind farms have used a nocturnal activity rate for this species of 25% in all months, which is much higher than those identified from analysis of tag data for the breeding and nonbreeding seasons (8% and 4%; Furness et al. 2018). It is straightforward to adjust existing mortality estimates to account for this reduction (i.e. it is not necessary to rerun the collision model for this update). However, it is necessary to calculate a mortality adjustment rate for each month at each wind farm because the duration of night varies with month and latitude (both of which are inputs to the collision model). This has not been undertaken for the current assessment but would be expected to reduce the cumulative total by at least 10%. This further emphasises the precautionary nature of the current assessment.

32. The background mortality for the BDMPS population (456,298), using an all age mortality rate, is 87,153, and for the biogeographic population (1,180,000) is 225,380. An addition of 2,723.5 to this increases the mortality rate by 3.1% (BDMPS) and 1.2% (biogeographic). As these are above the 1% level considered to be the threshold for detectability, further consideration of this is provided below.

33. Demographic data were collated for the British gannet population to produce a population model which was used to consider the potential impact of additional mortality (WWT, 2012). Two versions of the model were developed, with and without density dependence. Of these two models, the density independent one was considered to provide more reliable predictions since it predicted baseline growth at a rate close to that recently observed (1.28% per year compared with an observed rate of 1.33%) while the density dependent model predicted baseline growth of 0.9%.

34. The study concluded that, using the density independent model, on average population growth would remain positive until additional mortality exceeded 10,000 individuals per year, while the lower 95% confidence interval on population growth remained positive until additional mortality exceeded 3,500 individuals, which is greater than the cumulative total in Table 5. Consideration was also given to the risk of population decline. The risk of a 5% population decline was less than 5% for additional annual mortalities below 5,000 (using either the density dependent or density independent model; WWT, 2012).

35. It is important to note that the gannet model presented in WWT (2012) was based on the whole British population, so collisions at wind farms on the west coast (e.g. Irish Sea) also need to be added for consistency. However, a review of applications

in the Irish Sea and Solway Firth (Barrow, Burbo Bank, Burbo Bank Extension, Gwynt Y Mor, North Hoyle, Ormonde, Rhyl Flats, Robin Rigg, Walney 1 and 2, Walney Extension and West of Duddon Sands) gave a gannet annual collision cumulative total of 32.4 at an avoidance rate of 98.9%. Therefore, inclusion of these wind farms in the assessment does not alter the conclusion that cumulative collisions are below a level at which a significant impact on the British gannet population would result.

36. Furthermore, the WWT (2012) analysis was conducted using the estimated gannet population in 2004 (the most recent census available at that time), when the British population was estimated to be 261,000 breeding pairs. The most recent census indicates the equivalent number of breeding pairs is now a third higher at 349,498 (Murray *et al.,* 2015). This increase in size will raise the thresholds at which impacts would be predicted and therefore further reduces the risk of significant impacts.

37. In conclusion, the cumulative impact on the gannet population due to collisions is considered to be of low magnitude, and the relative contribution of the proposed Norfolk Vanguard project to this cumulative total is very small. Gannet is considered to be of low to medium sensitivity to collision mortality and the impact significance is therefore **minor adverse**.

3.1.1.3.2 In-combination assessment

38. The in-combination total, adult annual gannet collision estimate for the FFC SPA is 231, of which Norfolk Vanguard contributes 19.9 (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 212.

39. The increase in the background mortality due to this in-combination collision risk (including Hornsea Project Three) is between 12.9% (designated population) and 10.6% (2017 count). Without Hornsea Project Three these increases are 11.8% and 9.8%, respectively.

40. Outputs from a 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 these models for adult mortality levels of 225 and 250 (the values which most closely correspond to the above estimates) are provided in Table 6.

Table 6. Gannet FFC SPA population modelling results from MacArthur Green (2018).

Model	Adult mortality	Counterfactual metric (after 30 years)		Source table (MacArthur Green 2018)
		Growth rate	Population size	
Rate set 1, density independent	225	0.990	0.743	Table A2 1.1 & 1.3
	250	0.989	0.719	
Rate set 1, density dependent	225	0.994	0.814	Table A2 2.1 & 2.3
	250	0.993	0.796	
Rate set 2, density independent	225	0.990	0.743	Table A2 3.1 & 3.3
	250	0.989	0.719	
Rate set 2, density dependent	225	0.994	0.814	Table A2 4.1 & 4.3
	250	0.993	0.795	

41. The maximum reduction in the population growth rate, at an adult mortality of 250, using the more precautionary density independent model was 1.1% (0.989). Using the more realistic density dependent model the maximum reduction in growth rate was 0.7% (0.993).

42. 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 just over 1% in this case represents a negligible risk for the population.

43. 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.

44. 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 the integrity of the SPA.

45. These totals also include several sources of precaution, including (among other sources of precaution) 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.

46. Therefore, the conclusions presented in the Norfolk Vanguard ES and HRA and subsequent submissions (ExA; AS; 10.D6.17) remain the same; it can be concluded that there will be no adverse effect on the integrity of the Flamborough & Filey Coast

SPA from collision impacts on gannet due to the proposed Norfolk Vanguard project in-combination with other plans and projects.

47. Furthermore, the contribution from Norfolk Vanguard to this total has been substantially reduced following design revisions to mitigate collision risks, with the annual collision mortality estimate for gannet reduced by 66% when the removal of the 9MW turbine, revised layout and turbine draught height increase are considered together.).

3.1.2 Combined displacement and collision risk

3.1.2.1 HRA In-combination

48. Adding the in-combination annual gannet collision estimate of 231 (estimated using Natural England's preferred methods and including Hornsea Project Three) to the in-combination annual displacement prediction of 49 to 65 (see section 2.1.2 of ExA; AS; 10.D6.17), gives a combined SPA mortality estimate of 280 to 296. 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.

49. 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 15.6% and 16.5% (designated population) and 12.9% and 13.6% (2017 count).

50. Outputs from the gannet PVA model for this population (MacArthur Green 2018) for adult mortality levels of 275 and 300 (the nearest values to this impact prediction) are provided in Table 7.

Table 7. Gannet FFC SPA population modelling results from MacArthur Green (2018).

Model	Adult 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	
Rate set 1, density dependent	275	0.992	0.776	Table A2 2.1 & 2.3
	300	0.991	0.757	
Rate set 2, density independent	275	0.988	0.696	Table A2 3.1 & 3.3
	300	0.986	0.673	
Rate set 2, density dependent	275	0.992	0.776	Table A2 4.1 & 4.3
	300	0.991	0.757	

51. The maximum reduction in the population growth rate, at a mortality of 300, using the more precautionary density independent model was 1.4% (0.986). Using the more realistic density dependent model the maximum reduction in growth rate was 0.9% (0.991).

52. 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 1.4% to this rate represents a negligible risk for the population.

53. 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.

54. 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.

55. 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.

56. 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.

3.2 Kittiwake

3.2.1 Collision risk

3.2.1.1 EIA Project alone

57. The revised collision risk estimates for kittiwake for the 10MW turbine and the revised project layout (ExA; CRM 10.D6.5.1) and 5m turbine draught height increase (ExA;AS;10.D.7.5.2), calculated using the Band (2012) deterministic model and Natural England’s preferred parameter values, are provided in Table 8.

Table 8. Kittiwake seasonal and annual collision risk using the migration free (April to August) and full (March to September) breeding seasons.

Breeding season	Spring	Migration free breeding	Autumn	Annual
Migration-free	55.9 (38.49-76.41)	26.58 (9.89-48.14)	32.92 (18.53-50.2)	115.4 (66.9-174.75)
Full	38.66 (27.17-52.26)	45.26 (21.41-75.45)	31.48 (18.32-47.03)	

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

58. In the submission at Deadline 6.5 (ExA; CRM 10.D6.5.1, Table 2) it was concluded that a higher annual mortality of 186 (prior to the turbine draught height increase) would not increase the background rate by more than 1% and therefore the Norfolk Vanguard Offshore Wind Farm alone would have no significant impact at the EIA scale. This conclusion is further supported by the lower revised annual estimate of 115 (a reduction of 38% for the turbine draught height increase alone), and therefore the conclusion of no significant impact at the EIA scale remains valid.

3.2.1.2 HRA Project alone

59. The revised total collision risks for kittiwake, calculated using the Band (2012) deterministic model and Natural England's preferred parameter values are provided in Table 8. 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 Norfolk Vanguard, 2019b).

60. 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.

61. The study's authors (the Royal Society for the Protection of Birds, RSPB) provided the tracking data on request in order to enable analysis to estimate an alternative breeding season apportioning rate.

62. In the 2017 breeding season this research 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.

63. 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.

64. 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 Flamborough and Filey Coast SPA and Norfolk Vanguard in the breeding season, albeit this connectivity is probably quite low.

65. 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.

66. 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 figure of 4.1% 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 in calculating the lower estimate the number of Russian and Norwegian immatures present in the North Sea is almost certainly over-estimated, but it does indicate that the real value is likely to be between 4.1% and 26.1%, and a very substantial number of Russian and Norwegian immature birds are very likely to be present in the southern North Sea.

