THE PLANNING ACT 2008

THE INFRASTRUCTURE PLANNING (EXAMINATION PROCEDURE) RULES 2010

NORFOLK BOREAS OFFSHORE WIND FARM

Planning Inspectorate Reference: EN010087

Updated Ornithology Advice

Natural England's comments in relation to the Norfolk Boreas updated offshore ornithological assessment, submitted at Deadline 2 [REP2-035]

Deadline 4

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30 January 2020

Contents

Main comments and summary of Natural England's advice

We welcome the updated offshore ornithological assessments submitted by the Applicant at Deadline and in general we broadly agree with the approach to the assessments undertaken by the Applicant in this document. Following Issue Specific Hearing (ISH) 4 on 22nd January 2020, we understand that updated collision risk assessments for Norfolk Boreas alone will be submitted by the Applicant at Deadline 6 that will contain revised predicted collision figures for the project alone based on a revised worst case scenario of 11.55MW turbines (rather than 10MW as previously presented) and a raise of draught height by a minimum of 5m (i.e. from 22m HAT to 27m HAT). We also understand that revised cumulative and in-combination collision risk assessments will be submitted by the Applicant at Deadline 6, which will include the updated figures for Norfolk Boreas along with any updated figures to Norfolk Vanguard and Hornsea 3 in light of the SoS's request for additional information on offshore ornithology on further possible mitigation and potential compensation for these two projects. Therefore our advice provided in this document and associated appendices is based on best available evidence at the time of writing and is subject to change in the future in light of evidence being presented.

Main comments on updated assessments

1.1 Precaution in assessments

The Applicant asserts that the methods requested by Natural England, and used for the updated assessments in REP2-035, are over-precautionary and result in greatly over-estimated impacts with highly improbable outcomes. Our position/advice regarding the various aspects highlighted by the Applicant in REP2-035 has been set out in detail in our submission ahead of the ISH 4 and has also been previously set out in response to similar issues raised during the Norfolk Vanguard hearing (see our Deadline 9 response to this examination[1]). In summary, there is variability and/or uncertainty in most of the aspects of the assessments, including:

- Assessments are based on 2 years of survey data and the distribution of birds in the marine environment appears to be highly variable between days, seasons, years and even time of day. It is likely that for example, 24 days of surveys over 2 years - approximately 3.3% of the total number of 720 days - do not fully capture the full extent of variation density/abundance of seabirds that can be present within the survey areas during the 2 year period, including low as well as high counts, let alone over the 30-year period of the lifespan of the project. Tt is therefore appropriate for assessments to present and consider values from both lower and upper 95% confidence limits.
- Empirical evidence is scare or lacking in many areas of the assessments, including around empirical avoidance rates of birds at offshore sites (just one study from Thanet offshore wind farm) and mortality rates from displacement.

Therefore, in order to reflect such potential variability and uncertainty in assessments, it is appropriate to apply precaution and hence Natural England's advice to take a range based-approach to assessments.

The Applicant also considers in REP2-035 that *'the significant sources of over precaution in the approach taken to assess offshore wind farm impacts on seabirds is particularly apparent in the cumulative and in-combination assessments where the over-precaution in*

[1] Natural England (2019) Natural England's comments on Deadline 8 Submission – Offshore Ornithology Precaution in ornithological assessment for offshore wind farms [REP8-067]. Available from: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010079/EN010079-003190-DL9%20-%20Natural%20England%20-%20Deadline%20Submission.pdf

each wind farm assessment is added together and as a consequence in many instances the conclusions of the updated assessments are considered to greatly over-estimate impact magnitudes and present highly improbable outcomes.' Natural England's understanding is that in the collision assessments the central predicted value (i.e. those for the mean bird density, mean/central avoidance rate, mean/central flight height) from each individual project assessment to be carried forward into cumulative and in-combination assessments, rather than upper figures for of any predicted range based on 95% confidence limits on input data. Whilst for displacement assessments, the mean bird abundance data from each individual project are taken through to the cumulative/in-combination assessments, rather than upper figures based on 95% confidence limits. In any event, for all Round 1 and Round 2 projects the use of upper 95% confidence limits is simply not possible, because earlier windfarm Environmental Statements did not present such information.

We also note that the potential limitations in recording of site-specific data on seabird flight heights may have the potential to lead to underestimates of potential collisions and hence assessments may be lacking in precaution in this aspect. For example, using the mean values of the input parameters, the Option 1 collision risk modelling outputs (i.e. using the site-specific flight height data) predict over 1,000 kittiwake collision per annum at an EIA scale, compared to 203 per annum for Option 2 (generic flight height data from Johnston et al. 2014). **This highlights the need to collect real evidence on actual collisions (potentially through cameras deployed on turbines, together with surveys to establish numbers of birds at the site) and also highlights the need for consideration of mitigation through raising turbine draught heights by as much as is possible.**

With regard to the use of collision estimates calculated for consented wind farm designs in the cumulative and in-combination totals, as Natural England has previously stated during the Norfolk Vanguard examination (see our Deadline 2[2] and 8[3] responses for this examination), we acknowledge that this is an important issue with regard to cumulative/in-combination collision risk modelling (CRM) predictions and assessments. However, without a legally secured reduction in the consented Rochdale envelope, and a re-run CRM with the final design parameters (noting that the predicted impacts still need to be calculated for the worst case scenario within the consent unless there is documented evidence that what has been built cannot be added to/changed etc. over the lifetime of the project consent), cumulative assessments should be based on consented parameters. We note that East Anglia 1 is currently the only project to date to meet these tests.

1.2 Cumulative/in-combination assessments

As noted in our submission ahead of ISH 4, we welcome that the cumulative/in-combination collision and displacement assessments in REP2-035 have been updated to include the missing offshore wind farms noted in our Relevant Representations [RR-099] and to correct the figures for other projects (e.g. Norfolk Vanguard, Thanet Extension, Hornsea 3) as identified in RR-099. We also welcome that the Applicant has used in the auk cumulative/in-combination assessments the abundance estimates for the Hornsea 3 project those

[2] Natural England (2019) Norfolk Vanguard Offshore Wind Farm: Comments on Offshore Ornithological Aspects of Applicant's Response to Section 51 Advice from the Planning Inspectorate. Available from: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010079/EN010079-002461-Natural%20England%20-%20NE%20detailed%20comments%20on%20Offshore%20Ornithology%20S51%20Advice.pdf

[3] Natural England (2019) Norfolk Vanguard Offshore Wind Farm: Natural England's Comments on Norfolk Vanguard Ltd. Deadline 7 and Deadline 7.5 submissions in relation to Offshore Ornithology Related matter. Available from: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010079/EN010079-003121-DL8%20-%20Natural%20England%20-%20Deadline%20Submission.pdf

presented for the 'alternative analysis' in Annex C of Appendix 28 of the Deadline 4 submission by the Hornsea 3 Applicant (Hornsea Project Three Offshore Wind Farm 2019a) in Table 1.11 for guillemot and Table 1.15 for razorbill. We note that these are the figures used by Natural England in our Hornsea 3 Deadline 7 response for displacement.

With regard to the numbers included in the cumulative/in-combination assessments for Hornsea 3, we note that Natural England highlighted throughout our written and oral submissions for Hornsea 3 that the lack of sufficient baseline information for the Hornsea 3 Zone (i.e. the array area) means that there is a considerable degree of uncertainty (and thereby level of risk) associated with these figures and these should in no way be seen as Natural England's agreed position on the levels of impact from Hornsea 3. We acknowledge that the Hornsea 3 and Norfolk Vanguard decisions have been delayed and that BEIS has sought further information from the developers. We therefore note that there is the potential that the figures for these projects could change during the Norfolk Boreas examination process and there may hence be a requirement to update the figures included in the in-combination assessments for these projects. We welcome that the Applicant intends to submit revised assessments to account for these (and the mitigation proposed for Norfolk Boreas) at Deadline 6.

With regard to the numbers included in the cumulative/in-combination assessments for Hornsea 3, we note that Natural England highlighted throughout our written and oral submissions for Hornsea 3 that the lack of sufficient baseline information for the Hornsea 3 Zone (i.e. the array area) means that there is a considerable degree of uncertainty (and thereby level of risk) associated with these figures and these should in no way be seen as Natural England's agreed position on the levels of impact from Hornsea 3. **Therefore, due to Natural England's significant concerns regarding the incomplete baseline surveys for the Hornsea 3 project, and the associated level of uncertainty as regards the potential impacts of that project, Natural England is not in a position to advise that a significant adverse impact for cumulative impacts at EIA scale or that an adverse effect on integrity (AEOI) can be ruled out for any relevant feature of an SPA when the Hornsea 3 project is included in the totals.**

We note that there may be the potential for figures for the East Anglia One North and East Anglia Two projects to change during the examinations for these projects. However, we acknowledge that values currently included by the Norfolk Boreas Applicant for these projects represent the most appropriate at present.

We also note that the figures for Hornsea 4 come from the PEIR for that project. These figures and the methodologies to produce them are hence subject to ongoing discussions through the evidence plan process and therefore have an element of uncertainty associated with them and a likelihood of being subject to change. For example, the CRM figures presented in the Hornsea 4 PEIR were undertaken using the stochastic CRM, and therefore are potentially affected by the issues currently being investigated with this model. **The inevitable uncertainty around the Hornsea 4 figures along with that position set out above regarding inclusion of Hornsea 3 in the cumulative/in-combination assessments means that Natural England is not in a position to advise that a significant adverse impact for cumulative impacts at EIA scale or that an AEOI for in-combination impacts at HRA can be ruled out for any relevant species or feature of an SPA when the Hornsea 3 and Hornsea 4 projects are included in the totals.**

We understand that the figures included in the gannet and kittiwake cumulative assessment tables (Tables 7.1 and 7.2 of REP2-035) for the Dogger Bank Creyke Beck projects have been updated with numbers from collision risk modelling undertaken as part of a non-material change application (Dogger Bank Wind Farms 2018). Natural England notes that our initial response to this non-material change application suggested that any future

projects entering the consenting process should take into account the revised Dogger Bank Creyke Beck project envelope in their in-combination assessment, should this non-material change to the DCO be accepted. However, subsequent to this advice it became apparent from the developer that the non-material change application increased the Rochdale envelope to include larger turbines, but the rest of the envelope remained unchanged, i.e. smaller turbines aren't removed. Therefore, the worst case scenario for the Dogger Bank Creyke Beck projects still stands and we advise that these figures should be used in the cumulative/in-combination assessments. Natural England understands that the non-material change application increased the Rochdale envelope to include larger turbines, but the rest of the envelope remained unchanged, i.e. smaller turbines aren't removed. Therefore, we recommend that the Applicant updates the figures included for these projects and species in the updated cumulative/in-combination collision assessments expected at Deadline 6.

The Applicant has run EIA scale Population Viability Analysis (PVA) models for gannet, kittiwake, lesser black-backed gull (LBBG) and great black-backed gull (GBBG) for the Biologically Defined Minimum Population Scale (BDMPS) and biogeographic population scales using the Natural England commissioned Seabird PVA tool (https://github.com/naturalengland/Seabird_PVA_Tool). This updates the previous PVA models for EIA scale kittiwake and GBBG undertaken at East Anglia 3 assessment (EATL 2015 & 2016) and the SOSS national gannet PVA (WWT 2012), so that the models are run over 30 years, the stochastic simulations are run as 'matched pairs' and present outputs for the Natural England recommended metrics of the counterfactual of population growth rate and the counterfactual of population size to quantify the relative changes in a population in response to anthropogenic impacts. As noted in our submission ahead of ISH 4, updates to the tool are being undertaken. Natural England is aiming to make the updates to the tool available in the next 1-2 weeks, and we advise that the models are re-run when the updated version of the tool is available. We request that any revised assessments present the metrics calculated across the whole population (the new version of the tool will have this as a new option that can be selected as an output type). We therefore welcome the commitment by the Applicant in Appendix 3 of REP2-035 that it will be necessary for the Applicant to confirm that the updates to the tool have meant that the model structure and outputs remain the same once the revised model is available, and that this will be undertaken as soon as is practical and an update or clarification submitted to the Examination as appropriate. We also advise that the Applicant includes information the outputs from the models in terms of the growth rates predicted by the models for the un-impacted scenarios in order to assess whether the models are suggesting a reasonably sensible trajectory for the populations with no offshore wind farm impacts.

We note that some of the EIA scale PVA models have been run for only 500 or 1,000 simulations. The Seabird PVA Tool report (Searle et al. 2019) states that *'it is not recommended to use small values of sim.n (number of simulations) because PVAs based on small numbers of simulations are likely to be unreliable (using a value of less than 1,000 will generate a warning message in the tool, but in practice the minimum number of simulations may need to be substantially higher than this in order to achieve reliable results)'*. Natural England considers that a larger number of simulations than 500 would be needed to generate reliable results and for models run for 1,000 simulations, we recommend that the Applicant presents evidence to demonstrate that using 1,000 simulations in the models produces reliable results.

The Applicant has considered the PVAs undertaken during the Norfolk Vanguard examination for LBBG at the Alde-Ore Estuary SPA (MacArthur Green 2019); and the updated PVAs undertaken during the Hornsea examination for gannet, kittiwake, razorbill and guillemot at the FFC SPA (Hornsea Project Three Offshore Wind Farm 2019). As noted in our Relevant Representations for Norfolk Boreas [RR-099], we had outstanding concerns with the Hornsea 3 PVAs which were not resolved by the close of the Examination, relating

to the number of simulations and the demographic data not being updated (see our Deadline 6 response to the Hornsea 3 Examination – written summary of representations of ISH5[4]). Given these outstanding concerns, we would recommend that these models are updated/re-run using the Natural England commissioned Seabird PVA Tool (https://github.com/naturalengland/Seabird_PVA_Tool) once the updated tool is available.

Therefore, whilst Natural England has considered the outputs from these models (both for EIA and HRA) in our advice, as they nevertheless currently represent the best available evidence on which to base an assessment, this should not be taken as a Natural England endorsement or 'acceptance' of the model outputs and we reserve the right to revise the advice provided here based on the best available evidence presented.

Summary of Natural England Advice

Natural England has reviewed the evidence presented in the updated assessments in REP2-035 and have interpreted the predicted impacts following the approach outline in our submission ahead of the ISH 4. A summary of our advice is presented in **Table 1** and detailed advice around how these conclusions were reached are set out in Appendix 1 (for EIA) and Appendix 2 (for HRA).

The Norfolk Boreas project makes a meaningful contribution to cumulative and in-combination effects on several seabirds at both the EIA scale and with respect to qualifying features of seabird colony SPAs through collision mortality, particularly with respect to North Sea populations of great black-backed gull, gannet and kittiwake, Flamborough and Filey Coast SPA kittiwake and gannet, and Alde-Ore Estuary SPA lesser black-backed gull (see Table 1).