67. 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.

68. This estimated rate was presented to Natural England and the RSPB and discussed during a call on the 2nd April 2019. In their Deadline 7 submission, 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 and unrealistic). 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. In addition, a review of evidence on kittiwake movements throughout the year in relation to age classes and colonies is being prepared and will be submitted by the Applicant at Deadline 8.

69. Table 9 provides monthly and seasonal kittiwake collision estimates on Norfolk Vanguard for the two alternative development scenarios (a and b, equating to splits across the West and East sites of (a) two-thirds and one-third and (b) half in each), for both the migration free and full breeding seasons (and with the reduction due to increased turbine draught height).

Table 9. Kittiwake monthly collision risks on Norfolk Vanguard with migration free (May to July) and full (March to August) breeding seasons indicated. Scenario (a) corresponds to two-thirds of the turbines in Norfolk Vanguard West and one-third in Norfolk Vanguard East and scenario (b) corresponds to half in each site.

Month	Monthly		Seasonal total			
			Migration free		Full breeding	
	Scenario a	Scenario b	Scenario a	Scenario b	Scenario a	Scenario b
Jan	18.8	26.9				
Feb	8.5	11.8			27.2	38.7
Mar	13.3	17.2				
Apr	6.1	8.2	46.7	64.1		
May	6.0	7.8				
Jun	7.2	6.0				
Jul	3.0	2.5	16.2	16.3	39.8	45.3
Aug	2.5	2.1				
Sep	1.7	1.4				
Oct	3.3	3.1				
Nov	16.2	18.7	30.2	35.0		
Dec	6.5	9.7			26.1	31.5

Month	Monthly		Seasonal total			
			Migration free		Full breeding	
	Scenario a	Scenario b	Scenario a	Scenario b	Scenario a	Scenario b
Total	93.1	**115.4**	**93.1**	**115.4**		**115.5**

70. 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 scenario (b) with a higher proportion of turbines in this site (50%) represents the worst case for collisions overall. 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, rather than increasing numbers being recorded in the wind farm sites as the breeding season progresses, as has been suggested would be the case on the basis of the tracking observations (Wischnewsi et al. 2018), what was actually observed was a negative trend in density between April and August with very low densities in June to August (0.04 birds/km^2) on Norfolk Vanguard East. 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.

71. 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.

72. 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).

73. 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.

74. Taking all these aspects together, the estimated seasonally apportioned collision estimates are provided in Table 10.

Table 10. 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.

Scenario	Breeding season	Spring	Breeding	Autumn	Annual
A (67:33)	Migration-free	3.4	4.2	1.6	9.2
	Full	2.0	10.4	1.4	13.8
B (50:50)	Migration-free	4.6	4.3	1.9	10.8
	Full	2.8	11.8	1.7	16.3

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

75. As discussed above, apportioning breeding season mortality at the more distant Norfolk Vanguard East to the SPA is considered highly precautionary. Indeed, the tracking evidence provides very little evidence for connectivity to Norfolk Vanguard East at all. However, there is some 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.

76. Therefore, the Norfolk Vanguard FFC collision prediction comprises:

- Breeding season collisions at Norfolk Vanguard West, multiplied by the apportioning rate of 26.1%; and,
- Spring and autumn collisions at both Norfolk Vanguard East and West using the higher estimates from scenario (b) at apportioning rates of 7.2% and 5.4% respectively.

77. Thus, using the total breeding season collision estimate at Norfolk Vanguard West of 19.5 (for 120 10MW turbines, as per scenario (a)), gives an FFC (full) breeding season estimate (at 26.1%) of 5.1 individuals. This has been combined with the apportioned

spring and autumn migration estimates for scenario (b), the worst case scenario, of 2.8 and 1.7 to give a total FFC SPA mortality at Norfolk Vanguard of 9.6. The equivalent migration free estimate is 10.2 (=14.3 x 0.261 breeding, plus 64.1 x 0.072 spring, plus 35.0 x 0.054 autumn). Summing the upper 95% confidence intervals for these seasonal estimates (9.8, 3.8 and 2.3 respectively) the FFC annual total is 15.9, while the lower 95% confidence estimate is 4.3.

78. 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 11). 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 11. 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[1]).

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

79. 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.

80. 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 breeding season

[1] 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

connectivity on this site the HRA for Norfolk Vanguard combines the breeding seasons collisions at this site with the combined collisions across both sites in the migration seasons.

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); and

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.

81. The Norfolk Vanguard annual collisions apportioned to the FFC SPA using the full breeding season is 9.6. This combines several sources of precaution:

- 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%.

82. The SPA population at designation was 44,520 pairs (89,040 individuals). At an average natural adult mortality rate of 0.146, the natural annual mortality of the population is 13,000. The addition of up to 9.6 individuals would therefore increase the mortality rate by 0.07% (0.12% using the upper 95% confidence interval and 0.03% using the lower 95% confidence interval). 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.

3.2.1.3 EIA cumulative and HRA In-combination

83. 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 the Applicant's understanding from discussions with Natural England, 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. As set out above, in accordance with Natural England's advice, cumulative totals without Hornsea Project THREE are also provided. Table 12 presents the full cumulative and in-combination predictions.

Table 12. Kittiwake collision mortality for all wind farms, and collisions apportioned to the Flamborough and Filey Coast SPA

Wind farm	Spring		Breeding		Autumn		Annual	
	Total	FFC SPA	Total	FFC SPA	Total	FFC SPA	Total	FFC SPA
Beatrice Demonstrator	1.7	0.1	0.0	0.0	2.1	0.1	3.8	0.2
Greater Gabbard	11.4	0.8	1.1	0.0	15.0	0.8	27.5	1.6
Gunfleet Sands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kentish Flats	0.7	0.1	0.0	0.0	0.9	0.0	1.6	0.1
Lincs	0.7	0.0	0.7	0.7	1.2	0.1	2.6	0.8
London Array	1.8	0.1	1.4	0.0	2.3	0.1	5.5	0.3
Lynn and Inner Dowsing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Scroby Sands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sheringham Shoal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Teesside	2.5	0.2	38.4	0.0	24.0	1.3	64.9	1.5
Thanet	0.4	0.0	0.3	0.0	0.5	0.0	1.2	0.1
Humber Gateway	1.9	0.1	1.9	1.9	3.2	0.2	7.0	2.2
Westermost Rough	0.1	0.0	0.1	0.1	0.2	0.0	0.5	0.1
Hywind	0.9	0.1	16.6	0.0	0.9	0.0	18.3	0.1
Kincardine	1.0	0.1	22.0	0.0	9.0	0.5	32.0	0.6
Beatrice	39.8	2.9	94.7	0.0	10.7	0.6	145.2	3.4
Dudgeon	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Galloper	31.8	2.3	6.3	0.0	27.8	1.5	65.9	3.8
Race Bank	5.6	0.4	1.9	1.9	23.9	1.3	31.4	3.6
Rampion	29.7	2.1	54.4	0.0	37.4	2.0	121.5	4.2
Hornsea Project One	20.9	1.5	44.0	36.5	55.9	3.0	120.8	41.0
Blyth Demonstration Project	1.4	0.1	1.4	0.0	2.3	0.1	5.1	0.2
Dogger Bank Creyke Beck Projects A and B	295.0	21.2	288.0	55.6	135.0	7.3	718.0	84.1
East Anglia ONE	46.7	3.4	1.5	0.0	161.0	8.7	209.2	12.1
European Offshore Wind Deployment Centre	1.1	0.1	11.8	0.0	5.8	0.3	18.7	0.4
Firth of Forth Alpha and Bravo	247.6	17.8	153.1	0.0	313.1	16.9	713.8	34.7
Inch Cape	63.5	4.6	13.1	0.0	224.8	12.1	301.4	16.7

Wind farm	Spring		Breeding		Autumn		Annual	
	Total	FFC SPA	Total	FFC SPA	Total	FFC SPA	Total	FFC SPA
Moray Firth (EDA)	19.3	1.4	43.6	0.0	2.0	0.1	64.9	1.5
Neart na Gaoithe	4.4	0.3	32.9	0.0	56.1	3.0	93.4	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
Triton Knoll	45.4	3.3	24.6	24.6	139.0	7.5	209.0	35.4
Hornsea Project Two	3.0	0.2	16.0	13.3	9.0	0.5	28.0	14.0
East Anglia THREE	37.6	2.7	6.1	0.0	69.0	3.7	112.7	6.4
Hornsea Project Three	11.4	0.8	165.3	153.7	61.3	3.3	238.0	157.9
Thanet Extension	15.3	1.1	2.3	0.0	5.3	0.3	23.0	1.4
Moray West	7.0	0.5	79.0	0.0	24.0	1.3	110.0	1.8
Norfolk Vanguard	38.7	2.8	45.3	5.1	31.5	1.7	115.4	9.6
Total (inc. Hornsea Project Three)	**1205.2**	**86.7**	**1304.7**	**319.8**	**1544.9**	**83.2**	**4054.8**	**490**
Total (exc. Hornsea Project Three)	**1193.8**	**85.9**	**1139.4**	**166.1**	**1483.6**	**79.9**	**3816.8**	**332.1**

3.2.1.3.1 Cumulative assessment

84. The cumulative total, all age class annual kittiwake collision mortality is estimated to be 4,054.8 with the inclusion of Hornsea Project Three and 3,816.8 without this project. Note, however that many of the collision estimates for other wind farms were calculated on the basis of consented designs with higher total rotor swept areas than have been installed (or are planned), which is a key factor in collision risk. For example, the Beatrice wind farm, which is currently under construction, was consented on the basis of up to 125 x 7MW turbines but only 84 (of the same model) will be installed, leading to a reduction in mortality risk of 33%. A method for updating collision estimates for changes in wind farm design was presented in Trinder (2017). Updating the collision estimates for the Beatrice wind farm using this approach reduces the predicted annual mortality from 145 to 97. Applying the same method to the other wind farms in Table 12 can achieve a reduction in the cumulative annual mortality of around 550. Therefore, the values presented in Table 12, as well as being based on precautionary calculation methods, can be seen to overestimate the total risk by around 14% due to the reduced collision risks for projects which undergo design revisions post consent.

85. A review of nocturnal activity in kittiwakes (Furness, in prep.) has found that the value previously used for this parameter (50%) to estimate flight activity at night is a considerable overestimate and has identified evidence-based rates of 20% during the breeding season and 17% during the nonbreeding season.

86. It is straightforward to adjust mortality estimates using the new and old nocturnal activity rates and the monthly number of daytime and night time hours (i.e. it is not necessary to rerun the collision model for this update). However, it is necessary to calculate a mortality adjustment rate for each month at each wind farm because the duration of night varies with month and latitude (both of which are inputs to the collision model). This has not been undertaken for the current assessment but would be expected to reduce the cumulative total by at least 10%. This further emphasises the precautionary nature of the current assessment.

87. For the assessment of the adjacent East Anglia THREE wind farm a kittiwake population model was developed to assess the potential effects of cumulative mortality on the kittiwake BDMPS populations (EATL, 2015). Both density independent and density dependent models were developed. The outputs were presented in relation to additional adult mortality, therefore the cumulative total estimate here has been multiplied by 0.53 (Furness 2015) to estimate the adult component of the cumulative total, giving a figure of 2,149. For annual mortality of 2,250 (the nearest modelled mortality), the density dependent model predicted the population after 25 years would be 2.2% to 3.0% smaller than that predicted in the absence of additional mortality, while the more precautionary density independent model predicted equivalent declines of 6.8% to 7.1%. The population growth rate reduction for this level of mortality was estimated to be 0.3% using the density independent model and <0.01% using the density dependent model.

88. To place these predicted magnitudes of change in context, over three approximate 15 year periods (between censuses) the British kittiwake population changed by +24% (1969 to 1985), -25% (1985 to 1998) and -61% (2000 to 2013) (http://jncc.defra.gov.uk/page-3201 accessed 26th August 2015). Changes of between 2% and 7% across a longer (modelled 25 year) period against a background of natural changes an order of magnitude larger will almost certainly be undetectable. Although the Norfolk Vanguard application is for a 30 year project life time, compared with the above PVA span of 25 years, the additional 5 years will make very little difference to the growth rate predictions from either the density dependent or density independent models.

89. Natural England advised that the results from density independent models should be used 'where there is no information on population regulation for the focal population' (NE 2017).

90. Evidence for density dependent regulation of the North Sea kittiwake population was summarised in EATL (2016b). While Natural England accepted there was strong evidence for the presence of density dependence operating in the population they maintained that because its mode of operation was less clear the results of the

density independent PVA models should be used in preference to the density dependent ones (acknowledging that using these results the predictions were the most precautionary ones). However, Trinder (2014) explored a range of strengths of density dependence for this species and identified model parameters which produced population predictions consistent with patterns of seabird population growth which have been observed across a wide range of taxa (inc. kittiwake) worldwide (Cury et al. 2011). Thus, there is robust evidence for density dependent regulation of the North Sea kittiwake population (and for seabirds more widely) and its inclusion in the kittiwake population model (EATL 2015) balanced this evidence with reasonable precaution. Consequently, the density dependent kittiwake model results are considered to be the more robust ones on which to base this assessment.

91. Kittiwake is considered to be of low to medium sensitivity, low to medium conservation value and the magnitude of effect described above is considered to be low. Consequently, the worst case cumulative collision mortality is considered to be of low magnitude, resulting in impacts of **minor adverse** significance. However, when the various sources of precaution are taken into account (precautionary avoidance rate estimates, reduction in wind farm sizes, over-estimated nocturnal activity) the cumulative collision risk impact magnitude is almost certainly smaller still.

3.2.1.3.2 In-combination assessment

92. The in-combination adult total annual kittiwake collision estimate is 490, of which Norfolk Vanguard contributes 9.6 (1.9%), 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 332.1 (of which Norfolk Vanguard contributes 2.9%).

93. The increase in the background mortality due to this in-combination collision risk is 3.8% with the inclusion of Hornsea Project Three, and 2.5% without Hornsea Project Three.

94. 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 these models for adult mortality levels of 350 and 500 (the closest upper values to these totals) are provided in Table 13.

Table 13. 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	350	0.996	0.892	Table A2 5.1 & 5.3
	500	0.994	0.849	
Rate set 1, density dependent	350	0.999	0.968	Table A2 6.1 & 6.3
	500	0.999	0.954	
Rate set 2, density independent	350	0.996	0.892	Table A2 7.1 & 7.3
	500	0.994	0.850	
Rate set 2, density dependent	350	0.999	0.966	Table A2 8.1 & 8.3
	500	0.999	0.946	

95. The maximum reduction in the population growth rate, at a mortality of 500, using the more precautionary density independent model was 0.6% (0.9947) and without Hornsea Project Three this was 0.4%. Using the more realistic density dependent model these maximum reductions in growth rate were 0.1% (0.999) both with and without Hornsea Project Three.

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

97. 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. On the basis of the precautionary in-combination collision estimate (including over-estimates for consented vs. built designs and over-estimated nocturnal activity) combined with the precautionary density independent model predictions for the total adult mortality of 490, there may be to be a small risk that further population growth will be restricted. However, the much more realistic density dependent model suggests that this level of mortality will have a much smaller effect on the population, with only a very slight reduction in the growth rate, and that the population's conservation status will not be affected.

98. Natural England contends that density dependence should only be included in population models when evidence for this is available for the population in question and that this is not the case for the Flamborough and Filey Coast SPA kittiwake population. However, as noted above, there is evidence for density dependence in

the North Sea kittiwake population (EATL 2016) and exploratory analysis has been used to guide the most appropriate method for inclusion in population models (Trinder 2014). Therefore, while there may not be direct evidence for the SPA population, there is evidence of density dependence for the wider population of which it is an integral part and there is no reason that the SPA population would not be affected by the same regulatory drivers. Therefore, the arguments against the inclusion of density dependence are not considered to apply in this case.

99. Therefore, the conclusions presented in the Norfolk Vanguard ES and HRA and subsequent submissions (ExA; AS; 10.D6.17) remain the same; it can be concluded that there will be no adverse effect on the integrity of Flamborough & Filey Coast SPA from collision impacts on kittiwake due to the proposed Norfolk Vanguard project in-combination with other plans and projects.

100. Furthermore, the contribution from Norfolk Vanguard to this total has been substantially reduced following design revisions to mitigate collision risks, with the annual collision mortality estimate for kittiwake reduced by 67% when the removal of the 9MW turbine, revised layout and turbine draught height increase are considered together.

3.3 Herring gull

3.3.1 Collision risk

3.3.1.1 EIA Project alone

101. The revised collision risk estimates for herring gull for the 10MW turbine and the revised project layout (ExA; CRM 10.D6.5.1) and 5m turbine draught increase (ExA;AS;10.D.7.5.2), calculated using the Band (2012) deterministic model and Natural England's preferred parameter values, are provided in Table 14.

Table 14. Herring gull seasonal and annual collision risk using the migration free (April to August) and full (March to September) breeding seasons.

Breeding season	Migration free breeding	Midwinter/non-breeding	Annual
Migration-free	0.46 (0-1.62)	12.99 (7.24-21.13)	13.45 (7.24-22.75)
Full	0.76 (0-2.8)	12.7 (7.24-19.95)	

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

102. In the submission at Deadline 6.5 (ExA; CRM 10.D6.5.1, Table 2) it was concluded that a higher annual mortality of 17.9 (prior to the turbine draught height increase) would not increase the background rate by more than 1% and therefore it was concluded that Norfolk Vanguard alone would have no significant impact at the EIA scale. This conclusion is further supported by the lower revised annual estimate of

13.4 (a reduction of 25% for the turbine draught height increase alone), and therefore the conclusion of no significant impact at the EIA scale remains valid.

3.3.1.2 EIA Cumulative

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

104. 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.

105. 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.