[4] Natural England (2019) Hornsea Project Three Offshore Wind Farm: Natural England Written Submission for Deadline 6 – Written Submission of Natural England's Representations at Issue Specific Hearing 5, Offshore Ecology. Available from: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010080/EN010080-001688-Natural%20England%20-%20Written%20Submission%20of%20Natural%20England's%20Representations%20at%20Issue%20Specific%20Hearing%205%20-%20Offshore%20Ecology.pdf

Table 1 Summary of conclusions for assessments of Norfolk Boreas alone and cumulatively / in-combination with other plans and projects for relevant species following Applicant's updated assessments in REP2-035

EIA species	**Norfolk Boreas Alone**	**Norfolk Boreas cumulatively with other plans & projects**
Gannet: collision	No significant adverse impact	Unable to rule out significant adverse impact excl. & incl. H3 & H4
Gannet: displacement	No significant adverse impact	No significant adverse impact
Gannet: collision + displacement	No significant adverse impact	Unable to rule out significant adverse impact excl. & incl. H3 & H4
Kittiwake: collision	No significant adverse impact	Unable to rule out significant adverse impact excl. & incl. H3 & H4
Lesser black-backed gull: collision	No significant adverse impact	No significant adverse impact
Herring gull: collision	No significant adverse impact	No significant adverse impact
Great black-backed gull: collision	No significant adverse impact	Unable to rule out significant adverse impact excl. & incl. H3 & H4
Little gull: collision	No significant adverse impact	No significant adverse impact
Red-throated diver: displacement	Unable to rule out significant adverse impact	Unable to rule out significant adverse impact excl. & incl. H3 & H4
Guillemot: displacement	No significant adverse impact	Unable to rule out significant adverse impact excl. & incl. H3 & H4
Razorbill: displacement	No significant adverse impact	Unable to rule out significant adverse impact excl. & incl. H3 & H4
HRA species & site	**Norfolk Boreas alone**	**Norfolk Boreas in-combination with other plans & projects**
Gannet, Flamborough & Filey Coast SPA: collision	No adverse effect on site integrity (AEOI)	No AEOI excl. H3 and H4 Unable to rule out AEOI incl. H3 & H4
Gannet, Flamborough & Filey Coast SPA: displacement	No AEOI	No AEOI excl. H3 and H4 Unable to rule out AEOI incl. H3 & H4
Gannet, Flamborough & Filey Coast SPA: collision + displacement	No AEOI	No AEOI excl. H3 and H4 Unable to rule out AEOI incl. H3 & H4
Kittiwake, Flamborough & Filey Coast SPA: collision	No AEOI	Unable to rule out AEOI excl. and incl. H3 & H4
Guillemot, Flamborough & Filey Coast SPA: displacement	No AEOI	No AEOI excl. H3 and H4 Unable to rule out AEOI incl. H3 & H4
Razorbill, Flamborough & Filey Coast SPA: displacement	No AEOI	No AEOI excl. H3 and H4 Unable to rule out AEOI incl. H3 & H4

Assemblage, Flamborough & Filey Coast SPA	No AEOI	No AEOI excl. H3 and H4 Unable to rule out AEOI incl. H3 & H4
Lesser black-backed gull, Alde-Ore Estuary SPA: collision	No AEOI	Unable to rule out AEOI excl. H3 & H4 (no collisions apportioned from H3 & H4)
Little gull, Greater Wash SPA: collision	No AEOI	No AEOI excl. H3 and H4 Unable to rule out AEOI incl. H3 & H4
Red-throated diver, Greater Wash SPA: displacement (cable construction and O&M vessel movements)	No AEOI, based on Applicant's commitment to mitigation	No AEOI, based on Applicant's commitment to mitigation
Common scoter, Greater Wash SPA: displacement	No AEOI	No AEOI
Red-throated diver, Outer Thames Estuary SPA: displacement (O&M vessel movements)	No AEOI, based on Applicant's commitment to mitigation	No AEOI, based on Applicant's commitment to mitigation

Natural England has previously provided regulators with our advice regarding our concerns about predicted level of cumulative/in-combination impacts on North Sea seabirds, e.g. EIA great black-backed gull at East Anglia 3 and Norfolk Vanguard, Flamborough and Filey Coast (FFC) SPA kittiwakes at Hornsea 2 and Norfolk Vanguard. These concerns have intensified given the three further offshore wind farm NSIPs now submitted to PINS (Norfolk Boreas, East Anglia One North, East Anglia Two) and with a further project planned to submit in the next 12 months (Hornsea 4). Therefore, Natural England considers that without major project-level mitigation being applied to all relevant projects coming forward, there is a significant risk of large-scale impacts on seabird populations.

Natural England therefore recommends that for all relevant future projects located in the North Sea, raising turbine draught height should be considered as standard mitigation practice, and that where appropriate relevant proposals should include this measure in order to minimise their contributions to the cumulative/in-combination collision totals by as much as is possible. **Therefore we appreciate the commitment made by the Applicant at ISH 4 to present revised collision assessments for Norfolk Boreas based on mitigation to now consider an 11.55MW turbine worst case scenario along with a minimum of 5m raise in draught height (which is to be submitted at Deadline 6). We advise that the Applicant considers options of raising the draught height by as much as is possible and includes information regarding the reasoning behind the draught height increases chosen**.

Appendix 1: Environmental Impacts Assessment (EIA) detailed comments and conclusions.

This document is a technical document submitted into the Norfolk Boreas Examination to provide scientific justification for Natural England's advice provided on the significance of the potential impacts at the Environmental Impact Assessment (EIA) scale, as summarised within each section. Our advice is based on best available evidence at the time of writing and is subject to change in the future should further evidence be presented.

EIA Impacts from Norfolk Boreas alone

1.1 EIA impacts from operational collision risk from Norfolk Boreas alone

Natural England has evaluated the collision risk modelling (CRM) outputs presented by the Applicant in the Environmental Statement offshore ornithology chapter of the submission documents [APP-226] for each of the six key seabird species considered to be at risk of collision impacts from Norfolk Boreas at an EIA scale: gannet, kittiwake, lesser black-backed gull (LBBG), herring gull, great black-backed gull (GBBG) and little gull. We agree with the predicted collision figures presented by the Applicant in Table 13.34 of APP-226 for the central predicted figures (based on mean density) and the range of figures based on the 95% confidence intervals of the density data.

As shown in Table 2 below, based on the submission figures, we agree with the Applicant that all the central CRM predictions (i.e. using mean density, mean avoidance rate, maximum likelihood flight height data and the standard nocturnal activity rates) equate to less than 1% baseline mortality of the largest Biologically Defined Minimum Population Scale (BDMPS) and biogeographic populations for all of the six key species (gannet, kittiwake, LBBG, herring gull, GBBG and little gull). This is also the case for the upper 95% confidence intervals of the bird density for all species with the exception of GBBG, where the predicted CRM figure of 202 equates to 1.53% of baseline mortality of the largest BDMPS and 0.60% of baseline mortality of the biogeographic population. **Therefore, based on these figures we agree with the Applicant's conclusion in APP-226 that the collision risk from Norfolk Boreas alone would have no significant adverse impact at the EIA scale for all species, although this conclusion is made with reduced confidence regarding impacts on GBBG.**

Table 2 Percentage of baseline mortality for predicted impact levels for Norfolk Boreas operational collision risk alone for EIA, using average across all age class mortality rates, as used by the Applicant

	CRM prediction, Boreas alone	**Largest BDMPS (North Sea) individuals, Furness (2015)**	**% baseline mortality largest BDMPS**	**Biogeographic population individuals (Furness 2015)**	**% baseline mortality biogeographic**
Gannet	118 (32-240)	456,298	0.14 (0.04-0.28)	1,180,000	0.05 (0.01-0.11)
Kittiwake	203 (86-355)	829,937	0.16 (0.07-0.27)	5,100,000	0.03 (0.01-0.04)
LBBG	40 (4-108)	209,007	0.15 (0.02-0.42)	864,000	0.04 (0.00-0.10)
Herring gull	18 (0-56)	466,511	0.02 (0.00-0.07)	1,098,000	0.01 (0.00-0.03)
GBBG	93 (14-202)	91,399	0.71 (0.11-1.53)	235,000	0.27 (0.04-0.60)
Little gull	4 (1-14)	10,000*	0.10 (0.03-0.35)	75,000**	0.03 (0.01-0.09)

* Precautionary estimate based on the surveys conducted across the Greater Wash Area of Search and analysis of those data in Natural England & JNCC (2016), as used by Applicant
** Little gull population with connectivity to the southern North Sea was estimated to be up to 75,000 (Stienen et al. 2007), as used by Applicant

1.2 EIA impacts from operational displacement from Norfolk Boreas alone

We welcome that the Applicant has considered in REP2-035 the range of predicted displacement impacts based on the range of displacement and mortality rates. The ranges considered cover those recommended by Natural England (i.e. up to 100% displacement and 1-10% mortality for red-throated diver and 30-70% displacement and 1-10% mortality for auks). The Applicant has also considered the range of predicted impacts based on consideration of the mean abundance and 95% confidence intervals (CIs) around the abundance data in the updated assessment in REP2-035.

Table 3 Percentage of baseline mortality for predicted impact levels for operational displacement for Norfolk Boreas alone at EIA scale, using average across all age class mortality rates, as used by the Applicant

	Bird abundance	**Displacement prediction, Boreas alone (from Tables in REP2-035)***	**Largest BDMPS individuals, Furness (2015)**	**% baseline mortality largest BDMPS**	**Biogeographic population individuals, Furness (2015)**	**% baseline mortality biogeographic**
Red-throated diver	Lower 95% CI	1-7	13,277	0.02-0.24	27,000	0.01-0.11
	Mean	7-80		0.24-2.64		0.12-1.30
	Upper 95% CI	16-172		0.51-5.69		0.25-2.80
Gannet	Lower 95% CI	10-14	456,298	0.01-0.02	1,180,000	0.004-0.006
	Mean	21-28		0.02-0.03		0.009-0.012
	Upper 95% CI	34-45		0.04-0.05		0.01-0.02
Razorbill	Lower 95% CI	3-71	591,874	0.00-0.07	1,707,000	0.001-0.02
	Mean	7-161		0.01-0.16		0.002-0.05
	Upper 95% CI	11-266		0.01-0.26		0.004-0.09
Guillemot	Lower 95% CI	30-693	1,617,306	0.01-0.31	4,125,000	0.01-0.12
	Mean	65-1,508		0.03-0.67		0.01-0.26
	Upper 95% CI	102-2,372		0.04-1.05		0.02-0.41

*Displacement predictions based on ranges of 90-100% displacement and 1-10% mortality for RTD, 60-80% displacement and 1% mortality for gannet, and 30-70% displacement and 1-10% mortality for razorbill and guillemot. Lower figure relates to the lower displacement and mortality rates, upper figure relates to the upper displacement and mortality rates

With regard to red-throated diver (RTD), the annual predicted impacts for operational displacement do not exceed 1% of baseline mortality of the largest BDMPS for the Applicant's preferred rates of 90% displacement and 1% mortality, even using the upper 95% confidence intervals. However, using the upper range of the Natural England advised rates of up to 100% displacement and 10% mortality exceed 1% of baseline mortality of the largest BDMPS scale and the biogeographic population (Furness 2015) – the figure equates to up to 2.64% of baseline mortality of the BDMPS using the mean abundance and up to 5.69% using the upper 95% CI of abundance. Whilst using the mean abundance equates to up to 1.30% of baseline mortality of the biogeographic population and to up to 2.80% using the 95% CI of abundance, and the figure including all projects equates to 3.61% of the BDMPS and 1.40% of the biogeographic population baseline mortality (Table 3 above). This significant and based on these figures **we would therefore advise that a significant adverse impact from operational displacement from Norfolk Boreas alone could not be ruled out at the EIA scale for RTD.**

From Table 3 above, using the upper 95% confidence intervals of abundance/density data, the predicted impacts for gannet, and razorbill even at the Natural England worst case range

of 70% displacement and 10% mortality do not exceed 1% of baseline mortality of the largest BDMPS for either of these species. For guillemot, only at the worst case range of 70% displacement and 10% mortality and using the upper 95% confidence interval of abundance/density data does the predicted figure equate to just over 1% of baseline mortality of the largest BDMPS (i.e. 1.05%). Based on these figures, we would agree with the Applicant's conclusions in REP2-035 **that operational displacement from Norfolk Boreas alone would have no significant adverse impact at the EIA scale for gannet, razorbill and guillemot.**

1.3 EIA Impacts from operational collision risk and displacement for gannet from Norfolk Boreas alone

As noted in the 2017 SNCB interim advice on displacement (SNCBs 2017), the number of birds at risk of reduced individual fitness (i.e. mortality and productivity losses) as a result of displacement is based on the numbers of birds present within a development area and buffer both on the water and in flight. Assessment of the number of birds at risk of mortality as a result of collisions (e.g. with wind turbines) is based on the number of birds present within a development area that are in flight only. The mortality impacts estimated from CRM are assumed to be in addition to any mortality caused by displacement impacts (because the collision estimates take account of birds that avoid the wind farm). Productivity impacts due to displacement would be a further addition (but this is not currently quantitatively accounted for under existing methods/advice).

Therefore, at present, the SNCBs regard the **two impacts (collision and displacement) as additive and advise that they should be summed**. In summing the predicted mortalities that arise via these two mechanisms, there is a risk of some degree of double counting as a bird that collides with a turbine and dies cannot be displaced and a bird that dies as a result of displacement cannot collide with the turbine. Thus, it is acknowledged that this simplistic approach will therefore incorporate a degree of precaution. The level of precaution is difficult to gauge, but will be highest when the number of birds recorded flying at turbine height (and therefore the predicted number of collisions) is greatest (SNCBs 2017). We therefore welcome that the Applicant has undertaken this assessment in REP2-035.

The combined impact of collision plus displacement to gannet from Boreas alone equals: 118 (range: 32-240) mortalities per annum from collisions plus up to 29 (range: up to 14-45) mortalities per annum from displacement = up to 147 (range: up to 46-285) mortalities. This combined impact alone equates to 0.17% (range: 0.05-0.33%) of baseline mortality of the largest BDMPS and to 0.07% (range: 0.02-0.13%) of the biogeographic population. **Therefore, based on these figures we agree with the Applicant's conclusion in APP2-035 that the predicted impacts of operational collision combined with displacement from Norfolk Boreas alone would have no significant adverse impact at the EIA scale for gannet.**

EIA Impacts from Norfolk Boreas cumulatively with other plans and projects

2.1 EIA Impacts from operational collision risk from Norfolk Boreas cumulatively with other plans and projects

Table 4 shows the cumulative collision risk total predictions for all relevant projects excluding Hornsea 3 and Hornsea 4 and for all projects including Hornsea 3 and Hornsea 4, as presented by the Applicant in REP2-035, for each of the key species considered to be at risk of collisions. The shaded cells of the table indicate where the predicted cumulative totals exceed 1% of baseline mortality of the largest BDMPS or biogeographic population.