Wind farm	Breeding	Nonbreeding	Annual
Beatrice Demonstrator	0.0	0	0.0
Greater Gabbard	0.0	0	0.0
Gunfleet Sands	0.0	0	0.0
Kentish Flats	0.5	1.7	2.2
Lincs	0.0	0	0.0
London Array	0.0	0	0.0
Lynn and Inner Dowsing	0.0	0	0.0
Scroby Sands	0.0	0	0.0
Sheringham Shoal	0.0	0	0.0
Teesside	8.7	34.5	43.2
Thanet	4.9	19.6	24.5
Humber Gateway	0.4	1.1	1.5
Westermost Rough	0.1	0.0	0.1
Hywind	0.6	7.8	8.4
Kincardine	1.0	0.0	1.0
Beatrice	49.4	197.4	246.8
Dudgeon	0.0	0	0.0
Galloper	27.2	0	27.2
Race Bank	0.0	0	0.0
Rampion	155.0	0	155.0
Hornsea Project One	2.9	11.6	14.5

Wind farm	Breeding	Nonbreeding	Annual
Blyth Demonstration Project	0.5	2.2	2.7
Dogger Bank Creyke Beck Projects A and B	0.0	0	0.0
East Anglia ONE	0.0	28.0	28.0
European Offshore Wind Deployment Centre	4.8	0	4.8
Firth of Forth Alpha and Bravo	10.0	21.0	31.0
Inch Cape	0.0	13.5	13.5
Moray Firth (EDA)	52.0	0	52.0
Neart na Gaoithe	5.0	12.5	17.5
Dogger Bank Teesside Projects A and B	0.0	0	0.0
Triton Knoll	0.0	0	0.0
Hornsea Project Two	23.8	0	23.8
East Anglia THREE	0.0	23.0	23.0
Hornsea Project Three	1.0	7.0	8.0
Thanet Extension	10.0	4.0	14.0
Moray West	12.0	1.0	13.0
Norfolk Vanguard	0.8	12.7	13.5
Total (inc. Hornsea Project Three)	**370.6**	**398.6**	**769.2**
Total (exc. Hornsea Project Three)	**369.6**	**391.6**	**761.2**

3.3.1.2.1 Cumulative assessment

106. On the basis of the worst case Norfolk Vanguard collision estimate the annual cumulative total including Hornsea Project Three is 769.2 and without this project is 761.2.

107. 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 769.2 to this increases the rate by 0.95%, and without Hornsea Project Three this would be 0.94%. These are below the 1% threshold of detectability.

108. This total also includes, among other sources of precaution, 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.

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

3.4 Lesser black-backed gull

3.4.1 Collision risk

3.4.1.1 EIA Project alone

110. The revised collision risk estimates for lesser black-backed gull for the 10MW turbine and the revised project layout (ExA; CRM 10.D6.5.1) and 5m turbine draught height increase (ExA;AS;10.D7.5.2), calculated using the Band (2012) deterministic model and Natural England's preferred parameter values, are provided in Table 16.

Table 16. Lesser black-backed gull seasonal and annual collision risk using the migration free (May to July) and full (April to August) breeding seasons.

Breeding season	Spring	Migration free breeding	Autumn	Midwinter / nonbreeding	Annual
Migration-free	1.23 (0-4.38)	7.25 (2.15-14.52)	12.9 (4.36-24.43)	1.67 (0-4.06)	23.05 (6.51-47.38)
Full	0.56 (0-2.23)	15.57 (4.97-30.44)	5.25 (1.53-10.65)	1.67 (0-4.06)	

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

111. In the submission at Deadline 6.5 (ExA; CRM 10.D6.5.1, Table 2) it was concluded that a higher annual mortality of 31.7 (prior to the turbine draught height increase) would not increase the background rate by more than 1% and therefore it was concluded that Norfolk Vanguard alone would have no significant impact at the EIA scale. This conclusion is further supported by the lower revised annual estimate of 23.1 (a reduction of 27% for the turbine draught height increase alone), and therefore the conclusion of no significant impact at the EIA scale remains valid.

3.4.1.2 Apportioning to the Alde Ore Estuary SPA

112. 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.

113. 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 30% (Natural

England Deadline 7 submission, EN010079 280590 Norfolk Vanguard Natural England's Comments by species on Vanguard Deadline 6 (REP6-021) and Deadline 6.5 (AS-043) information). 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.

114. 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.

115. 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.

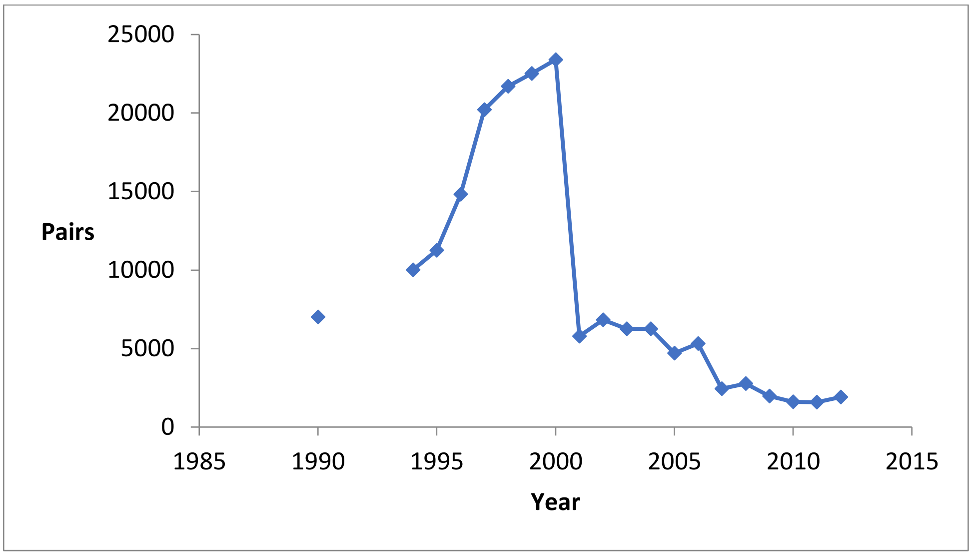

Plate 3.1 Number of breeding pairs of lesser black-backed gulls in the Alde-Ore Estuary SPA; Orfordness plus Havergate (data from JNCC SCM database).

116. 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.

117. 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.

118. 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).

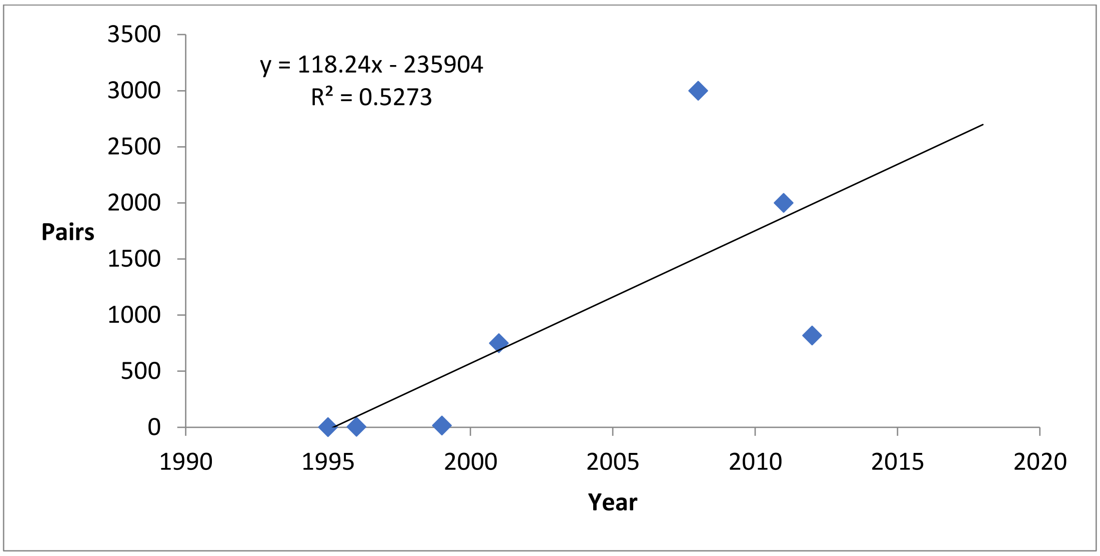

Plate 3.2 Number of breeding pairs of lesser black-backed gulls in Lowestoft (data from JNCC SCM database and Piotrowski 2013).