Table 4 Percentage of baseline mortality for cumulative CRM for EIA for both all projects (so includes figs for Hornsea 3 and Hornsea 4) and also for all projects excluding Hornsea 3 and Hornsea 4 – agreed with them that this was probably the least complicated way of doing things for now given the uncertainty over figures for both of these projects. (Using average across all age class mortality rates, as used by the Applicant)

	Cumulative collision prediction*		**Largest BDMPS (North Sea) individuals, Furness (2015)**	**% baseline mortality largest BDMPS**		**Biogeographic population individuals (Furness 2015)**	**% baseline mortality biogeographic**	
	Excl. H3 & H4	**ALL projects**		**Excl. H3 & H4**	**ALL projects**		**Excl. H3 & H4**	**ALL projects**
Gannet	3,047	3,157	456,298	3.50	3.62	1,180,000	1.35	1.40
Kittiwake	3,903	4,397	829,937	3.01	3.40	5,100,000	0.49	0.55
LBBG	563	582	209,007	2.17	2.25	864,000	0.53	0.54
Herring gull	801	812	466,511	1.00	1.01	1,098,000	0.42	0.43
GBBG	1,065	1,144	91,399	6.30	6.77	235,000	2.45	2.63
Little gull	63.5	64	10,000**	1.59	1.60	75,000***	0.42	0.43

* Based on the Applicant's cumulative figures presented in REP2-035
** Precautionary estimate based on the surveys conducted across the Greater Wash Area of Search and analysis of those data in Natural England & JNCC (2016), as used by Applicant
*** Little gull population with connectivity to the southern North Sea was estimated to be up to 75,000 (Stienen et al. 2007), as used by Applicant

2.1.1 Gannet cumulative impacts

a) Operational collision risk:

The Applicant's cumulative collision totals for gannet of 3,047 birds excluding Hornsea 3 and Hornsea 4 and of 3,157 including all projects exceed 1% of baseline mortality of the North Sea BDMPS scale and the biogeographic population (Furness 2015) – the figure excluding Hornsea 3 and Hornsea 4 equates to 3.50% of baseline mortality of the BDMPS and 1.35% of baseline mortality of the biogeographic population, and the figure including all projects equates to 3.62% of the BDMPS and 1.40% of the biogeographic population baseline mortality (Table 4 above). This is significant and requires further consideration.

As noted in our main comments on REP2-035, the Applicant has run BDMPS and biogeographic scale PVAs using the Natural England PVA tool. We note the issues we have identified in the general comments above regarding the updates being undertaken on the tool and advise that the PVA is re-run following completion of these updates. However, the model nevertheless currently represents the best available evidence on which to base an assessment, though this should not be taken as a Natural England endorsement or 'acceptance' of the model outputs.

Using the PVA models undertaken by the Applicant in REP2-035, if the additional mortality from the offshore wind farms is 3,100-3,200 per annum (closest PVA outputs to the

cumulative collision mortality figures of 3,047 excluding Hornsea 3 and Hornsea 4 and 3,157 including all projects) then:

- The BDMPS population after 30 years will be 21.95-22.56% lower than it would have been in the absence of the additional mortality using the density independent model and 21.76-22.39% lower using the density dependent model. The population growth rate would be reduced by 0.8-0.82% using the density independent model and by 0.79-0.81% using the density dependent model (Table 5).
- The biogeographic population after 30 years will be 9.13-9.41% lower than it would have been in the absence of the additional mortality using the density independent model and 9.03-9.30% lower using the density dependent model. The population growth rate would be reduced by 0.31-0.32% using the density independent model and by 0.30-0.31% using the density dependent model (Table 5).

Table 5 Predicted Population impacts on the gannet BDMPS and biogeographic population for the range of mortality impacts predicted for cumulative collision. PVA Impact Metrics are as provided in Table 3.2 of REP2-035. The ranges of predicted figures are indicated in purple. The darker shaded cells represent the level of impact closest to the combined cumulative collision predictions

GANNET, EIA CUMULATIVE COLLISIONS – DENSITY INDEPENDENT PVA MODELS						
Additional mortality	**% baseline mortality largest BDMPS as used by Applicant**	**Counterfactual of Final Population Size (CPS), BDMPS**	**Counterfactual of Growth Rate (CGR), BDMPS**	**% baseline mortality biogeographic, as used by Applicant**	**Counterfactual of Final Population Size (CPS), biogeographic**	**Counterfactual of Growth Rate (CGR), biogeographic**
3,000	3.44	0.7867	0.9923	1.33	0.9116	0.9970
3,100	3.56	0.7805	0.9920	1.38	0.9087	0.9969
3,200	3.67	0.7744	0.9918	1.42	0.9059	0.9968
GANNET, EIA CUMULATIVE COLLISIONS – DENSITY DEPENDENT PVA MODELS						
Additional mortality	**% baseline mortality largest BDMPS as used by Applicant**	**Counterfactual of Final Population Size (CPS), BDMPS**	**Counterfactual of Growth Rate (CGR), BDMPS**	**% baseline mortality biogeographic, as used by Applicant**	**Counterfactual of Final Population Size (CPS), biogeographic**	**Counterfactual of Growth Rate (CGR), biogeographic**
3,000	3.44	0.7885	0.9924	1.33	0.9125	0.9971
3,100	3.56	0.7824	0.9921	1.38	0.9097	0.9970
3,200	3.67	0.7761	0.9919	1.42	0.9070	0.9969

As noted in our main comments on REP2-035, the collision figures included in REP2-035 for the Dogger Bank Creyke Beck projects have been updated with numbers from CRM undertaken as part of a non-material change application (Dogger Bank Wind Farms 2018). Therefore, we advise that these are updated by the Applicant to those for the original consented worst case scenario for these projects when the next update to the cumulative figures is submitted by the Applicant at Deadline 6.

The northern gannet is classified as 'Least Concern' with respect to the potential for global extinction (BirdLife International 2018). However, at the UK scale the species is Amber listed in Birds of Conservation Concern (BoCC) 4 (Eaton et al. 2015). The BoCC Amber listing is due to:

- Localisation of breeding population within Important Bird Areas (IBAs)/Special Protection Areas (SPAs) (Eaton et al. 2015).
- International importance of UK population – threshold of 20% of global population (Eaton et al. 2015). It has been estimated that the UK holds 55.6% of the global population (JNCC 2016).

Based on current UK gannet population growth rates of ~2-3% per annum and using the PVA model outputs, then the level of additional cumulative mortality from collisions from the offshore wind farms would still allow the population to grow. However, it is not known what the growth rate of the UK gannet population will be over the next 30 years and this should therefore be considered when judging the significance of predicted impacts and whether a 0.8% reduction in annual growth rate would be significant. It is considered likely that the level of predicted cumulative impact would not be significant for a population growing at 2-3% per annum. However, if the population does not grow at that level for the next 30 years (say if the growth rate was around 1% per annum), we consider that it is uncertain that a 0.8% reduction in growth rate would not be significant.

Based on consideration of the PVA metrics as currently presented, the above conservation assessment, and given the UK's particular responsibility for gannet because of supporting over half of the global population, the predicted impacts at the North Sea population scale have the potential to give rise to significant effects. **Therefore we are unable to rule out a significant adverse impact on gannet from cumulative collision mortality at an EIA scale irrespective of whether the Hornsea 3 and Hornsea 4 projects are included in the cumulative totals or not**. However, as the Natural England PVA tool is currently undergoing some updates, there will be the need for the Applicant to re-run the PVA once these updates have been completed (Natural England are aiming to make the updates to the tool available in the next 1-2 weeks). Hence, Natural England reserves the right to revise the advice provided here based on the best available evidence presented.

b) Operational Displacement

Based on the figures presented by the Applicant in Table 4.16 of REP2-035 the total cumulative number of gannets to be at risk of displacement for all projects (including from Hornsea 3 and Hornsea 4) is estimated to be 22,156 in the breeding season, 22,570 in the autumn migration season and 6,629 in the spring migration season. This equals an annual cumulative total for all projects including Hornsea 3 and Hornsea 4 of 51,355 gannets at risk of displacement.

For the rates considered by the Applicant of 60-80% displacement and 1% mortality, the number of predicted additional cumulative mortalities **including** Hornsea 3 and Hornsea 4 is between 308 (60% displacement and 1% mortality) and 411 (80% displacement and 1% mortality) gannets. This equates to 0.35-0.47% of baseline mortality for the largest BDMPS.

Given the uncertainty involved with the figures for both Hornsea 3 and Hornsea 4, the cumulative totals excluding these two projects are estimated to be 19,061 in the breeding season, 19,884 in the autumn migration season and 4,871 in the spring migration season, which gives an annual figure of 43,816 gannets at risk of displacement.

For the rates considered by the Applicant of 60-80% displacement and 1% mortality, the number of predicted additional cumulative mortalities **excluding** Hornsea 3 and Hornsea 4 is between 263 (60% displacement and 1% mortality) and 351 (80% displacement and 1% mortality) gannets. This equates to 0.30-0.40% of baseline mortality for the largest BDMPS.

Based on the above, **we agree with the Applicant's conclusion in REP2-035 of no significant adverse impact to gannet from cumulative operational displacement at an EIA scale if the Hornsea 3 and Hornsea 4 projects are excluded from the cumulative totals.**

However, due to Natural England's significant concerns regarding the incomplete baseline surveys for the Hornsea 3 project, and the associated level of uncertainty as regards the potential impacts of that project, together with the inevitable uncertainty associated with the figures for Hornsea 4 from the PEIR and are subject to change, Natural England therefore is not in a position to advise that significant impact can be ruled out for gannets for cumulative displacement impacts when the Hornsea 3 and Hornsea 4 projects are included in the cumulative totals.

c) Operational collision risk plus displacement

As noted previously, the SNCBs regard the two impacts (collision and displacement) as additive and advise that they should be summed. However, we acknowledge that this simplistic approach will incorporate a degree of precaution (SNCBs 2017). We welcome that the Applicant has undertaken this assessment for gannet cumulative impacts in REP2-035.

The combined cumulative impact excluding Hornsea 3 and Hornsea 4 of collision plus displacement to gannet equals:
3,047 mortalities per annum from collisions plus up to 351 mortalities per annum from displacement = up to 3,398 mortalities. This combined cumulative impact equates to 3.90% of baseline mortality of the largest BDMPS and to 1.51% of the biogeographic population.

The combined cumulative impact including all projects of collision plus displacement to gannet equals:
3,157 mortalities per annum from collisions plus up to 411 mortalities per annum from displacement = up to 3,568 mortalities. This combined cumulative impact equates to 4.09% of baseline mortality of the largest BDMPS and to 1.58% of the biogeographic population.

As with gannet cumulative collision impacts, the Applicant has run BDMPS and biogeographic scale PVAs using the Natural England PVA tool. We note the issues we have identified in the general comments above regarding the updates being undertaken on the tool and advise that the PVA is re-run following completion of these updates. However, the model nevertheless currently represents the best available evidence on which to base an assessment, though this should not be taken as a Natural England endorsement or 'acceptance' of the model outputs.

Using the PVA models undertaken by the Applicant in REP2-035, if the additional mortality from the offshore wind farms is 3,400-3,600 per annum (closest PVA outputs to the cumulative collision + displacement mortality figures of 3,398 excluding Hornsea 3 and Hornsea 4 and 3,568 including all projects) then:

- The BDMPS population after 30 years will be 23.82-25.05% lower than it would have been in the absence of the additional mortality using the density independent model and 23.59-24.83% lower using the density dependent model. The population growth rate would be reduced by 0.87-0.93% using the density independent model and by 0.86-0.92% using the density dependent model (Table 6).
- The biogeographic population after 30 years will be 9.96-10.51% lower than it would have been in the absence of the additional mortality using the density independent model and 9.86-10.42% lower using the density dependent model. The population growth rate would be reduced by 0.34-0.36% using the density independent model and by 0.33-0.35% using the density dependent model (Table 6).

Table 6 Predicted Population impacts on the gannet BDMPS and biogeographic population for the range of mortality impacts predicted for cumulative collision + displacement. PVA Impact Metrics are as provided in Table 4.22 of REP2-035. The ranges of predicted figures are indicated in purple. The darker shaded cells represent the level of impact closest to the combined cumulative collision predictions

GANNET, EIA CUMULATIVE COLLISIONS – DENSITY INDEPENDENT PVA MODELS						
Additional mortality	**% baseline mortality largest BDMPS as used by Applicant**	**Counterfactual of Final Population Size (CPS), BDMPS**	**Counterfactual of Growth Rate (CGR), BDMPS**	**% baseline mortality biogeographic, as used by Applicant**	**Counterfactual of Final Population Size (CPS), biogeographic**	**Counterfactual of Growth Rate (CGR), biogeographic**
3,400	3.90	0.7618	0.9913	1.51	0.9004	0.9914
3,500	4.02	0.7757	0.9910	1.55	0.8975	0.9911
3,600	4.13	0.7495	0.9907	1.60	0.8949	0.9908
GANNET, EIA CUMULATIVE COLLISIONS – DENSITY DEPENDENT PVA MODELS						
Additional mortality	**% baseline mortality largest BDMPS as used by Applicant**	**Counterfactual of Final Population Size (CPS), BDMPS**	**Counterfactual of Growth Rate (CGR), BDMPS**	**% baseline mortality biogeographic, as used by Applicant**	**Counterfactual of Final Population Size (CPS), biogeographic**	**Counterfactual of Growth Rate (CGR), biogeographic**
3,400	3.90	0.7641	0.9966	1.51	0.9014	0.9967
3,500	4.02	0.7578	0.9965	1.55	0.8986	0.9966
3,600	4.13	0.7517	0.9964	1.60	0.8958	0.9965

As noted in our main comments on REP2-035, the collision figures included in REP2-035 for the Dogger Bank Creyke Beck projects have been updated with numbers from CRM

undertaken as part of a non-material change application (Dogger Bank Wind Farms 2018). Therefore, we advise that these are updated by the Applicant to those for the original consented worst case scenario for these projects when the next update to the cumulative figures is submitted by the Applicant at Deadline 6.

The northern gannet is classified as 'Least Concern' with respect to the potential for global extinction (BirdLife International 2018). However, at the UK scale the species is Amber listed in Birds of Conservation Concern (BoCC) 4 (Eaton et al. 2015). The BoCC Amber listing is due to:

- Localisation of breeding population within Important Bird Areas (IBAs)/Special Protection Areas (SPAs) (Eaton et al. 2015).
- International importance of UK population – threshold of 20% of global population (Eaton et al. 2015). It has been estimated that the UK holds 55.6% of the global population (JNCC 2016).

As noted for gannet cumulative collisions above, based on current UK gannet population growth rates of ~2-3% per annum and using the PVA model outputs, then the level of additional cumulative mortality from collisions from the offshore wind farms would still allow the population to grow. However, it is not known what the growth rate of the UK gannet population will be over the next 30 years and this should therefore be considered when judging the significance of predicted impacts and whether a 0.9% reduction in annual growth rate would be significant. It is considered likely that the level of predicted cumulative impact would not be significant for a population growing at 2-3% per annum. However, if the population does not grow at that level for the next 30 years (say if the growth rate was around 1% per annum), we consider that it is uncertain that a 0.9% reduction in growth rate would not be significant.

Based on consideration of the PVA metrics as currently presented, the above conservation assessment, and given the UK's particular responsibility for gannet because of supporting over half of the global population, the predicted impacts at the North Sea population scale have the potential to give rise to significant effects. **Therefore we are unable to rule out a significant adverse impact on gannet from cumulative collision + displacement mortality at an EIA scale irrespective of whether the Hornsea 3 and Hornsea 4 projects are included in the cumulative totals or not**. However, as the Natural England PVA tool is currently undergoing some updates, there will be the need for the Applicant to re-run the PVA once these updates have been completed (Natural England are aiming to make the updates to the tool available in the next 1-2 weeks). Hence, Natural England reserves the right to revise the advice provided here based on the best available evidence presented.

2.1.2 Kittiwake cumulative operational collision risk

The Applicant's cumulative collision totals for kittiwake of 3,903 birds excluding Hornsea 3 and Hornsea 4 and of 4,397 including all projects exceeds 1% of baseline mortality of the North Sea scale BDMPS – the figure excluding Hornsea 3 and Hornsea 4 equates to 3.01% of baseline mortality, and the figure including all projects equates to 3.40% (Table 4 above). This is significant and requires further consideration.