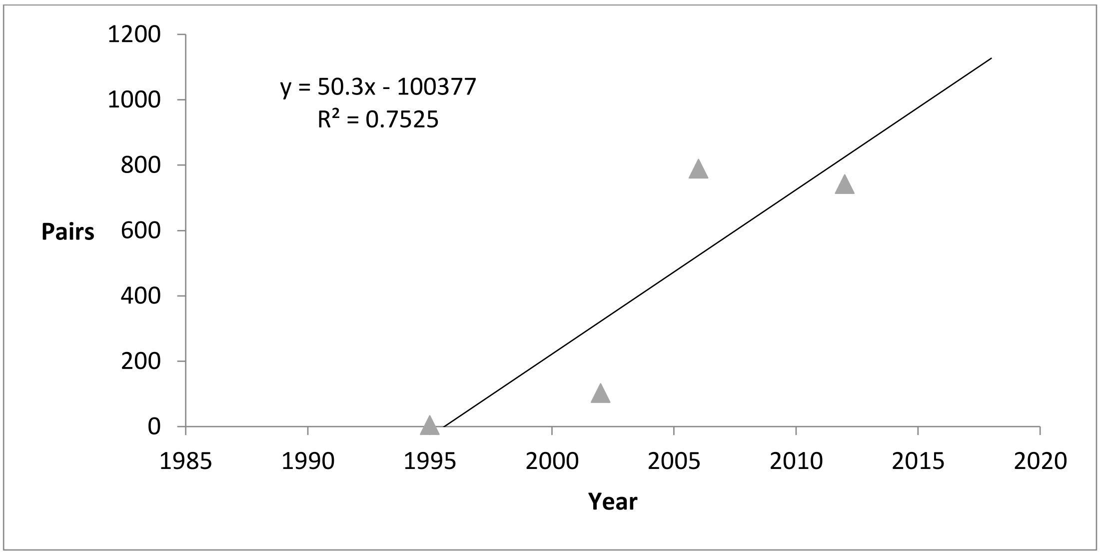

Plate 3.3 Number of breeding pairs of lesser black-backed gulls in Great Yarmouth (data from JNCC SCM database and Piotrowski 2013).

119. 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 remained relatively stable at Outer Trial Bank (1,704 pairs in 2006, 1,457 pairs in 2009 and 1,294 pairs in 2018) (JNCC SCM database).

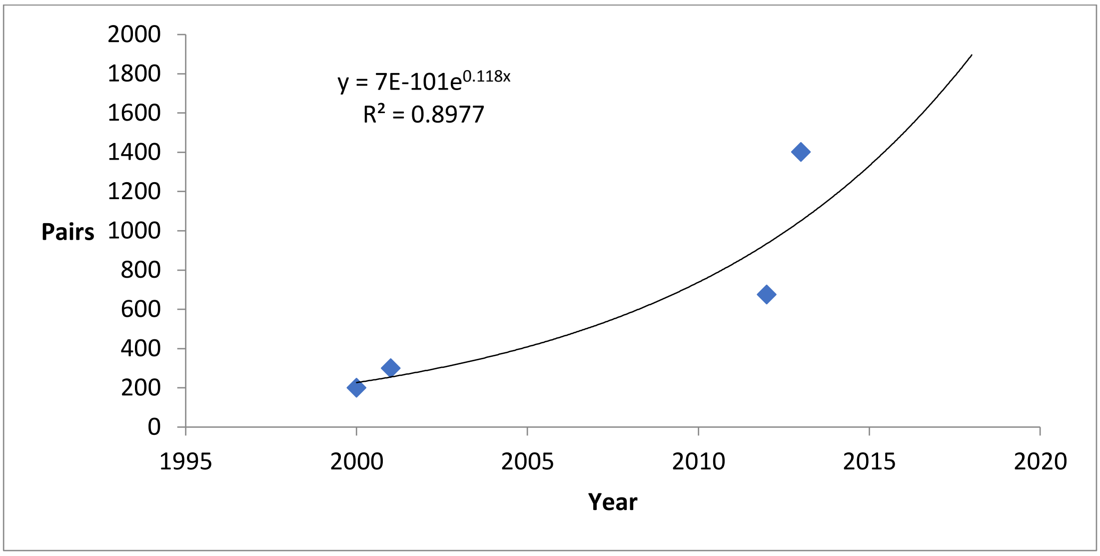

Plate 3.4 Numbers of breeding pairs of lesser black-backed gulls at Felixstowe (data from JNCC SCM database). For this colony an exponential growth curve is a better fit than a linear increase.

120. 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.

121. 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.

122. 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).

123. 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.

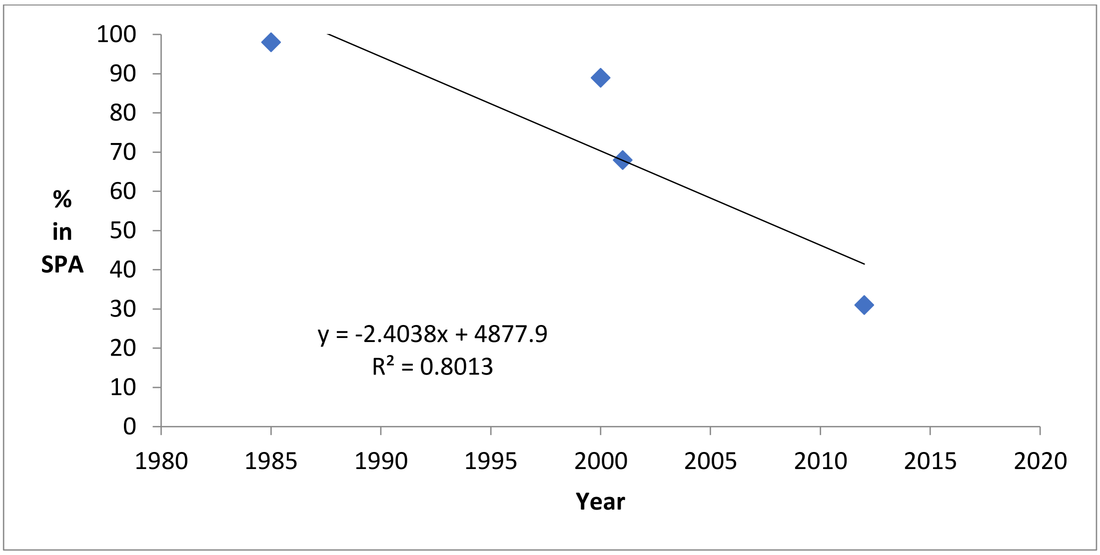

Plate 3.5 The percentage of lesser black-backed gulls breeding in East Anglia that were breeding within the Alde-Ore Estuary SPA in different survey years (based on JNCC SCM database and Piotrowski 2013).

124. 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 17). 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 17).

Table 17. Colonies of lesser black-backed gulls in East Anglia ranked according to the minimum distance from Norfolk Vanguard.

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

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[2]).

125. 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.

126. 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

[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

when rearing chicks. This is thought to be at least in part a strategy to provide chicks 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.

127. 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.

128. 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.

129. 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.

130. 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.

131. 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.

132. 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, it has been 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).

133. 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.

134. 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.

135. 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. Thus, a precautionary assumption of 5% was used for this assessment.

3.4.1.3 HRA Project alone

136. 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.

137. 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 18.

Table 18. 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).

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 3.4.1.2)
January	0.82 (0-1.89)	0.04 (0-0.09)

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 3.4.1.2)
February	0.22 (0-0.55)	0.01 (0-0.03)
March	0.56 (0-2.23)	0.02 (0-0.07)
April	**0.67 (0-2.15)**	**0.11 (0-0.37)**
May	**0 (0-0)**	**0 (0-0)**
June	**3.03 (0.43-6.5)**	**0.52 (0.07-1.11)**
July	**4.22 (1.72-8.02)**	**0.72 (0.29-1.36)**
August	**7.65 (2.82-13.78)**	**1.3 (0.48-2.34)**
September	2.5 (0.78-4.67)	0.08 (0.03-0.15)
October	2.75 (0.76-5.98)	0.09 (0.03-0.2)
November	0.33 (0-0.89)	0.02 (0-0.04)
December	0.29 (0-0.72)	0.01 (0-0.04)
Total	23.05 (6.51-47.38)	2.9 (0.9-5.8)

Months in bold indicate the full breeding months (note that the migration free breeding season has also considered in the assessment).

138. 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.

139. During the migration-free breeding season (May to July) the total number of predicted collisions was 7.2 (14.5using the upper 95% confidence interval), while for the full breeding season this figure was 18.1 (35.1 using the upper 95% confidence interval). 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 full breeding season would be up to 2.9 birds (Table 19).

Table 19. 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%)	1.23	0.13	0.56	0.02
Breeding season (17%)	7.25	1.23	15.57	2.65
Autumn (3.3%)	12.90	1.47	5.25	0.17
Winter (5%)	1.66	0.08	1.66	0.08
Total	**23.04**	**2.92**	**23.04**	**2.92**

140. Natural mortality for the SPA population (assuming approximately 4,000 adults) would be around 460 individuals at an average adult mortality rate of 11.5%

(Horswill and Robinson 2015). A total additional worst case mortality of up to 2.9 birds (using the full breeding season) due to collisions at the Norfolk Vanguard site would increase the mortality rate by 0.6. Using the upper 95% confidence interval (5.8) this increase would be 1.3% and using the lower 95% confidence interval this would be 0.2%.

141. Following SNCB recommendations, an increase in mortality of less than 1% is considered to be undetectable against the range of background variation. While the upper 95% confidence interval estimate slightly exceeds the 1% threshold of detectability, the margin above the threshold equates to one individual (i.e. one less mortality per year brings the prediction below the 1% threshold). Therefore, since the increased mortality predicted as a result of mean collisions at Norfolk Vanguard is below the agreed threshold, at which increases in mortality are detectable, and the upper confidence interval only just exceeds this level it is 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.