As noted in our main comments on REP2-035, the Applicant has run BDMPS and biogeographic scale PVAs using the Natural England PVA tool. We note the issues we have identified in the general comments above regarding the updates being undertaken on the tool and advise that the PVA is re-run following completion of these updates. We also note from Appendix 3 of REP2-035 that the kittiwake BDMPS and biogeographic density independent models have been run for only 500 simulations, which Natural England notes to be quite low and we consider that a larger number of simulations would potentially be needed to generate reliable results. However, the model nevertheless currently represents

the best available evidence on which to base an assessment, though this should not be taken as a Natural England endorsement or 'acceptance' of the model outputs.

Using the density independent PVA models undertaken by the Applicant in REP2-035, if the additional mortality from the offshore wind farms is 4,000-4,400 per annum (closest PVA outputs to the cumulative collision mortality figures of 3,903 excluding Hornsea 3 and Hornsea 4 and 4,397 including all projects) then:

- The BDMPS population after 30 years will be 16.24-17.71% lower than it would have been in the absence of the additional mortality and the population growth rate would be reduced by 0.57-0.63% (Table 7).
- The biogeographic population after 30 years will be 2.83-3.12% lower than it would have been in the absence of the additional mortality and the population growth rate would be reduced by 0.09-0.11% (Table 7).

Table 7 Predicted Population impacts on the kittiwake BDMPS and biogeographic population for the range of mortality impacts predicted for cumulative collision. PVA Impact Metrics are as provided in Table 3.6 of REP2-035. The ranges of predicted figures are indicated in purple. The darker shaded cells represent the level of impact closest to the combined cumulative collision predictions

KITTIWAKE, EIA CUMULATIVE COLLISIONS – DENSITY INDEPENDENT PVA MODELS						
Additional mortality	**% baseline mortality largest BDMPS as used by Applicant**	**Counterfactual of Final Population Size (CPS), BDMPS**	**Counterfactual of Growth Rate (CGR), BDMPS**	**% baseline mortality biogeographic, as used by Applicant**	**Counterfactual of Final Population Size (CPS), biogeographic**	**Counterfactual of Growth Rate (CGR), biogeographic**
3,900	3.01	0.8410	0.9944	0.49	0.9723	0.9991
4,000	3.09	0.8376	0.9943	0.50	0.9717	0.9991
4,100	3.17	0.8335	0.9941	0.52	0.9711	0.9990
4,200	3.24	0.8302	0.9940	0.53	0.9703	0.9990
4,300	3.32	0.8268	0.9939	0.54	0.9697	0.9990
4,400	3.40	0.8229	0.9937	0.55	0.9688	0.9989

As noted in our main comments on REP2-035, the collision figures included in REP2-035 for the Dogger Bank Creyke Beck projects have been updated with numbers from CRM undertaken as part of a non-material change application (Dogger Bank Wind Farms 2018). Therefore, we advise that these are updated by the Applicant to those for the original consented worst case scenario for these projects when the next update to the cumulative figures is submitted by the Applicant at Deadline 6.

Kittiwake are listed as 'Vulnerable' to global extinction on the IUCN Red List (raised from Least Concern to Vulnerable in 2017) as a result of breeding population declines in Europe of >40% over 39 years (Birdlife International 2018). Kittiwake is also listed as Red on BoCC4 (Eaton et al. 2015) as a result of severe population declines in the UK.

Based on consideration of the PVA metrics as currently presented, the above conservation assessment and particularly given the population declines at a UK and wider scale for the species, the predicted impacts at the North Sea population scale have the potential to give rise to significant effects. Therefore **we are unable to rule out a significant adverse impact on kittiwake from cumulative collision mortality at an EIA scale irrespective of whether the Hornsea 3 and Hornsea 4 projects are included in the cumulative totals or not**. However, as the Natural England PVA tool is currently undergoing some updates, there will be the need for the Applicant to re-run the PVA once these updates have been completed (Natural England are aiming to make the updates to the tool available in the next 1-2 weeks). Hence, Natural England reserves the right to revise the advice provided here based on the best available evidence presented.

2.1.3 Lesser black-backed gull (LBBG) cumulative operational collision risk

The Applicant's cumulative collision totals for LBBG of 563 birds excluding Hornsea 3 and Hornsea 4 and of 582 including all projects exceeds 1% of baseline mortality of the North Sea BDMPS scale (Furness 2015) – the figure excluding Hornsea 3 and Hornsea 4 equates to 2.17% of baseline mortality, and the figure including all projects equates to 2.25% (Table 4 above). This is not insignificant and requires further consideration.

As noted in our main comments on REP2-035, the Applicant has run a density independent BDMPS scale PVA using the Natural England PVA tool. The model has been run using 1,000 simulations. We note the issues we have identified in the general comments above regarding the updates being undertaken on the tool and advise that the PVA is re-run following completion of these updates. We also note our comments above regarding the number of simulations used in models. However, the model nevertheless currently represents the best available evidence on which to base an assessment, though this should not be taken as a Natural England endorsement or 'acceptance' of the model outputs.

Using the density independent PVA model undertaken by the Applicant in REP2-035, if the additional mortality from the offshore wind farms is 600 per annum (closest PVA output to the cumulative collision mortality figures of 563 excluding Hornsea 3 and Hornsea 4 and 582 including all projects) then:

- The BDMPS population after 30 years will be 9.65% lower than it would have been in the absence of the additional mortality and the population growth rate would be reduced by 0.33% (Table 8).

Table 8 Predicted Population impacts on the LBBG BDMPS and biogeographic population for the range of mortality impacts predicted for cumulative collision. PVA Impact Metrics are as provided in Table 3.11 of REP2-035. The ranges of predicted figures are indicated in purple. The darker shaded cells represent the level of impact closest to the combined cumulative collision predictions

LBBG, EIA CUMULATIVE COLLISIONS – DENSITY INDEPENDENT PVA MODEL			
Additional mortality	**% baseline mortality largest BDMPS as used by Applicant**	**Counterfactual of Final Population Size (CPS), BDMPS**	**Counterfactual of Growth Rate (CGR), BDMPS**
500	1.93	0.9191	0.9973
600	2.32	0.9035	0.9967

The LBBG is classified as 'Least Concern' (BirdLife International 2018). The overall population trend across its range is increasing, although it has experienced recent declines at a UK level (Balmer et al. 2013). The species is Amber listed in BoCC 4 (Eaton et al. 2015) due to:

- Localisation of breeding population within Important Bird Areas (IBAs (Eaton et al. 2015).
- International importance of UK population.

Quite a high proportion of birds in the largest BDMPS of 209,007 will be UK breeding birds (Furness 2015).

Between the 1969-70 and 1998-2002 censuses the UK LBBG population increased by 81% (only UK wide estimates considered reliable; JNCC 2019), which represents an annual average growth rate of approximately 1.8% per annum. Based on this and using the PVA model outputs, then the level of additional cumulative mortality from collisions from the offshore wind farms would still allow the population to grow. However, it is not known what the growth rate of the UK gannet population will be over the next 30 years and this should therefore be considered when judging the significance of predicted impacts and whether a 0.3% reduction in annual growth rate would be significant. It is considered likely that the level of predicted cumulative impact would not be significant for a population growing at 1-2% per annum. It should also be noted there is uncertainty in the predicted collision figures due the uncertainty/variability in the input parameters and some degree of precaution in the cumulative total regarding the nocturnal activity rate and build out scenarios. It is also worth noting that there is limited evidence and therefore some uncertainty around baseline mortality rates.

Based on consideration of the above, the PVA metrics as currently presented and the above conservation assessment, **we therefore agree with the Applicant's conclusion of no significant adverse impact from cumulative collision to LBBG at an EIA scale if the Hornsea 3 and Hornsea 4 projects are excluded from the cumulative total**. However, as the Natural England PVA tool is currently undergoing some updates, there will be the need for the Applicant to re-run the PVA once these updates have been completed (Natural England are aiming to make the updates to the tool available in the next 1-2 weeks). Hence, Natural England reserves the right to revise the advice provided here based on the best available evidence presented.

However, due to Natural England's significant concerns regarding the incomplete baseline surveys for the Hornsea 3 project, and the associated level of uncertainty as regards the potential impacts of that project, together with the inevitable uncertainty associated with the figures for Hornsea 4 from the PEIR and are subject to change, Natural England therefore is not in a position to advise that significant impact can be ruled out for LBBG for cumulative collision impacts when the Hornsea 3 and Hornsea 4 projects are included in the cumulative totals.

2.1.4 Herring gull cumulative operational collision risk

The Applicant's cumulative collision totals for herring gull of 801 birds excluding Hornsea 3 and Hornsea 4 and of 812 including all projects equates to 1.00% (excluding Hornsea 3 and Hornsea 4) and to 1.01% (including all projects) of baseline mortality of the largest BDMPS and to 0.42% (excluding Hornsea 3 and Hornsea 4) and 0.43% (including all projects) of baseline mortality of the biogeographic population (Table 4 above).

Herring gull is classified as Near Threatened on the IUCN Red List as a result of population declines. The species is also Red listed on BoCC 4 (Eaton et al. 2015) as a result of population declines in the UK. There has been a 31% decline in the UK since 1999-2011. However, the cumulative collision totals equate to 1% or just above 1% (1.01%) of baseline mortality of the largest BDMPS and there is uncertainty in the predicted collision figures due the uncertainty/variability in the input parameters and some degree of precaution in the cumulative total regarding the nocturnal activity rate and build out scenarios. It is also worth

noting that there is limited evidence and therefore some uncertainty around baseline mortality rates. Therefore, the cumulative collision mortality is unlikely to be detectable against background mortality and **we agree with the Applicant's conclusion of no significant adverse impact from cumulative collision to herring gull at an EIA scale if the Hornsea 3 and Hornsea 4 projects are excluded from the cumulative total.**

However, due to Natural England's significant concerns regarding the incomplete baseline surveys for the Hornsea 3 project, and the associated level of uncertainty as regards the potential impacts of that project, together with the inevitable uncertainty associated with the figures for Hornsea 4 from the PEIR and are subject to change, Natural England therefore is not in a position to advise that significant impact can be ruled out for herring gull for cumulative collision impacts when the Hornsea 3 and Hornsea 4 projects are included in the cumulative totals.

2.1.5 Great black-backed gull (GBBG) cumulative operational collision risk

The Applicant's cumulative collision totals for GBBG of 1,065 birds excluding Hornsea 3 and Hornsea 4 and of 1,144 including all projects exceed 1% of baseline mortality of the North Sea BDMPS scale and the biogeographic population (Furness 2015) – the figure excluding Hornsea 3 and Hornsea 4 equates to 6.30% of baseline mortality of the BDMPS and 2.45% of baseline mortality of the biogeographic population, and the figure including all projects equates to 6.77% of the BDMPS and 2.63% of the biogeographic population baseline mortality (Table 4 above). This is not insignificant and requires further consideration.

As noted in our main comments on REP2-035, the Applicant has run BDMPS and biogeographic scale PVAs using the Natural England PVA tool. The models have been run using 1,000 simulations. We note the issues we have identified in the general comments above regarding the updates being undertaken on the tool and advise that the PVA is re-run following completion of these updates. We also note our comments above regarding the number of simulations used in models. However, the models nevertheless currently represent the best available evidence on which to base an assessment, though this should not be taken as a Natural England endorsement or 'acceptance' of the model outputs.

Using the PVA models undertaken by the Applicant in REP2-035, if the additional mortality from the offshore wind farms is 1,100-1,200 per annum (closest PVA outputs to the cumulative collision mortality figures of 1,065 excluding Hornsea 3 and Hornsea 4 and 1,144 including all projects) then:

- The BDMPS population after 30 years will be 33.23-35.63% lower than it would have been in the absence of the additional mortality using the density independent model and 27.75-29.86% lower using the density dependent model. The population growth rate would be reduced by 1.30-1.41% using the density independent model and by 1.04-1.14% using the density dependent model (Table 9).
- The biogeographic population after 30 years will be 14.48-15.68% lower than it would have been in the absence of the additional mortality using the density independent model and 11.55-12.54% lower using the density dependent model. The population growth rate would be reduced by 0.50-0.55% using the density independent model and by 0.40-0.43% using the density dependent model (Table 9).

Table 9 Predicted Population impacts on the GBBG BDMPS and biogeographic population for the range of mortality impacts predicted for cumulative collision. PVA Impact Metrics are as provided in Table 3.18 of REP2-035. The ranges of predicted figures are indicated in purple. The darker shaded cells represent the level of impact closest to the combined cumulative collision predictions

GBBG, EIA CUMULATIVE COLLISIONS – DENSITY INDEPENDENT PVA MODELS						
Additional mortality	**% baseline mortality largest BDMPS as used by Applicant**	**Counterfactual of Final Population Size (CPS), BDMPS**	**Counterfactual of Growth Rate (CGR), BDMPS**	**% baseline mortality biogeographic, as used by Applicant**	**Counterfactual of Final Population Size (CPS), biogeographic**	**Counterfactual of Growth Rate (CGR), biogeographic**
1,000	5.91	0.6930	0.9882	2.30	0.8764	0.9954
1,100	6.51	0.6677	0.9870	2.53	0.8552	0.9950
1,200	7.10	0.6437	0.9859	2.76	0.8432	0.9945
GBBG, EIA CUMULATIVE COLLISIONS – DENSITY DEPENDENT PVA MODELS						
Additional mortality	**% baseline mortality largest BDMPS as used by Applicant**	**Counterfactual of Final Population Size (CPS), BDMPS**	**Counterfactual of Growth Rate (CGR), BDMPS**	**% baseline mortality biogeographic, as used by Applicant**	**Counterfactual of Final Population Size (CPS), biogeographic**	**Counterfactual of Growth Rate (CGR), biogeographic**
1,000	5.91	0.7446	0.9905	2.30	0.9844	0.9964
1,100	6.51	0.7225	0.9896	2.53	0.8845	0.9960
1,200	7.10	0.7014	0.9886	2.76	0.8746	0.9957

GBBG is classed as 'Least Concern' of global extinction by IUCN. The overall population trend across its range is stable, although at a UK level the species is Amber listed in BoCC 4 (Eaton et al. 2015) due to moderate declines in both the breeding and non-breeding populations.

Based on consideration of the PVA metrics as currently presented, the above conservation assessment and particularly that the GBBG population is stable to possibly declining and that we are not aware of any evidence to suggest that the population is going to start increasing, the predicted impacts at the North Sea population scale have the potential to give rise to significant effects. Therefore **we are unable to rule out a significant adverse impact on GBBG from cumulative collision mortality at an EIA scale irrespective of whether the Hornsea 3 and Hornsea 4 projects are included in the cumulative totals or not**. However, as the Natural England PVA tool is currently undergoing some updates, there

will be the need for the Applicant to re-run the PVA once these updates have been completed (Natural England are aiming to make the updates to the tool available in the next 1-2 weeks). Hence, Natural England reserves the right to revise the advice provided here based on the best available evidence presented.

2.1.6 Little gull cumulative operational collision risk

No figures have been included by the Applicant for the East Anglia One North and East Anglia Two projects in Table 3.19 of REP2-035. We note that predicted collision figures are available for this species from the submission documents for these projects and the predicted figures are 1.1 collisions from East Anglia One North and 1.7 from East Anglia Two. Therefore, the cumulative collision totals for little gull become 66 birds excluding Hornsea 3 and Hornsea 4 and 67 including all projects (based on the consented project layout scenarios). These totals exceed 1% of baseline mortality of the precautionary BDMPS estimate based on the surveys conducted across the Greater Wash Area of Search and analysis of those data in Natural England & JNCC (2016), as used by Applicant. However, for the larger figure estimated to be up to 75,000 for the little gull population with connectivity to the southern North Sea, the cumulative totals equate to less than 1% of baseline mortality for this population and can be considered undetectable against background mortality. Therefore, based on this we agree with a **conclusion of minor adverse impact from cumulative collisions to little gull at an EIA scale if the Hornsea 3 and Hornsea 4 projects are excluded from the cumulative total.** However, it should be noted that this is made on the basis that the cumulative assessment includes all appropriate and publicly available collision estimates for other wind farms and as a consequence our confidence in this conclusion is reduced.