3.4.1.4 EIA cumulative and HRA In-combination

142. The cumulative lesser black-backed gull collision risk prediction has been calculated for all wind farms in the North Sea (Table 20).

Table 20. 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.

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
Beatrice Demonstrator	0.0	0.0	0.0	0
Greater Gabbard	62.0	49.6	12.4	12.4
Gunfleet Sands	1.0	0.0	1.0	1.0
Kentish Flats	1.6	1.3	0.3	0.3
Lincs	8.5	6.8	1.7	0
London Array	0.0	0.0	0.0	0
Lynn and Inner Dowsing	0.0	0.0	0.0	0
Scroby Sands	0.0	0.0	0.0	0
Sheringham Shoal	8.3	6.6	1.7	1.7
Teesside	0.0	0.0	0.0	0
Thanet	16.0	12.8	3.2	3.2
Humber Gateway	1.3	1.1	0.3	0
Westermost Rough	0.3	0.3	0.1	0
Hywind	0	0	0	0
Kincardine	0	0	0	0

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
Beatrice	0.0	0.0	0.0	0
Dudgeon	38.3	30.6	7.7	7.7
Galloper	138.8	111.0	27.8	27.8
Race Bank	54.0	10.8	43.2	0
Rampion	7.9	6.3	1.6	0
Hornsea Project One	21.8	17.4	4.4	0
Blyth Demonstration Project	0.0	0.0	0.0	0
Dogger Bank Creyke Beck Projects A and B	13.0	10.4	2.6	0
East Anglia ONE	39.7	33.8	5.9	5.9
European Offshore Wind Deployment Centre	0.0	0.0	0.0	0
Firth of Forth Alpha and Bravo	10.5	8.4	2.1	0
Inch Cape	0.0	0.0	0.0	0
Moray Firth (EDA)	0.0	0.0	0.0	0
Neart na Gaoithe	1.5	1.2	0.3	0
Dogger Bank Teesside Projects A and B	12.0	9.6	2.4	0
Triton Knoll	37.0	29.6	7.4	0
Hornsea Project Two	4.0	2.0	2.0	0
East Anglia THREE	10.0	8.2	1.8	1.8
Hornsea Project Three	17.3	0	17.3	0
Thanet Extension	2.3	0.8	1.5	1.5
Moray West	0	0	0	0
Norfolk Vanguard	23.0	7.5	15.6	2.9
Total (inc. Hornsea Project Three)	**530.1**	**366.1**	**164.3**	**66.2**
Total (exc. Hornsea Project Three)	**512.8**	**366.1**	**147**	**66.2**

3.4.1.4.1 Cumulative assessment

143. On the basis of the worst case Norfolk Vanguard collision estimates the annual cumulative total is 530.1 including Hornsea Project Three and 512.8 without this project.

144. The background mortality for the largest BDMPS population (209,007) at an all age class average mortality rate of 0.141 is 26,335. The addition of 530.1 to this increases the rate by 1.8%, and without Hornsea Project Three this would be 1.7%.

145. Note, however that many of the collision estimates for other wind farms were calculated on the basis of consented designs with higher total rotor swept areas than have been installed (or are planned), which is a key factor in collision risk. For example, the Galloper wind farm, which is currently under construction, was consented on the basis of 140 turbines but only 56 have been installed. A method

for updating collision estimates for changes in wind farm design was presented in Trinder (2017). Updating the collision estimates for the Galloper wind farm using this approach reduces the predicted annual mortality from 139 to 60. Applying the same method to the other wind farms in Table 20 can achieve a reduction in the cumulative annual mortality of around 200. Therefore, the values presented in Table 20, as well as being based on precautionary calculation methods, can be seen to overestimate the total risk by around 35% due to the reduced collision risks for projects which undergo design revisions post consent.

146. Lesser black-backed gull collision assessments undertaken prior to 2014 were made on the basis of Band model Option 1 and an avoidance rate of 98%, with the change to 99.5% dating from November 2014 (JNCC *et al.,* 2014). Therefore, projects consented prior to this date were on the basis of a cumulative collision mortality 4 times that presented in Table 20. Accounting for projects up to Triton Knoll consented after November 2014 (Hornsea Project 1, 22 annual collisions at 99.5%; Dogger Bank Creyke Beck A&B, 13 annual collisions at 98.9% Option 3; Dogger Bank Teesside A&B, 12 annual collisions at 98.9% Option 3) the previous cumulative collision total (at 98%) excluding these three projects would have been 1,656 (461 – (22+13+12) x 4). The current worst case cumulative total of 530.1, including all consented and still to be consented projects, is therefore much lower than this previously accepted cumulative total. Indeed, even if all of the previous consents had been granted on the basis of an avoidance rate of 99% this would still be around 828, 1.5 times the current cumulative prediction. The same approach can be applied to the seasonal estimates, which are all lower than the cumulative totals for the projects granted consent in 2014.

147. A review of nocturnal activity in seabirds (EATL, 2015) has indicated that the value currently used for this parameter (50%, as used for estimating the collisions at Norfolk Vanguard detailed above) to estimate collision risk at night for lesser black-backed gull is almost certainly an overestimate, possibly by as much as a factor of two (i.e. study data suggest that 25% is more appropriate). This study found that reducing the nocturnal activity factor to 25% reduces collision estimates by around 15%. This adjustment to nocturnal activity is also applicable to the other cumulative collision estimates in Table 20. A correction applied by this method would reduce the overall collision estimate for all wind farms by a significant amount (e.g. between 7% and 25%; note the magnitude of reduction varies depending on the time of year and wind farm latitude due to the variation in day and night length). This further emphasises the precautionary nature of the current assessment.

148. In conclusion, the current cumulative total is considerably lower than previously consented cumulative totals (between 1.5 and 3 times lower), and yet this total still includes several sources of precaution (e.g. consented vs. built impacts and

overestimated nocturnal activity). Therefore, the cumulative impact on the lesser black-backed gull population due to collisions both year round and within individual seasons is considered to be of low magnitude and lesser black-backed gull are considered to be of low sensitivity, therefore the impact significance is **minor adverse**.

3.4.1.4.2 In-combination assessment

149. The total breeding season lesser black-backed gull collision estimate is 164.3, including Hornsea Project Three and 147.0 without this project. 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 66.2, to which Norfolk Vanguard adds 2.9. 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.

150. 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 19.9 (30% of the other wind farm total of 63.3 plus 2.9 at Norfolk Vanguard).

151. 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 (366 x 4%) from the Alde-Ore Estuary SPA population could be at risk of collision during the nonbreeding season (of which 0.3 are attributed to Norfolk Vanguard).

152. The annual mortality of lesser black-backed gulls from the Alde-Ore SPA is therefore 15 during the nonbreeding season and 19.9 during the breeding season, 35 in total (of which Norfolk Vanguard contributes up to 2.9).

153. In-combination mortality of up to 35 birds attributable to the Alde-Ore SPA population of lesser black-backed gulls compares with estimated natural mortality of about 460 birds per year. Thus, the additional in-combination mortality would increase the mortality rate by 7.6%.

154. 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 (Trinder 2017). 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% (Trinder 2017), 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 2.9 (15.6 in total). The same reduction applied to the nonbreeding estimate of 15 would reduce this to 10. Therefore, the annual mortality would be 25.6 which would result in an increase in background mortality of 5.5%.

155. 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 35 above, and more than three times the more likely prediction of 25.6.

156. 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.

157. To summarise the above calculations, the adult annual, in-combination mortality predictions are:

- 35 (based on 141 km foraging range) comprising:
  - 15 nonbreeding (0.3 at Norfolk Vanguard),
  - 19.9 breeding (63.3 x 0.3 for other wind farms within 141km plus 2.9 at Norfolk Vanguard);
- 30 (based on 72 km foraging range) comprising:
  - 15 nonbreeding (0.3 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);
- 25.6 (based on 141 km foraging range and consent vs. built reduction) comprising:
  - 10 nonbreeding (15 x 67%; 0.3 at Norfolk Vanguard),
  - 15.6 breeding (63.3 x 0.3 x 0.67 of the existing wind farm total plus 2.9 at Norfolk Vanguard).

158. 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 21.

Table 21. 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	25	0.991	0.833	Tables A.1 & A.2
	40	0.987	0.687	
Density dependent	25	0.997	0.0.947	Tables A.3 & A.4
	40	0.996	0.914	

159. Taking the modelled adult mortality of 40 (as the worst case), the population growth rate was predicted to be 1.3% lower (0.987) than the baseline using the density independent model, and 0.4% lower (0.996) using the density dependent model. At

the lower modelled adult mortality of 25, the reduction in growth rate was 0.9% for the density independent model and 0.3% for the density dependent model.