However, due to Natural England's significant concerns regarding the incomplete baseline surveys for the Hornsea 3 project, and the associated level of uncertainty as regards the potential impacts of that project, together with the inevitable uncertainty associated with the figures for Hornsea 4 from the PEIR and are subject to change, Natural England therefore is not in a position to advise that significant impact can be ruled out for little gull for cumulative collision impacts when the Hornsea 3 and Hornsea 4 projects are included in the cumulative totals.

2.1.7 Red-throated diver (RTD) cumulative operational displacement

We welcome that the Applicant has undertaken a cumulative RTD operational displacement assessment using the 'like for like' approach using the SeaMast data (Bradbury et al. 2014), as was undertaken at Thanet Extension and hence also used at Norfolk Vanguard during the examination.

Based on the cumulative figures presented by the Applicant in Table 4.2 of REP2-035 we consider that the predicted figures are significant**. Therefore, we are unable to rule out a significant adverse impact on RTD from cumulative collision mortality at an EIA scale** (noting that no figures have been included for sites further offshore as SeaMast yielded no density estimates for such sites and the following projects were omitted from the cumulative totals: Dudgeon, Hornsea Project One, Hornsea Project Two, Hornsea Project Three, Hornsea Project Four, Dogger Bank Creyke Beck A and B, Dogger Bank Teesside A and B (now Sofia) and Triton Knoll). However, we note that Norfolk Boreas's contribution to the cumulative total is small at 0.1%.

2.1.8 Razorbill cumulative operational displacement

We welcome that the error in razorbill abundance for Vanguard East for the non-breeding (winter) period highlighted in our Relevant Representations [RR-099] has been corrected by the Applicant in REP2-035.

Based on the figures presented by the Applicant in Table 4.10 of REP2-035 the total cumulative number of razorbills to be at risk of displacement for all projects (including from Hornsea 3 and Hornsea 4) is estimated to be 32,704 in the breeding season, 41,066 in the autumn/post breeding season, 26,211 in the winter/non-breeding season and 33,665 in the spring/pre-breeding season. This equals an annual cumulative total for all projects including Hornsea 3 and Hornsea 4 of 133,646 razorbills at risk of displacement.

For the Natural England recommended rates of 30-70% displacement and 1-10% mortality, the number of predicted additional cumulative mortalities **including** Hornsea 3 and Hornsea 4 is between 401 (30% displacement and 1% mortality) and 9,355 (70% displacement and 10% mortality) razorbills. This equates to 0.39-9.08% of baseline mortality for the largest BDMPS. At the Applicant's preferred rates of 50% displacement and 1% mortality this equates to 0.65% of baseline mortality of the largest BDMPS (Table 10). This is significant at the upper level of the displacement/mortality range that the SNCBs advise for auks (70% displacement and 10% mortality) and therefore requires further consideration.

Given the uncertainty involved with the figures for both Hornsea 3 and Hornsea 4, the cumulative totals excluding these two projects are estimated to be 31,494 in the breeding season, 33,086 in the autumn/post breeding season, 20,502 in the winter/non-breeding season and 30,550 in the spring/pre-breeding season, which gives an annual figure of 115,632 razorbills at risk of displacement.

For the Natural England recommended rates of 30-70% displacement and 1-10% mortality, the number of predicted additional cumulative mortalities **excluding** Hornsea 3 and Hornsea 4 is between 347 (30% displacement and 1% mortality) and 8,094 (70% displacement and 10% mortality) razorbills. This equates to 0.34-7.86% of baseline mortality for the largest BDMPS. At the Applicant's preferred rates of 50% displacement and 1% mortality this equates to 0.56% of baseline mortality of the largest BDMPS (Table 10). Again, this is significant at the upper level of the displacement/mortality range that the SNCBs advise for auks (70% displacement and 10% mortality) and therefore requires further consideration.

Table 10 below indicates that when considering the cumulative totals, either excluding or including Hornsea 3 and Hornsea 4, for the Natural England recommended range of 30-70% displacement and 1-10% mortality and the predicted impacts against baseline mortality for the largest BDMPS:

- 1% of baseline mortality of the largest BDMPS is not exceed for any displacement scenario (30-70%) at 1% mortality;
- At 4%-10% mortality, 1% of baseline mortality is exceeded at all displacement rates from 30-70%.

Table 10 Percent of baseline mortality (using 17.4% average across all age class mortality rates, as used by the Applicant) that predicted razorbill cumulative operational displacement impacts equate to of largest BDMPS for Natural England preferred range of 30-70% displacement and 1-10% mortality (note covers Applicant's preferred rates of 50% displacement and 1% mortality) for calculated cumulative totals excluding and including Hornsea 3 and Hornsea 4. Shaded cells are those where 1% of baseline mortality is exceeded

INCLUDING HORNSEA 3 & HORNSEA 4							
Displacement (%)	**% Baseline mortality of largest BDMPS***						
	Mortality rate (%)						
	1	**2**	**4**	**5**	**6**	**8**	**10**
30	0.39	0.78	1.56	1.95	2.34	3.11	3.89
40	0.52	1.04	2.08	2.60	3.11	4.15	5.19
50	0.65	1.30	2.60	3.24	3.89	5.19	6.49
60	0.78	1.56	3.11	3.89	4.67	6.23	7.79
70	0.91	1.82	3.63	4.54	5.45	7.27	9.08
EXCLUDING HORNSEA 3 & HORNSEA 4							
Displacement (%)	**% Baseline mortality of largest BDMPS***						
	Mortality rate (%)						
	1	**2**	**4**	**5**	**6**	**8**	**10**
30	0.34	0.67	1.35	1.68	2.02	2.69	3.37
40	0.45	0.90	1.80	2.25	2.69	3.59	4.49
50	0.56	1.12	2.25	2.81	3.37	4.49	5.61
60	0.67	1.35	2.69	3.37	4.04	5.39	6.74
70	0.79	1.57	3.14	3.93	4.72	6.29	7.86

* 591,874 individuals for largest North Sea Population scale (from Furness 2015)

Razorbill are listed as 'near threatened' on the IUCN Red List (Birdlife International 2018) and is also listed as amber on BoCC4 (Eaton et al. 2015).

While there is some empirical evidence to support the displacement levels for auks we do not know what the likely mortality impacts of displacement are. We therefore consider it appropriate to consider a range of mortalities from 1-10%. However, on the basis that the projects that have been scoped into the assessment lie in areas of the North Sea that represent low to medium levels of razorbill density during both the breeding (where relevant) and non-breeding seasons (Seabird Sensitivity Mapping Tool), it is assumed that areas of low/medium density will be less important/desirable feeding areas and therefore mortality impacts of displacement from lower quality areas would be lower than displacement from optimal/important areas. Therefore, we do not expect mortality rates to be at the top of the range considered.

Predicted cumulative mortality predictions exceed 1% of baseline mortality of the largest BDMPS at a 2% mortality rate and between 40 and 50% displacement. **Therefore, we advise that a significant adverse impact to razorbill from cumulative operational displacement cannot be ruled out at an EIA scale irrespective of whether the Hornsea 3 and Hornsea 4 projects are included in the cumulative totals or not..**

2.1.9 Guillemot cumulative operational displacement

We welcome that following the issues noted in our Relevant Representation [RR-099], the figures included in the guillemot cumulative (and hence in-combination) assessment have been checked and updated for Galloper, Greater Gabbard and the Hornsea projects in REP2-035.

Based on the figures presented by the Applicant in Table 4.5 of REP2-035 the total cumulative number of guillemots to be at risk of displacement for all projects (including from Hornsea 3 and Hornsea 4) is estimated to be 185,878 in the breeding season and 242,936 in the non-breeding season. This equals an annual cumulative total for all projects including Hornsea 3 and Hornsea 4 of 428,814 guillemots at risk of displacement.

For the Natural England recommended rates of 30-70% displacement and 1-10% mortality, the number of predicted additional cumulative mortalities **including** Hornsea 3 and Hornsea 4 is between 1,286 (30% displacement and 1% mortality) and 30,017 (70% displacement and 10% mortality) guillemots. This equates to 0.45-10.48% of baseline mortality for the largest BDMPS. At the Applicant's preferred rates of 50% displacement and 1% mortality this equates to 0.75% of baseline mortality of the largest BDMPS (Table 11). This is significant at the upper level of the displacement/mortality range that the SNCBs advise for auks (70% displacement and 10% mortality) and therefore requires further consideration.

Given the uncertainty involved with the figures for both Hornsea 3 and Hornsea 4, the cumulative totals excluding these two projects are estimated to be 157,259 in the breeding season and 154,207 in the non-breeding season, which gives an annual figure of 311,466 guillemots at risk of displacement.

For the Natural England recommended rates of 30-70% displacement and 1-10% mortality, the number of predicted additional cumulative mortalities **excluding** Hornsea 3 and Hornsea 4 is between 934 (30% displacement and 1% mortality) and 21,803 (70% displacement and 10% mortality) guillemots. This equates to 0.33-7.62% of baseline mortality for the largest BDMPS. At the Applicant's preferred rates of 50% displacement and 1% mortality this equates to 0.54% of baseline mortality of the largest BDMPS (Table 11). Again, this is significant at the upper level of the displacement/mortality range that the SNCBs advise for auks (70% displacement and 10% mortality) and therefore requires further consideration.

Table 11 below indicates that when considering the cumulative totals, including or excluding Hornsea 3 and Hornsea 4 for the Natural England recommended range of 30-70% displacement and 1-10% mortality and the predicted impacts against baseline mortality for the largest BDMPS:

- 1% of baseline mortality of the largest BDMPS is only exceeded for displacement at 70% or above and 1% mortality when Hornsea 3 and Hornsea 4 are included in the cumulative total, but not for any displacement scenario (30-70%) at 1% mortality when these projects are excluded from the cumulative total. At 2% mortality, 1% of baseline mortality is exceeded when displacement exceeds 30% for including Hornsea 3 and Hornsea 4 or when it exceeds 40% when these projects are excluded.
- At 4% mortality and above, 1% of baseline mortality is exceeded at all displacement rates from 30-70%.

Table 11 Percent of baseline mortality (using 14% average across all age class mortality rates, as used by the Applicant) that predicted guillemot cumulative operational displacement impacts equate to of largest BDMPS for Natural England preferred range of 30-70% displacement and 1-10% mortality (note covers Applicant's preferred rates of 50% displacement and 1% mortality) for calculated cumulative totals excluding and including Hornsea 3 and Hornsea 4. Shaded cells are those where 1% of baseline mortality is exceeded

INCLUDING HORNSEA 3 & HORNSEA 4							
Displacement (%)	**% Baseline mortality of largest BDMPS***						
	Mortality rate (%)						
	1	**2**	**4**	**5**	**6**	**8**	**10**
30	0.45	0.90	1.80	2.25	2.70	3.59	4.49
40	0.60	1.20	2.40	3.00	3.59	4.79	5.99
50	0.75	1.50	3.00	3.74	4.49	5.99	7.49
60	0.90	1.80	3.59	4.49	5.39	7.19	8.99
70	1.05	2.10	4.19	5.24	6.29	8.39	10.48
EXCLUDING HORNSEA 3 & HORNSEA 4							
Displacement (%)	**% Baseline mortality of largest BDMPS***						
	Mortality rate (%)						
	1	**2**	**4**	**5**	**6**	**8**	**10**
30	0.33	0.65	1.31	1.63	1.96	2.61	3.26
40	0.44	0.87	1.72	2.18	2.61	3.48	4.35
50	0.54	1.09	2.18	2.72	3.26	4.35	5.44
60	0.65	1.31	2.61	3.26	3.92	5.22	6.53
70	0.76	1.52	3.05	3.81	4.57	6.09	7.62

* 2,045,078 individuals for largest North Sea Population scale (from Furness 2015)

Guillemot are listed as 'least concern' on the IUCN Red List (Birdlife International 2018) and is also listed as amber on BoCC4 (Eaton et al. 2015).

While there is some empirical evidence to support the displacement levels for auks we do not know what the likely mortality impacts of displacement are. We therefore consider it appropriate to consider a range of mortalities from 1-10%. However, on the basis that the projects that have been scoped into the assessment lie in areas of the North Sea that represent low to medium levels of guillemot density during both the breeding (where relevant) and non-breeding seasons (Seabird Sensitivity Mapping Tool), it is assumed that areas of low/medium density will be less important/desirable feeding areas and therefore mortality impacts of displacement from less good areas would be lower than displacement from optimal/important areas. Therefore, we do not expect mortality rates to be at the top of the range considered.

Predicted cumulative mortality predictions exceed 1% of baseline mortality of the largest BDMPS at a 2% mortality rate and when displacement rates exceed between 30 and 50% displacement depending on whether Hornsea 3 and Hornsea 4 are included in the cumulative total or not. **Therefore, we advise a significant adverse impact to guillemot from cumulative operational displacement cannot be ruled out at an EIA scale**

irrespective of whether the Hornsea 3 and Hornsea 4 projects are included in the cumulative totals or not.

Appendix 2 Habitats Regulations Assessment (HRA) detailed comments and conclusions

This document is a technical document submitted into the Norfolk Vanguard Examination to provide scientific justification for Natural England's advice provided on the significance of the potential impacts on designated site features, as summarised within each section. Our advice is based on best available evidence at the time of writing and is subject to change in the future should further evidence be presented.

FLAMBOROUGH & FILEY COAST (FFC) SPA: GANNET

1.1 Impacts from Norfolk Boreas alone: operational collision risk, displacement and collision and displacement

We agree with the apportionment rates of 100% in the breeding season, 4.8% in autumn and 6.2% in spring used by the Applicant in APP-201 for collision risk assessment of Norfolk Boreas alone and in REP2-035 for the updated displacement and collision plus displacement assessment of Norfolk Boreas alone. We also welcome that the full breeding season with adjusted migration seasons has also been used in the assessments.

We welcome that the Applicant has also considered the uncertainty/variability in the assessments through considering in the assessments the range of collision and density predictions based on using the 95% confidence intervals around the bird density/abundance data.

We welcome that the Applicant has considered the predicted impact figures for Norfolk Boreas alone with the outputs from the updated FFC SPA gannet PVA undertaken during the Hornsea 3 examination (Hornsea Project Three Offshore Wind Farm 2019). As noted in our main comments on REP2-035, we had outstanding concerns with the Hornsea 3 PVAs which were not resolved by the close of the Examination. However, this nevertheless represents the best available evidence on which to base an assessment, though this should not be taken as an endorsement or 'acceptance' of the model outputs.

There is no clear evidence to support the application of any particular form or magnitude of density dependence in the modelling; therefore Natural England has based its advice on the outputs of the density independent PVA model (as these make no assumptions about the form or strength of any density dependent effects). Therefore, Natural England has focused our conclusions on the PVA outputs from the density independent model for demographic rate set 2 (the rates Natural England considers to be the most appropriate) using a matched runs approach (as per Natural England advice).

We agree with the Applicant's apportioned figures for collision and displacement of gannets to the FFC SPA from Norfolk Boreas alone.