160. Although there is a lack of reliable evidence on the population trend at the SPA since 2010 (the last all SPA count available), the predicted reductions in growth rate, which only just exceed 1% for the most precautionary combination of worst case collisions (including the use of the much higher mortality predictions estimated for consented wind farm designs rather than for the as built designs and over-estimated nocturnal activity) and worst case modelled predictions, are considered very unlikely to have a detectable effect on the population.

161. 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 0.9% (density independent), which further reduces any concerns about the impact on the SPA population.

162. 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 2.9) 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.

163. Therefore, the conclusions presented in the Norfolk Vanguard ES and HRA and subsequent submissions (ExA; AS; 10.D6.17) remain the same; it can be concluded that there will be no adverse effect on the integrity of Alde-Ore Estuary SPA from collision impacts on lesser black-backed gull due to the proposed Norfolk Vanguard project in-combination with other plans and projects.

164. Furthermore, the contribution from Norfolk Vanguard to this total has been substantially reduced following design revisions to mitigate collision risks, with the annual collision mortality estimate for lesser black-backed gull reduced by 47% when the removal of the 9MW turbine, revised layout and turbine draught height increase are considered together.

165. 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 improve this population's conservation status.

3.5 Great black-backed gull

3.5.1 Collision risk

3.5.1.1 EIA Project alone

166. The revised collision risk estimates for great black-backed gull for the 10MW turbine and the revised project layout (ExA; CRM 10.D6.5.1) and 5m turbine draught height increase (ExA;AS;10.D.7.5.2), calculated using the Band (2012) deterministic model and Natural England's preferred parameter values, are provided in Table 22.

Table 22. Great black-backed gull seasonal and annual collision risk using the migration free (May to July) and full (March to August) breeding seasons.

Breeding season	Migration free breeding2.3	Midwinter/non-breeding	Annual
Migration-free	1.31 (0-3.49)	45.54 (22.68-74.6)	46.84 (22.68-78.08)
Full	8.09 (1.72-16.69)	38.76 (20.96-61.39)	

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

167. In the submission at Deadline 6.5 (ExA; CRM 10.D6.5.1, Table 2) it was concluded that a higher annual mortality of 61.9 (prior to the turbine draught height increase) would not increase the background rate by more than 1% and therefore it was concluded that Norfolk Vanguard alone would have no significant impact at the EIA scale. This conclusion is further supported by the lower revised annual estimate of 46.8 (a reduction of 24% for the draught height alone) and therefore the conclusion of no significant impact at the EIA scale remains valid.

3.5.1.2 EIA Cumulative

168. The cumulative great black-backed gull collision risk prediction is presented in Table 23. 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 estimates for wind farms submitted since that project's application.

169. The collision values presented in Table 23 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 great black-backed gull. Therefore, for those sites where a seasonal split was not presented the annual numbers in Table 23 have been multiplied by 0.8 to estimate the nonbreeding component and 0.2 to estimate the breeding component.

Table 23. Great black-backed gull cumulative collision risk.

Wind farm	Breeding	Nonbreeding	Annual
Beatrice Demonstrator	0.0	0.0	0.0
Greater Gabbard	15.0	60.0	75.0
Gunfleet Sands	0.0	0.0	0.0
Kentish Flats	0.1	0.2	0.3
Lincs	0.0	0.0	0.0
London Array	0.0	0.0	0.0
Lynn and Inner Dowsing	0.0	0.0	0.0
Scroby Sands	0.0	0.0	0.0
Sheringham Shoal	0.0	0.0	0.0
Teesside	8.7	34.8	43.6
Thanet	0.1	0.4	0.5
Humber Gateway	1.3	5.1	6.3
Westermost Rough	0.0	0.0	0.1
Hywind	0.3	4.5	4.8
Kincardine	0.0	0.0	0.0
Beatrice	30.2	120.8	151.0
Dudgeon	0.0	0.0	0.0
Galloper	4.5	18.0	22.5
Race Bank	0.0	0.0	0.0
Rampion	5.2	20.8	26.0
Hornsea Project One	17.2	68.6	85.8
Blyth Demonstration Project	1.3	5.1	6.3
Dogger Bank Creyke Beck Projects A and B	5.8	23.3	29.1
East Anglia ONE	0.0	46.0	46.0
European Offshore Wind Deployment Centre	0.6	2.4	3.0
Firth of Forth Alpha and Bravo	13.4	53.4	66.8
Inch Cape	0.0	36.8	36.8
Moray Firth (EDA)	9.5	25.5	35.0
Neart na Gaoithe	0.9	3.6	4.5
Dogger Bank Teesside Projects A and B	6.4	25.5	31.9
Triton Knoll	24.4	97.6	122.0
Hornsea Project Two	3.0	20.0	23.0
East Anglia THREE	4.6	34.4	39.0

Wind farm	Breeding	Nonbreeding	Annual
Hornsea Project Three*	19.4	46.6	66.0
Thanet Extension	1.3	20.8	22.1
Moray West	4.0	5.0	9.0
Norfolk Vanguard	8.1	38.8	46.8
Total (inc. Hornsea Project Three)	**185.3**	**818**	**1003.2**
Total (exc. Hornsea Project Three)	**165.9**	**771.4**	**937.2**

170. On the basis of the worst case Norfolk Vanguard collision estimate the annual cumulative total including Hornsea Project Three is 1,003.2 and without this project is 937.2.

171. The background mortality for the largest BDMPS population (91,399) at an all age class average mortality rate of 0.185 is 16,909. The addition of 1018.2 to this increases the rate by 5.9%, and without Hornsea Project Three this would be 5.5%.

172. Many of the collision estimates for other wind farms were calculated on the basis of consented designs with higher total rotor swept areas than have been installed (or are planned), which is a key factor in collision risk. For example, the Beatrice wind farm, which is currently under construction, was consented on the basis of 125 turbines but only 84 are being installed. A method for updating collision estimates for changes in wind farm design was presented in Trinder (2017). Updating the collision estimates for the Beatrice wind farm using this approach reduces the predicted annual mortality from 151 to 101. Applying the same method to the other wind farms in Table 23 can achieve a reduction in the cumulative annual mortality of around 260. Therefore, the values presented in Table 23, as well as being based on precautionary calculations, can be seen to overestimate the total risk by around 30% due to the reduced collision risks for projects which undergo design revisions post consent.

173. Great black-backed gull collision assessments undertaken prior to 2014 were made on the basis of Band model Option 1 and an avoidance rate of 98%, with the change to 99.5% dating from November 2014 (JNCC *et al.,* 2014). Therefore, projects consented prior to this date were on the basis of a cumulative collision mortality 4 times that presented in Table 23. Accounting for projects up to Triton Knoll consented after November 2014 (Hornsea Project One, 86 annual collisions at 99.5%; Dogger Bank Creyke Beck A&B, 29 annual collisions at 98.9% Option 3; Dogger Bank Teesside A&B, 32 annual collisions at 98.9% Option 3) the previous cumulative collision total (at 98%) excluding these three projects would have been 2,524 (778 - (86 + 29 + 32) x 4. The current worst case cumulative total of 1,018.2, including all consented and still to be consented projects, is therefore much lower than the previously accepted cumulative total. Indeed, even if all of the previous consents

had been granted on the basis of an avoidance rate of 99% this would still be higher than the current cumulative prediction. The same approach can be applied to the seasonal estimates, which are all lower than the cumulative totals for the projects granted consent in 2014.

174. A review of nocturnal activity in seabirds (EATL, 2015) has indicated that the value currently used for this parameter (50%) to estimate collision risk at night for great black-backed gull is almost certainly an overestimate, possibly by as much as a factor of two (i.e. study data suggest that 25% is more appropriate). Reducing the nocturnal activity factor to 25% reduced collision estimates by around 15%. This adjustment to nocturnal activity is also applicable to the other cumulative collision estimates. A correction applied by this method would reduce the overall collision estimate for all wind farms by a significant amount (e.g. between 7% and 25%; note the magnitude of reduction varies depending on the time of year and wind farm latitude due to the variation in day and night length). This further emphasises the precautionary nature of the current assessment.

175. In the decision for the Rampion wind farm (Planning Inspectorate, 2014a; DECC, 2014), the cumulative collision mortality for great black-backed gull was considered. In their recommendations to the Secretary of State (Planning Inspectorate, 2014), the Examining Authority reported the cumulative mortality for this species as either 1,803 individuals per year (Applicant's estimate) or 3,025 (Natural England's estimate). The difference in these two values remained unresolved between the applicant and Natural England, however the Examining Authority (Planning Inspectorate, 2014) concluded:

'that the addition of Rampion OWF does not tip the balance in terms of exceeding a threshold that would not otherwise be exceeded.'

(Note that the threshold referred to in the above quote was the PBR value for this species, although PBR is no longer considered an appropriate tool for assessing wind farm impacts).

176. The current cumulative mortality of 1,003.2 is much lower than either of the cumulative totals reported for Rampion (1,803 and 3,025). The increase in the avoidance rate for this species has resulted in a large reduction in predicted cumulative totals to the extent that the current estimate is much lower than those on which it has been concluded there will be no effect on the population in the long term (DECC, 2014).