Table 12 Percentage of baseline mortality for impact levels for Norfolk Boreas alone for gannet for FFC SPA. Baseline mortality calculated using adult only colony size and adult mortality rate (8.1% from Horswill & Robinson 2015).

GANNET PREDICTED MORTALITY NORFOLK BOREAS ALONE, HRA: FFC SPA				
	Mortality prediction (range based on 95% CIs of density data)	% of baseline mortality of FFC SPA designated population* (used by Applicant)	% of baseline mortality of FFC SPA 2017 count** (used by Applicant)	% of baseline mortality of FFC SPA mean of 2012, 15 & 17 census data***
Collision risk alone, based on CRM figures from APP-201	57 (4-138)	3.20 (0.24-7.70)	2.65 (0.20-6.36)	2.88 (0.22-6.93)
Displacement alone, based on Table 4.14 of REP2-035	80% displacement, 1% mortality: 11 (1-23) 60% displacement, 1% mortality: 8 (1-17)	80% displacement, 1% mortality: 0.60 (0.04-1.29) 60% displacement, 1% mortality: 0.45 (0.03-0.97)	80% displacement, 1% mortality: 0.50 (0.03-1.06) 60% displacement, 1% mortality: 0.37 (0.02-0.80)	80% displacement, 1% mortality: 0.54 (0.03-1.16) 60% displacement, 1% mortality: 0.40 (0.03-0.87)
Collision + displacement**** alone, based on Section 4.4.3.2 of REP2-035	68 (5-161)	3.81 (0.27-8.99)	3.14 (0.22-7.43)	3.42 (0.24-8.09)

* 11,061 pairs (22,122 adults), 1% baseline mortality = 18 birds
** 13,391 pairs (26,782 adults), 1% baseline mortality = 22 birds
*** 24,594 adults, 1% baseline mortality = 20 birds
**** based on displacement figures for 80% displacement and 1% mortality combined with the collision predictions

From Table 12 above, the predicted collision impacts presented in the Applicant's APP-201 for the gannet feature of FFC SPA are **57 (4-138)** collisions per annum for Norfolk Boreas alone. The predicted 57 adults per annum equates to over 1% of baseline mortality of the colony. Therefore, the potential impact from collision risk on the SPA requires further consideration.

From Table 12 above, the predicted displacement impacts presented in the Applicant's updated assessment in REP2-035 for the gannet feature of FFC SPA range from **8 (1-17)** predicted mortalities per annum at 60% displacement and 1% mortality to up to **11 (1-23)** predicted mortalities per annum at 80% displacement and 1% mortality for Norfolk Boreas alone. The predicted values based on the mean abundances equate to less than 1% of baseline mortality for the colony and hence would not be detectable against background mortality. However, for the most precautionary scenario of the upper 95% confidence interval of the abundance data combined with 80% displacement and 1% mortality, the predicted number of additional mortalities per annum equates to over 1% of baseline mortality of the colony.

As noted in the 2017 SNCB interim advice on displacement (SNCBs 2017), the number of birds at risk of reduced individual fitness (i.e. mortality and productivity losses) as a result of

displacement is based on the numbers of birds present within a development area and buffer both on the water and in flight. Assessment of the number of birds at risk of mortality as a result of collisions (e.g. with wind turbines) is based on the number of birds present within a development area that are in flight only. The mortality impacts estimated from CRM are assumed to be in addition to any mortality caused by displacement impacts (because the collision estimates take account of birds that avoid the wind farm). Productivity impacts due to displacement would be a further addition (but this is not currently quantitatively accounted for under existing methods/advice). Therefore, at present, the SNCBs regard the **two impacts (collision and displacement) as additive and advise that they should be summed**. In summing the predicted mortalities that arise via these two mechanisms, there is a risk of some degree of double counting as a bird that collides with a turbine and dies cannot be displaced and a bird that dies as a result of displacement cannot collide with the turbine. Thus, it is acknowledged that this simplistic approach will therefore incorporate a degree of precaution. The level of precaution is difficult to gauge, but will be highest when the number of birds recorded flying at turbine height (and therefore the predicted number of collisions) is greatest (SNCBs 2017). We therefore welcome that the Applicant has undertaken this assessment for gannets from the FFC SPA in REP2-035.

The combined impact of collision plus displacement to FFC SPA gannets from Norfolk Boreas alone equals:
57 (range: 4-138) mortalities per annum from collisions plus up to 11 (range: up to 1-23) mortalities per annum from displacement = **up to 68 (range: up to 5-161)** mortalities per annum (see Table 12 above). The predicted 68 adults per annum equates to over 1% of baseline mortality of the colony. Therefore, the potential combined impact from collision plus displacement on the SPA requires further consideration.

Table 13 Predicted population impacts on the gannet population of FFC SPA for the range of collision mortality impacts predicted for Norfolk Boreas alone. PVA impact metrics are as provided in Hornsea Project Three Offshore Wind Farm (2019). The range of predicted project alone figures are indicated in pink. The darker shaded cells represent the level of impact closest to the central value of the prediction.

GANNET – FFC SPA NORFOLK BOREAS ALONE					
Additional mortality	% Baseline Mortality using designation population size (22,122 adults), as used by Applicant	% Baseline Mortality using 2017 count size (26,782 adults), as used by Applicant	% Baseline Mortality using mean of 2012, 15 & 17 census data (24,594 adults)	Counterfactual of Final Population Size (CPS)*	Counterfactual of Growth rate (CGR)**
5	0.28	0.23	0.25	No value available	No value available
10	0.56	0.46	0.50	No value available	No value available
20	1.12	0.92	1.00	No value available	No value available
25	1.40	1.15	1.25	0.968 (0.967-0.968)	0.999
50	2.79	2.30	2.51	0.936 (0.936-0.937)	0.998
75	4.19	3.46	3.76	0.906 (0.905-0.907)	0.997
100	5.58	4.61	5.02	0.877 (0.876-0.878)	0.995
125	6.98	5.76	6.27	0.848 (0.847-0.850)	0.994
150	8.37	6.91	7.53	0.821 (0.819-0.823)	0.993
175	9.77	8.07	8.78	0.794 (0.792-0.796)	0.992

* Gannet, demographic rate set 2, counterfactuals of population size after 30 years, estimated using a matched runs method, from 1,000 density independent simulations. See Table A2_3.1 in Hornsea Project Three Offshore Wind Farm (2019)
** Gannet, demographic rate set 2, counterfactuals of population growth rate after 35 years, estimated using a matched runs method, from 1,000 density independent simulations. See Table A2_3.3 in Hornsea Project Three Offshore Wind Farm (2019). Whilst Norfolk Boreas's lifespan is 30 years, data on counterfactuals of growth rate are only available in Hornsea Project Three Offshore Wind Farm (2019) for after 35 years.

For the collision risk impact to gannets from the FFC SPA from Norfolk Boreas alone, if the additional mortality from the wind farm is 50-75 adults per annum (closest PVA outputs available in Hornsea Project Three Offshore Wind Farm 2019 to Norfolk Boreas alone predicted 57 mortalities from collision risk) then the population of FFC SPA after 30 years will be 6.4-9.4% lower than it would have been in the absence of the additional mortality. The population growth rate would be reduced by 0.2-0.3% (Table 13).
).

If the upper range of collision predictions of 138 birds is considered, then if the additional mortality from Norfolk Boreas alone is 125-150 adults per annum (closest PVA outputs available in Hornsea Project Three Offshore Wind Farm 2019 to Norfolk Boreas upper range predicted for collisions of 138 mortalities) then the population of FFC SPA after 30 years will be 15.2-17.9% lower than it would have been in the absence of the additional mortality and the population growth rate would be reduced by 0.6-0.7% (Table 13).

Considering the upper range of displacement predictions of up to 23 birds (for upper 95% confidence interval of abundance, 80% displacement and 1% mortality), then if the additional mortality from Norfolk Boreas alone is 25 adults per annum (closest PVA outputs available in Hornsea Project Three Offshore Wind Farm 2019 to Norfolk Boreas upper displacement range predicted of 23 mortalities) then the population of FFC SPA after 30 years will be 3.2% lower than it would have been in the absence of the additional mortality and the population growth rate would be reduced by 0.1% (Table 13).

For the combined collision plus displacement impact to gannets from the FFC SPA from Norfolk Boreas alone, if the additional mortality from the wind farm is 75 adults per annum (closest PVA outputs available in Hornsea Project Three Offshore Wind Farm 2019 to Norfolk Boreas alone predicted 68 mortalities from collision plus displacement) then the population of FFC SPA after 30 years will be 9.4% lower than it would have been in the absence of the additional mortality. The population growth rate would be reduced by 0.3% (Table 13).

If the upper range of collision plus displacement predictions of up to 161 birds is considered, then if the additional mortality from Norfolk Boreas alone is 150-175 adults per annum (closest PVA outputs available in Hornsea Project Three Offshore Wind Farm 2019 to Norfolk Boreas upper range predicted for collisions of 161 mortalities) then the population of FFC SPA after 30 years will be 17.9-20.6% lower than it would have been in the absence of the additional mortality and the population growth rate would be reduced by 0.7-0.8% (Table 13).

The gannet population of FFC SPA increased at 11.1% per annum (between 2003/4 and 2015, JNCC Seabird Monitoring Programme SMP data). Using FFC SPA census data 2002-2017 the growth rate was 9.4% per annum. However, it is not known what the growth rate of the colony will be over the next 30 years and this should therefore be considered when judging the significance of predicted impacts against the conservation objectives for the feature.

As was undertaken during the Norfolk Vanguard examination, Natural England has reviewed growth rates for the 22 gannet colonies across Britain, Channel Islands and Ireland with repeated census data (Cramp et al. 1974, Lloyd et al. 1991, Mitchell et al. 2004, plus more recent count data from the SMP). The Flamborough/Bempton gannet colony was founded in the late 1930s (Cramp et al. 1974) and so has been in existence now for about 80 years. Thus, by the end of 30 years of Vanguard it will be about 110 years in age. Given the analysis of trends in gannet colony growth rates amongst a suite of long-established colonies, it is highly likely that its annual growth rate averaged over the whole period since founding will drop from its current average of c 11% over the first 80 years. The highest annual colony growth rate calculated over a period of >100 years is 4.5% at Grassholm. The Flamborough colony is unlikely to achieve a higher annual growth rate than this. The average annual growth rate calculated over a period of >90 years across the 8 gannet colonies with records exceeding 90 years is 1.8%. Amongst these colonies the mean annual growth rate over the most recent years of their records (80+ years) has been just 1.2% per annum (or 1.3% excluding Sula Sgeir (as the growth rate here may be influenced adversely by an annual licenced harvest of young birds)) compared to an average rate of 2.0% per

annum during the first 80 or so years of their existence. Therefore, Natural England has considered the counterfactuals of final population size for the predicted levels of alone additional mortality for a range of plausible future growth rate scenarios for FFC of 1, 2, 3, 4 and 5% per annum.

The Conservation Objective for the gannet population of the FFC SPA is to maintain the size of the breeding population at a level which is above 8,469 pairs (16,938 adults), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. The latest mean count is 24,594 adults based on the mean of the 2012, 2015 and 2017 counts.

For the predicted Norfolk Boreas alone collision predictions to FFC SPA gannets of 57 (range 4-138) mortalities per year, from the closest updated PVA outputs in Hornsea Project Three (2019) of 50-75 (range up to 125-150) additional mortalities, the colony would still be predicted to grow above the current mean population of 24,594 adults under any growth rate scenario from 1% to up to 5%. This would allow the conservation objective to be met and therefore, **Natural England advises that an adverse effect on integrity (AEOI) of the gannet feature of the FFC SPA can be ruled out for collision impacts from Norfolk Boreas alone**.

For the predicted worst case Norfolk Boreas alone displacement predictions to FFC SPA gannets of up to 23 mortalities per year (for most precautionary scenario of upper 95% confidence interval of abundance, 80% displacement and 1% mortality), from the closest updated PVA outputs in Hornsea Project Three (2019) of 25 additional mortalities, the colony would still be predicted to grow above the current mean population of 24,594 adults under any growth rate scenario from 1% to up to 5%. This would allow the conservation objective to be met and therefore, **Natural England advises that an adverse effect on integrity (AEOI) of the gannet feature of the FFC SPA can be ruled out for displacement impacts from Norfolk Boreas alone**.

For the predicted Norfolk Boreas alone collision plus displacement predictions to FFC SPA gannets of up to 68 (range up to 5-161) mortalities per year, from the closest updated PVA outputs in Hornsea Project Three (2019) of 75 (range up to 150-175) additional mortalities, the colony would still be predicted to grow above the current mean population of 24,594 adults under any growth rate scenario from 1% to up to 5%. This would allow the conservation objective to be met and therefore, **Natural England advises that an adverse effect on integrity (AEOI) of the gannet feature of the FFC SPA can be ruled out for collision plus displacement impacts from Norfolk Boreas alone**.

1.2 Impacts from Norfolk Boreas in-combination with other plans and projects: operational collision risk, displacement and collision and displacement

We agree with the apportionment rates of 4.8% in autumn and 6.2% in spring used by the Applicant for apportionment of collision and/or displacement impacts in these seasons for each of the other offshore wind farm predictions to the FFC SPA in the assessments in REP2-035.

We welcome that the in-combination assessments in REP2-035 make reference to the PVA undertaken for Hornsea 3, but note our above comments regarding the outstanding concerns with this PVA**.** For the reasons set out above in the discussion regarding impacts to gannet from the FFC SPA from Norfolk Boreas alone, Natural England has again focused our conclusions on the PVA outputs from the density independent model for demographic rate set 2 using a matched runs approach.

Table 14 Percentage of baseline mortality for in-combination impact levels for excluding and including the Hornsea 3 (H3) and Hornsea 4 (H4) for gannet for the FFC SPA. Baseline mortality calculated using adult only colony size and adult mortality rate (8.1% from Horswill & Robinson 2015).

GANNET PREDICTED IN-COMBINATION MORTALITY, HRA: FFC SPA				
	Mortality prediction	% of baseline mortality of FFC SPA designated population* (used by Applicant)	% of baseline mortality of FFC SPA 2017 count** (used by Applicant)	% of baseline mortality of FFC SPA mean of 2012, 15 & 17 census data***
In-combination CRM, based on figures from Table 3.3 of REP2-035	331 excl. H3 & H4 403 incl. H3 & H4	18.49 excl. H3 & H4 22.48 incl. H3 & H4	15.27 excl. H3 & H4 18.57 incl. H3 & H4	16.63 excl. H3 & H4 20.22 incl. H3 & H4
In-combination displacement (60-80% displacement and 1% mortality, based on Table 4.18 of REP2-035	41-55 excl. H3 & H4 61-82 incl. H3 & H4	2.29-3.07 excl. H3 & H4 3.40-4.58 incl. H3 & H4	1.89-2.54 excl. H3 & H4 2.81-3.78 incl. H3 & H4	2.06-2.76 excl. H3 & H4 3.06-4.12 incl. H3 & H4
In-combination CRM + displacement****, based on Table 4.23 of REP2-035	386 excl. H3 & H4 485 incl. H3 & H4	21.56 excl. H3 & H4 27.06 incl. H3 & H4	17.81 excl. H3 & H4 22.35 incl. H3 & H4	19.39 excl. H3 & H4 24.34 incl. H3 & H4

* 11,061 pairs (22,122 adults), 1% baseline mortality = 18 birds
** 13,391 pairs (26,782 adults), 1% baseline mortality = 22 birds
*** 24,594 adults, 1% baseline mortality = 20 birds
**** In-combination displacement figure used in total is that for WCS of 80% displacement and 1% mortality combined with the collision predictions

The in-combination collision total calculated by the Applicant in REP2-035 is 331 gannets from the FFC SPA per annum excluding Hornsea 3 and Hornsea 4 and 403 for all projects including Hornsea 3 and Hornsea 4. These predicted in-combination collision impacts equate to more than 1% of baseline mortality of the colony (see Table **14** above).