177. A population model for great black-backed gull was developed to inform the East Anglia THREE assessment (EATL 2016a). Four versions of the model were presented, using two different sets of demographic rates (from the literature) and both with

and without density dependent regulation of reproduction. Comparison of the historical population trend with the outputs from these models indicated that the density dependent versions generated population predictions which were much more closely comparable to the population trend. The density dependent models were also less sensitive to which set of demographic rates was used. The density dependent versions were therefore considered to provide a more reliable predictive tool.

178. Using the density dependent model, application of an additional annual mortality of 1,000 to the great black-backed gull BDMPS resulted in reductions in the population growth rate of up to 1.6% for the most precautionary density independent predictions (it should be noted that this was estimated across a period of 25 years, however the difference in growth rate changes across this period and that for a 30 year period will be small and would not alter the conclusion that this level of mortality would not have a significant effect on the long term growth rate of the population).

179. On the basis of the results from the modelling Natural England concluded that whilst a significant cumulative effect could not be ruled out, the project's (East Anglia THREE) individual contribution was so small that it would not materially affect the overall cumulative impact magnitude. It is also worth reiterating that the current cumulative total is considerably lower (due to the lower avoidance rates applied to this species in the past) than that which would have been estimated for older wind farm projects for which consent was granted.

180. The final East Anglia THREE annual collision impact for great black-backed gull was 39, which is only slightly lower than that for Norfolk Vanguard (46.8) . And as noted above, there are several sources of precaution involved in reaching this estimate (e.g. over-estimates of nocturnal activity and use of predictions for consented rather than built wind farm designs) and therefore it is reasonable to assume that the same conclusion (that Norfolk Vanguard's contribution will not materially alter the overall cumulative impact magnitude) would apply for the current project.

181. In conclusion, the cumulative impact on the great black-backed gull population due to collisions both year round and within individual seasons is considered to be of low magnitude and great black-backed gull are considered to be of low to medium sensitivity, therefore the impact significance is **minor adverse**.

3.6 Little gull

3.6.1 Collision risk

3.6.1.1 EIA Project alone

182. The revised collision risk estimates for little gull for the 10MW turbine and the revised project layout (ExA; CRM 10.D6.5.1)) and 5m turbine draught height increase (ExA;AS;10.D.7.5.2), calculated using the Band (2012) deterministic model and Natural England's preferred parameter values, are provided in Table 24.

Table 24. Little gull seasonal and annual collision risk.

Breeding season	Nonbreeding season	Annual
1.95 (0.65-3.57)	3.14 (1.06-6.09)	5.09 (1.71-9.66)

183. Considering the reduction in mortality due to the removal of the 9MW turbine, the revised layout and the increase in turbine draught height together, the predicted collision mortality for little gull at Norfolk Vanguard has been reduced by 71%.

184. In the Norfolk Vanguard HRA (Vattenfall 2018) the little gull population with connectivity to the southern North Sea was estimated to be up to 75,000 (Steinen et al. 2007), with a precautionary estimate of between 10,000 and 20,000 based on the surveys conducted across the Greater Wash Area of Search (a larger area than the SPA within which surveys were conducted to inform the spatial extent of the SPA) and analysis of those data in Natural England and JNCC (2016).

185. The adult survival rate for little gull is reported as 0.8 (Horswill and Robinson 2015). Therefore, the natural mortality of the population will vary between 2,000 and 15,000 (for populations of 10,000 and 75,000, respectively). An addition of 5.1 mortalities to these would increase the mortality rate by 0.25% and 0.03% respectively. These are less than the 1% threshold below which impacts are considered undetectable against background changes and therefore the magnitude of collision impacts at the EIA scale for Norfolk Vanguard alone is negligible and the impact is **minor adverse**.

3.6.1.2 HRA Project alone

186. Since the Norfolk Vanguard Offshore Wind Farm is wholly outside the Great Wash SPA boundary, for assessment of potential impacts, it is appropriate to consider the wider population in the southern North Sea of which the SPA population is a component. This was presented in the HRA submitted for Norfolk Vanguard (Vattenfall 2018, section 6.1.3.2) and the population estimates thus derived were summarised above (precautionary estimates of 10,000 to 20,000; note also that in

their comments on the Norfolk Vanguard HRA, Natural England agreed with the approach to estimating population sizes and apportioning, Natural England 2018).

187. The Greater Wash SPA designated population of little gull is 1,255, which is 12.6% of the most precautionary population estimate of 10,000 or 6.3% of a population of 20,000. On this basis, and assuming collisions would be distributed uniformly throughout the population, this would imply that a maximum of 0.6 individuals from the Greater Wash SPA population of little gull would be at risk of mortality due to collisions (12.6% of 5.1), which would be reduced further to 0.3 on the basis of the more realistic wider population (of 20,000). For the SPA population of 1,255, and assuming the wider population is 10,000, the addition of 0.6 individuals would increase the background mortality rate by 0.24%, while using the more realistic wider population estimate of 20,000 this increase in mortality rate would be 0.12%.

188. Thus, it can be concluded that the maximum additional mortality of one individual from the SPA population will be undetectable and there will be no adverse effect on the integrity of the Greater Wash SPA as a result of collisions at the Norfolk Vanguard project alone.

3.6.1.3 HRA In-combination

189. The predicted mortality of little gull at Norfolk Vanguard in-combination with other wind farms with potential connectivity to the Greater Wash SPA little gull population is 60.1 (Table 25).

Table 25. Assessed collision rates and updated little gull collision predictions for offshore wind farm sites with potential connectivity to the Greater Wash SPA.

Wind farm	Annual collisions	Avoidance rate (%)	Assessed wind farm size	Collisions updated for 99.2% avoidance rate	Built or proposed wind farm size	Collisions updated for built or proposed wind farm
Triton Knoll	65	98	288 * 3.6MW	26	TBC. c. 120	c. 15
Race Bank	52	98	206 * 3MW	21	91 * 6MW	12
Sheringham Shoal	8	98	108 * 3MW	3	88 * 3.6MW	3
Hornsea Project One	10	98	332 * 3.6MW	4	174 * 7MW	2
Hornsea Project Two	1.3	98	360 * 5MW	0.5	N/A	0.5
Hornsea Project Three	0.5	99.2	300 * 6MW	0.5	N/A	0.5
Norfolk Vanguard	5.1	99.2	180 * 10MW	5.1	N/A	5.1
In-combination total				**60.1**		**38.1**

190. Given a regional little gull population of between 10,000 and 20,000 this figure (60.1) represents an increase in background mortality of between 1.5% and 3.0% (although as noted above the population may be as large as 75,000, further reducing the magnitude of potential impact, to an increase in mortality of less than 0.4%). The Greater Wash SPA designated population of little gull is 1,255, which is 12.6% of a population of 10,000 or 6.3% of a population of 20,000. On this basis, and assuming collisions would be distributed uniformly throughout the population, this would imply that a maximum of 7.6 individuals from the Greater Wash SPA population would be at risk of in-combination collisions (12.6% of 60.1), although using the actual built projects (or planned designs) and noting that Triton Knoll has reduced its capacity to 90 turbines this would reduce to 4.8 individuals. Furthermore, the in-combination collisions would be reduced to 2.4 individuals on the basis of the more realistic wider population (of 20,000). These would give rise to increases in mortality for the SPA population of between 0.95% (2.4 individuals, for built projects and the realistic population of 20,000) and 3.0% using the most precautionary combination of consented development predictions and the smallest regional population estimate of 10,000 (7.6 individuals).

191. A very similar total collision estimate of 7 individuals was assessed by the Secretary of State (SoS) for the in-combination assessment for the Triton Knoll non-material change application (BEIS 2018). In relation to this estimate the SoS stated:

"Assuming collisions are attributed evenly amongst the regional population, this equates to 7 individuals from the Greater Wash population. Such a small impact would also be undetectable in the SPA population."

And also:

"in view of the small impacts quantified above, the Secretary of State considers that an Appropriate Assessment is not required in this case."

192. Thus, on the basis of an SPA in-combination mortality of 7.6, for the most precautionary interpretation of the potential risk to the population or a more realistic total of 2.4, the likelihood of an adverse effect on the integrity of the Greater Wash SPA population of little gull can be ruled out for the proposed Norfolk Vanguard project in-combination with other plans and projects.

3.7 Conclusion

193. This note provides updated cumulative and in-combination assessment for the Norfolk Vanguard Offshore Wind Farm following reductions in the project's predicted collision mortality risks achieved through design mitigations which included removal of the 9MW turbine from the design envelope, a limit to the

proportion of turbines which will be installed across the East and West sites and an increase of 5m in turbine draught height (from 22m to 27m). Together these mitigations have reduced the project collision risks by an average of 65% across all species, which results in a considerable reduction in the project's contribution to the cumulative and in-combination totals.

194. The conclusions of the collision risk assessments presented in the ES, HRA and updates submitted during the project's examination (ExA; AS; 10.D6.17, ExA; As;10.D7.21) remain unchanged, with no significant impacts predicted for collisions at the project alone or cumulatively and no predicted adverse effects on SPA integrity due to the project alone or in-combination with other plans or projects.

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