For the collision impacts in-combination with other plans and projects, if the additional mortality from the offshore wind farms is 325-350 per annum (closest PVA outputs to the in-combination collision mortality figure of 331 for all projects excluding Hornsea 3 and Hornsea 4) then the population of FFC SPA after 30 years will be 34.9-37% lower than it would have been in the absence of the additional mortality. The population growth rate would be reduced by 1.5-1.6% (Table 15 below).

For the collision impacts in-combination with other plans and projects, if the additional mortality from the offshore wind farms is 400 per annum (closest PVA outputs to the in-combination collision mortality figure of 403 for all projects including Hornsea 3 and Hornsea 4) then the population of FFC SPA after 30 years will be 41.1% lower than it would have

been in the absence of the additional mortality. The population growth rate would be reduced by 1.9% (Table 15 below).

Table 15 Predicted population impacts on the gannet population of FFC SPA for the range of mortality impacts predicted for in-combination collision. PVA Impact Metrics are as provided in Hornsea Project Three Offshore Wind Farm (2019). The ranges of predicted figures are indicated in purple. The darker shaded cells represent the level of impact closest to the combined in-combination collision predictions

GANNET	FFC SPA				
Additional mortality	% Baseline Mortality using designation population size (22,122 adults), as used by Applicant	% Baseline Mortality using 2017 count size (26,782 adults), as used by Applicant	% Baseline Mortality using mean of 2012, 15 & 17 census data (24,594 adults)	Counterfactual of Final Population Size (CPS)*	Counterfactual of Growth rate (CGR)**
325	18.14	14.98	16.31	0.651 (0.648-0.654)	0.985
350	19.53	16.13	17.57	0.630 (0.627-0.633)	0.984
375	20.93	17.29	18.82	0.609 (0.605-0.613)	0.983
400	22.32	18.44	20.08	0.589 (0.586-0.593)	0.982
425	23.72	19.59	21.33	0.570 (0.566-0.573)	0.981

* Gannet, demographic rate set 2, counterfactuals of population size after 30 years, estimated using a matched runs method, from 1,000 density independent simulations. See Table A2_3.1 in Hornsea Project Three (2019)
** Gannet, demographic rate set 2, counterfactuals of population growth rate after 35 years, estimated using a matched runs method, from 1,000 density independent simulations. See Table A2_3.3 in Hornsea Project Three (2019).

The in-combination displacement total calculated by the Applicant in REP2-035 is 41-55 gannets from the FFC SPA per annum excluding Hornsea 3 and Hornsea 4 and 61-82 for all projects including Hornsea 3 and Hornsea 4 (based on 60-80% displacement and 1% mortality). These predicted in-combination collision impacts equate to more than 1% of baseline mortality of the colony (see
Table **14** above).

For the displacement impacts in-combination with other plans and projects, if the additional mortality from the offshore wind farms is 50-75 per annum (closest PVA outputs to the in-combination displacement mortality figure of 41-55 for all projects excluding Hornsea 3 and Hornsea 4) then the population of FFC SPA after 30 years will be 6.4-9.4% lower than it would have been in the absence of the additional mortality. The population growth rate would be reduced by 0.2-0.3% (Table 16).

For the displacement impacts in-combination with other plans and projects, if the additional mortality from the offshore wind farms is 75-100 per annum (closest PVA outputs to the in-combination displacement mortality figure of 61-82 for all projects including Hornsea 3 and

Hornsea 4) then the population of FFC SPA after 30 years will be 9.4-12.3% lower than it would have been in the absence of the additional mortality. The population growth rate would be reduced by 0.3-0.5% (Table 16).

Table 16 Predicted population impacts on the gannet population of FFC SPA for the range of mortality impacts predicted for in-combination displacement. PVA Impact Metrics are as provided in Hornsea Project Three Offshore Wind Farm (2019). The ranges of predicted figures are indicated in purple. The darker shaded cells represent the level of impact closest to the combined in-combination displacement predictions

GANNET	FFC SPA				
Additional mortality	% Baseline Mortality using designation population size (22,122 adults), as used by Applicant	% Baseline Mortality using 2017 count size (26,782 adults), as used by Applicant	% Baseline Mortality using mean of 2012, 15 & 17 census data (24,594 adults)	Counterfactual of Final Population Size (CPS)*	Counterfactual of Growth rate (CGR)**
50	2.79	2.30	2.51	0.936 (0.936-0.937)	0.998
75	4.19	3.46	3.76	0.906 (0.905-0.907)	0.997
100	5.58	4.61	5.02	0.877 (0.876-0.878)	0.995

* Gannet, demographic rate set 2, counterfactuals of population size after 30 years, estimated using a matched runs method, from 1,000 density independent simulations. See Table A2_3.1 in Hornsea Project Three (2019)
** Gannet, demographic rate set 2, counterfactuals of population growth rate after 35 years, estimated using a matched runs method, from 1,000 density independent simulations. See Table A2_3.3 in Hornsea Project Three (2019).

The combined in-combination impact excluding Hornsea 3 and Hornsea 4 of collision plus displacement to gannet from the FFC SPA equals:

- 331 mortalities per annum from collisions plus up to 55 mortalities per annum from displacement = up to 386 mortalities from the FFC SPA.

The combined in-combination impact including Hornsea 3 and Hornsea 4 of collision plus displacement to gannet from the FFC SPA equals:

- 403 mortalities per annum from collisions plus up to 82 mortalities per annum from displacement = up to 485 mortalities from the FFC SPA.

These combined in-combination impacts equate to over 1% of baseline mortality of the colony (see
Table **14** above). Therefore, the potential combined impacts from in-combination collision plus displacement on the SPA requires further consideration.

For the collision plus displacement impacts in-combination with other plans and projects, if the additional mortality from the offshore wind farms is 375-400 per annum (closest PVA outputs to the in-combination collision plus displacement mortality figure of 386 for all projects excluding Hornsea 3 and Hornsea 4) then the population of FFC SPA after 30 years will be 39.1-41.1% lower than it would have been in the absence of the additional mortality. The population growth rate would be reduced by 1.7-1.8% (Table 17).

For the collision plus displacement impacts in-combination with other plans and projects, if the additional mortality from the offshore wind farms is 475-500 per annum (closest PVA outputs to the in-combination collision plus displacement mortality figure of 485 for all projects including Hornsea 3 and Hornsea 4) then the population of FFC SPA after 30 years will be 46.7-48.5% lower than it would have been in the absence of the additional mortality. The population growth rate would be reduced by 2.1-2.3% (Table 17).

Table 17 Predicted population impacts on the gannet population of FFC SPA for the range of mortality impacts predicted for in-combination collision plus displacement. PVA Impact Metrics are as provided in Hornsea Project Three Offshore Wind Farm (2019). The ranges of predicted figures are indicated in purple. The darker shaded cells represent the level of impact closest to the combined in-combination collision predictions

GANNET	FFC SPA				
Additional mortality	% Baseline Mortality using designation population size (22,122 adults), as used by Applicant	% Baseline Mortality using 2017 count size (26,782 adults), as used by Applicant	% Baseline Mortality using mean of 2012, 15 & 17 census data (24,594 adults)	Counterfactual of Final Population Size (CPS)*	Counterfactual of Growth rate (CGR)**
375	20.93	17.29	18.82	0.609 (0.605-0.613)	0.983
400	22.32	18.44	20.08	0.589 (0.586-0.593)	0.982
425	23.72	19.59	21.33	0.570 (0.566-0.573)	0.981
450	25.11	20.74	22.59	0.551 (0.547-0.555)	0.980
475	26.51	21.90	23.84	0.533 (0.529-0.537)	0.979
500	27.90	23.05	25.10	0.515 (0.511-0.519)	0.977

* Gannet, demographic rate set 2, counterfactuals of population size after 30 years, estimated using a matched runs method, from 1,000 density independent simulations. See Table A2_3.1 in Hornsea Project Three (2019)
** Gannet, demographic rate set 2, counterfactuals of population growth rate after 35 years, estimated using a matched runs method, from 1,000 density independent simulations. See Table A2_3.3 in Hornsea Project Three (2019).

As noted in the assessment of impacts from Norfolk Boreas alone above, it is not known what the growth rate of the colony will be over the next 30 years and this should be considered when judging the significance of predicted impacts against the conservation objectives for the feature.

Natural England has used the same review of gannet colony growth rates as used in the alone assessment and has again considered the counterfactuals of final population size for the predicted levels of in-combination additional mortality for a range of plausible future growth rate scenarios for FFC of 1, 2, 3, 4 and 5% per annum.

The Conservation Objective for the gannet population of the FFC SPA is to maintain the size of the breeding population at a level which is above 8,469 pairs (16,938 adults), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. The latest mean count is 24,594 adults based on the mean of the 2012, 2015 and 2017 counts.

For the predicted in-combination with other plans and projects collision mortality to FFC SPA gannets of 331 mortalities per year for all projects excluding Hornsea 3 and Hornsea 4, from the closest updated PVA output in Hornsea Project Three (2019) of 325-350 additional mortalities, the colony would be predicted to reduce from its current size of 24,594 adults for a growth rate of 1%, but would still be above the size of the 8,469 pairs or 16,938 adults. The colony would be predicted to continue to grow above the current mean population of 24,594 adults under any growth rate scenario from 2% to up to 5% per annum.

For the predicted in-combination with other plans and projects displacement mortality to FFC SPA gannets of 41-55 mortalities per year for all projects excluding Hornsea 3 and Hornsea 4, from the closest updated PVA outputs in Hornsea Project Three (2019) of 50-75 additional mortalities, the colony would still be predicted to grow above the current mean population of 24,594 adults under any growth rate scenario from 1% to up to 5%. This would allow the conservation objective to be met.

For the predicted in-combination with other plans and projects collision mortality to FFC SPA gannets of 386 mortalities per year for all projects excluding Hornsea 3 and Hornsea 4, from the closest updated PVA output in Hornsea Project Three (2019) of 375-400 additional mortalities, the colony would be predicted to reduce from its current size of 24,594 adults for a growth rate of 1%, but would still be above the size of the 8,469 pairs or 16,938 adults. The colony would be predicted to continue to grow above the current mean population of 24,594 adults under any growth rate scenario from 2% to up to 5% per annum.

If the colony were to experience an annual growth rate of 2% or more per annum over the next 30 or so years, then the integrity of the site for this feature is high, with high rates for self-repair, and self-renewal under dynamic conditions with minimal external management. Therefore, the FFC gannet population is believed to be robust enough to allow the conservation objective to maintain the population at (or above) designation levels and sustain additional alone and in-combination mortalities from the offshore wind farms. Our justification for this position is we consider it to be highly unlikely that the FFC annual growth rate would be as low as 1%, and from the analysis of gannet colony growth rates we have conducted the current annual growth rate of c 11% appears to be relatively high for a colony of this age and so the colony is likely to do better than a 1.3 % annual growth rate in the foreseeable future.

Natural England advises that based on the above information, an adverse effect on integrity (AEOI) of the gannet feature of the FFC SPA can be ruled out for in-combination collision impacts, in-combination displacement impacts and in-combination collision plus displacement impacts if Hornsea 3 and Hornsea 4 are excluded from the in-combination totals.

However, due to Natural England's significant concerns regarding the incomplete baseline surveys for the Hornsea 3 project, and the associated level of uncertainty as regards the potential impacts of that project, together with the inevitable uncertainty associated with the figures for Hornsea 4 from the PEIR and are subject to change, Natural England therefore is not in a position to advise that an AEOI can be ruled out for the gannet feature of the FFC SPA for in-combination collision impacts, in-combination displacement impacts and in-combination collision plus displacement

impacts when the Hornsea 3 and Hornsea 4 projects are included in the in-combination totals.

As noted in our main comments, the collision figures included in REP2-035 for the Dogger Bank Creyke Beck projects have been updated with numbers from CRM undertaken as part of a non-material change application (Dogger Bank Wind Farms 2018). Therefore, we advise that these are updated by the Applicant to those for the original consented worst case scenario for these projects when the next update to the in-combination figures is submitted by the Applicant at Deadline 6.

FLAMBOROUGH & FILEY COAST (FFC) SPA: KITTIWAKE

2.1 Impacts from Norfolk Boreas alone: operational collision risk

We welcome that the Applicant has considered a range of breeding season apportionment rates up to 100% in Table 3.7 of REP2-035, as advised by Natural England. This includes the Applicant's preferred breeding season apportionment rate of 26.1%. We also welcome that the Applicant has provided the requested information on kittiwake age classes recorded in the baseline digital aerial site-specific surveys undertaken of the Norfolk Boreas site in Appendix 1 of REP2-035.

We agree with the apportionment rates of 5.4% in autumn and 7.2% in spring used by the Applicant in for collision risk assessment of Norfolk Boreas alone. We welcome that the Applicant has also considered in Table 3.7 of REP2-035 the uncertainty/variability in the input data through considering in the assessment the range of collision predictions based on using the 95% confidence intervals (CIs) around the bird density data and that the full breeding season with adjusted migration seasons has also been considered in the assessment.

Whilst the kittiwake tracking data from Flamborough up until 2015 suggests low connectivity of the Norfolk Boreas site with foraging birds from the FFC SPA colony, further tagging of kittiwakes from the FFC SPA colony has been undertaken in 2017 and the results of this does indicate that birds from the FFC SPA do forage within the Boreas site (Aitken et al. 2017; Wischnewski et al. 2018). Therefore, given that there is evidence from the tracking data for connectivity of kittiwakes from the FFC SPA with the Norfolk Boreas site during the breeding season, we consider the full breeding season with adjusted migration seasons to be the appropriate seasonal definitions to use for this assessment and have based our conclusions based on the figures presented for these seasonal definitions.

From Table 3.7 of REP2-035, using the Applicant's preferred apportionment rate of 26.1% in the breeding season and the agreed apportionment rates of 5.4% in autumn and 7.2% in spring, the predicted collision impacts for the kittiwake feature of FFC SPA are **20 (7-38)** collisions per annum for Norfolk Boreas alone. This equates to 0.16% (range 0.06-0.29%) of baseline mortality of the FFC SPA kittiwake colony using the designated colony adult population or to 0.14% (range 0.05-0.25%) of baseline mortality using the mean of 2016-17 population and an adult mortality rate of 14.6% (Horswill & Robinson 2015).

Using the most precautionary breeding season apportioning rate of 100% and the agreed apportionment rates of 5.4% in autumn and 7.2% in spring, the predicted collision impacts for the kittiwake feature of FFC SPA are **51 (16-100)** collisions per annum for Norfolk Boreas alone (from Table 3.7 of REP2-035). This equates to 0.39% (range 0.13-0.77%) of baseline mortality of the FFC SPA kittiwake colony using the designated colony adult population or to 0.34% (range 0.11-0.67%) of baseline mortality using the mean of 2016-17 population and an adult mortality rate of 14.6% (Horswill & Robinson 2015).

On the basis of these figures, **Natural England advises that an adverse effect on integrity (AEOI) of the kittiwake feature of the FFC SPA can be ruled out for collision impacts from Norfolk Boreas alone.**

2.2 Impacts from Norfolk Boreas in-combination with other plans and projects: operational collision risk

We agree with the apportionment rates of 5.4% in autumn and 7.2% in spring used by the Applicant for apportionment of collision impacts in these seasons for each of the other offshore wind farm predictions to the FFC SPA in the assessments in REP2-035. We also welcome that the in-combination assessment in REP2-035 makes reference to the PVA undertaken for Hornsea 3, but we note our comments regarding the outstanding concerns with this PVA set out in our main comments on REP2-035**.**

The in-combination collision total calculated by the Applicant in REP2-035 using the Applicant's preferred breeding season apportionment rate of 26.1% for both Norfolk Boreas and Norfolk Vanguard is 330 kittiwakes from the FFC SPA per annum excluding Hornsea 3 and Hornsea 4 and 669 for all projects including Hornsea 3 and Hornsea 4. These predicted in-combination collision impacts equate to more than 1% of baseline mortality of the colony (see Table 18).

If the precautionary 86% breeding season apportionment rate is applied to the Norfolk Boreas and Norfolk Vanguard figures (as was done by Natural England during the Vanguard examination), then this brings the in-combination collision totals to 389 excluding Hornsea 3 and Hornsea 4 and to 728 for all projects including Hornsea 3 and Hornsea 4. Again, the predicted in-combination impacts equate to more than 1% of baseline mortality of the colony (see Table 18).

Table 18 Percentage of baseline mortality for in-combination collision impacts for excluding and including Hornsea 3 (H3) and Hornsea 4 (H4) for kittiwake for FFC SPA. Baseline mortality calculated using adult only colony size and adult mortality rate (14.6% from Horswill & Robinson 2015).

KITTIWAKE PREDICTED IN-COMBINATION CRM MORTALITY, HRA: FFC SPA			
	Mortality prediction	% of baseline mortality of FFC SPA designated population* (used by Applicant)	% of baseline mortality of FFC SPA mean 2016-17 census data**
In-combination CRM, based on figures from Table 3.8 of REP2-035 (using 26.1% breeding season apportionment for Norfolk Boreas & Norfolk Vanguard)	330 excl. H3 & H4 669 incl. H3 & H4	2.54 excl. H3 & H4 5.15 incl. H3 & H4	2.20 excl. H3 & H4 4.47 incl. H3 & H4
In-combination CRM, based on figures from para 48 of REP2-035 (using 86% breeding season apportionment for Norfolk Boreas & Norfolk Vanguard)	389 excl. H3 & H4 728 incl. H3 & H4	2.99 excl. H3 & H4 5.60 incl. H3 & H4	2.60 excl. H3 & H4 4.86 incl. H3 & H4

* 89,040 adults, 1% baseline mortality = 130 birds
** 102,536 adults, 1% baseline mortality = 150 birds

There is no clear evidence to support application of any particular form or magnitude of density dependence in the modelling; therefore Natural England has based our advice on the outputs of the density independent models (as these make no assumptions about the form of strength of any density dependent effects). Therefore, Natural England has focused our conclusions on the PVA outputs from the density independent model for demographic rate set 2 using a matched runs approach (see Table 19).

Table 19 Predicted population impacts on the kittiwake population of FFC SPA for the range of mortality impacts predicted for Norfolk Vanguard in-combination with other plans and projects. PVA impact metrics are as provided in Hornsea Project Three Offshore Wind Farm (2019). The range of predicted in-combination figures are indicated in purple. The darker shaded cells represent the level of impact closest to the in-combination predictions in Table 18.

KITTIWAKE	FFC SPA			
Additional mortality	% Baseline Mortality using designation population size (89,040 adults)	% Baseline Mortality using mean 2016-17 census data (102,536 adults)	Counterfactual of Final Population Size (CPS)*	Counterfactual of Growth rate (CGR)**
300	2.31	2.00	0.907 (0.906-0.908)	0.997
350	2.69	2.34	0.892 (0.891-0.893)	0.996
400	3.08	2.67	0.878 (0.877-0.879)	0.996
450	3.46	3.01	0.863 (0.862-0.865)	0.995
500	3.85	3.34	0.849 (0.848-0.851)	0.994
550	4.23	3.67	0.835 (0.834-0.837)	0.994
600	4.62	4.01	0.822 (0.820-0.823)	0.993
650	5.00	4.34	0.808 (0.807-0.810)	0.993
700	5.38	4.68	0.795 (0.794-0.797)	0.992
750	5.77	5.01	0.782 (0.781-0.784)	0.992

* Kittiwake, demographic rate set 2, counterfactuals of population size after 30 years, estimated using a matched runs method, from 1000 density independent simulations. See Table A2_7.1 in Hornsea Project Three Offshore Wind Farm (2019)

** Kittiwake, demographic rate set 2, counterfactuals of population growth rate after 35 years, estimated using a matched runs method, from 1000 density independent simulations. See Table A2_7.3 in Hornsea Project Three Offshore Wind Farm (2019). Whilst Vanguard's lifespan is 30 years, data on counterfactuals of growth rate are only available in Hornsea Project Three Offshore Wind Farm (2019) for after 35 years. No CLs given as they are the same as the median values.

If the additional mortality from the windfarm is 350-400 adults per annum (closest PVA outputs available in Hornsea Project Three Offshore Wind Farm 2019 to predicted 330 mortalities for in-combination total excluding Hornsea 3 and Hornsea 4 using the Applicant's preferred 26.1% breeding season apportionment rate for Norfolk Boreas and Vanguard, and to the 389 in-combination total calculated using 86% breeding season apportionment rate for both Norfolk Boreas and Vanguard for excluding Hornsea 3 and Hornsea 4) then the population of FFC SPA after 30 years will be 10.8-12.2% lower than it would have been in the absence of the additional mortality. The population growth rate would be reduced by 0.4% (Table 19). If it is assumed that the population is stable then this would mean that the population would be 10.8-12.2% lower than the current population size. This would be counter to the restore conservation objective for this feature at the site and would result in an adverse effect on the integrity of the site.

If the additional mortality from the windfarm is 700-750 adults per annum (closest PVA outputs available in Hornsea Project Three Offshore Wind Farm 2019 to predicted 669 mortalities for in-combination total including Hornsea 3 and Hornsea 4 using the Applicant's preferred 26.1% breeding season apportionment rate for Norfolk Boreas and Vanguard, and to the 728 in-combination total calculated using 86% breeding season apportionment rate for both Norfolk Boreas and Vanguard for including Hornsea 3 and Hornsea 4) then the population of FFC SPA after 30 years will be 20.5-21.8% lower than it would have been in the absence of the additional mortality. The population growth rate would be reduced by 0.8% (Table 19). If it is assumed that the population is stable then this would mean that the population would be 20.5-21.8% lower than the current population size. This would be counter to the restore conservation objective for this feature at the site and would result in an adverse effect on the integrity of the site.

It is not known what the growth rate of the colony will be over the next 30 years and this should be considered when judging the significance of predicted impacts against the conservation objectives for the feature. There has been a 2.2% per annum decline in numbers for Flamborough Head and Bempton Cliffs colony[5] between 1987 and 2017 (a growth rate of 0.979 per annum). Over the period 2000 to 2017 the population has shown a 0.37% per annum increase in numbers (a growth rate of 1.0037 per annum) based on census counts in SMP (JNCC 2016).

Across colonies in the UK the kittiwake population declined by 44% between 1998/2000 and 2015. Between the SCR Census (1985–88) and Seabird 2000 (1998–2002) for major colonies in Britain, no sites showed a per annum increase that exceeded 4.5% (see Section B of Natural England's Deadline 4 submission for Hornsea Project 2[6]). The growth rate of the colony at Bempton/Flamborough between 2000 and 2017 was 0.37% per annum, following declines from 1987. So, it seems reasonable to assume that the FFC SPA colony growth rate is <1% per annum. Therefore Natural England has considered the counterfactuals of final population size for the predicted levels of in-combination additional mortality for a range of plausible future growth rate scenarios for FFC of stable, 0.37, 1, and 3% per annum.

The Conservation Objective for the kittiwake population of the FFC SPA is to restore the size of the breeding population at a level which is above 83,700 breeding pairs, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.

[5] It should be noted that the new Flamborough and Filey Coast SPA includes additional cliff areas at Filey which support kittiwake but were not previously monitored as part of the SPA, hence the reference to Flamborough Head and Bempton Cliffs.

[6] Natural England (2015) Hornsea Project Two Offshore Wind Farm – Written Submission for Deadline 4. Available from: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010053/EN010053-001163-Natural%20England.pdf

We note that in the updated assessment in REP2-035 whilst the Applicant has noted that the Conservation Objective is to restore the size of the breeding population, they have also noted that they consider that there are several compelling reasons to consider that the apparent population estimate in 1987 was recorded in error and in fact represented the estimate of breeding individuals and not of pairs (e.g. Coulson 2011, 2017), and hence consider that 'there is robust scientific evidence that the target objective for this population is in fact erroneous'. Natural England notes that this topic has been discussed in detail previous during the Hornsea 2 Examination in our Deadline 4[7] and Deadline 6[8] submissions for this examination. During the examination for Hornsea 2, JNCC and Natural England reviewed in detail the actual count forms from 1987 and as a result JNCC are happy for this count to be included in the Seabird Monitoring Programme (SMP) database as a legitimate count. Natural England has accepted this and this count has been used for all statistical analysis and reporting for the colony and hence used in setting the conservation objective target. The count forms were made available during the Hornsea 2 examination. Therefore, Natural England's position remains that the conservation objective is to restore the size of the breeding population at a level which is above 83,700 breeding pairs, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.

If we assume a 1% per annum growth rate then 350-400 additional mortalities per annum would result in the population being approximately 15,000-16,000 birds lower than without the additional mortality after 30 years and it would take over an additional 30 years to reach the target population compared to the no windfarm mortality scenario. If we assume a 1% per annum growth rate then 700-750 additional mortalities per annum would result in the population being around 30,000 birds lower than without the additional mortality after 30 years and it would take over an additional 190 years to reach the target population compared to the no windfarm mortality scenario. It is not possible to rule out adverse effect on integrity (AEOI) for these scenarios.

If the kittiwake population were to grow at the a rate of 3% per annum over the next 30 years, then 350-400 additional mortalities per annum would result in the population being approximately 25,000-30,000 birds lower than without the additional mortality after 30 years and it would take over an additional 2 years to reach the target population compared to the no windfarm mortality scenario. If we assume a 3% per annum growth rate then 700-750 additional mortalities per annum would result in the population being around 50,000 birds lower than without the additional mortality after 30 years and it would take over an additional 5 years to reach the target population compared to the no windfarm mortality scenario.

In the context of a population trajectory that is currently stable or increasing at <1% per annum an additional mortality of 350-400 adults per annum causing a reduction in growth rate of 0.4%, or of 700-750 adults per annum over 30 years causing a reduction in growth rate of 0.8% would further harm the population and make it more difficult to restore the population to a favourable condition. Natural England is therefore currently unable to advise beyond reasonable scientific doubt that this level of impact would not be an AEOI.

There is no evidence to suggest that the future population trend will be significantly different from the current trend of 0.37% per annum (2000-2017), for example productivity at the colony has not been increasing in recent years (see Figure 1). (Aitken et al. 2017). So, based on the review of growth rates above, it seems reasonable to assume that the FFC SPA colony growth rate will be <1% per annum.

[7] Natural England (2015) Hornsea Offshore Wind Farm - Project Two Application: Written Submission for Deadline 4. Planning Inspectorate Reference: EN010053.

[8] Natural England (2015) Hornsea Offshore Wind Farm Project Two Application: Written Submission for Deadline 6. Planning Inspectorate Reference: EN010053.

Therefore, as this feature has a restore conservation objective, and because there are indications that the predicted level of mortality would mean the population could decline from current levels should it currently be stable, **it is not possible to rule out AEOI of the kittiwake feature of the FFC SPA for collision impacts from in-combination with other plans and projects, both including and excluding Hornsea 3 and Hornsea 4.**

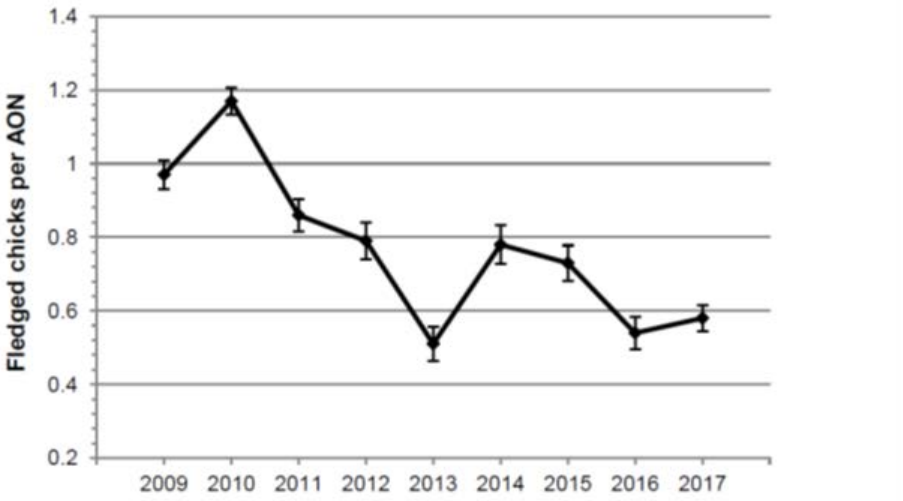

Figure 1 Flamborough/Bempton Black-legged kittiwake productivity 2009-2017, mean of plot results +/- SE. From Aitken et al. (2017). Note this does not include productivity data for Filey, where productivity is lower (e.g. in 2017 mean productivity for kittiwake at Filey was 0.39 (SE ± 0.0742) chicks per AON).

As noted in our main comments, the collision figures included in REP2-035 for the Dogger Bank Creyke Beck projects have been updated with numbers from CRM undertaken as part of a non-material change application (Dogger Bank Wind Farms 2018). Therefore, we advise that these are updated by the Applicant to those for the original consented worst case scenario for these projects when the next update to the in-combination figures is submitted by the Applicant at Deadline 6.

FLAMBOROUGH & FILEY COAST (FFC) SPA: GUILLEMOT

3.1 Impacts from Norfolk Boreas alone: displacement

As noted in our response to ExA Question 8.10.4 in REP2-080, **we advise that an adverse effect on integrity (AEOI) of the guillemot feature of the FFC SPA can be ruled out for displacement impacts from Norfolk Boreas alone** (see REP2-080 for full details and justification for this advice).

3.2 Impacts from Norfolk Boreas in-combination with other plans and projects: operational displacement

We welcome that the Applicant has used the apportionment rates advised by Natural England during the Norfolk Vanguard examination for the breeding season for Teesside (100%), Westernmost Rough (100%), Humber Gateway (100%), Triton Knoll (100%), Hornsea 1 (46.3%), Hornsea 2 (46.3%), Dogger Bank Creyke Beck A (35%), Dogger Bank Creyke Beck B (35%), Dogger Bank Teesside A (35%) and Dogger Bank Teesside B (35%).

We also welcome that the Applicant has apportioned 4.4% in the non-breeding season of guillemot abundances at all of the offshore wind farms to the FFC SPA, as recommended by Natural England during the Norfolk Vanguard examination.

We agree with the annual in-combination totals calculated by the Applicant in Table 4.6 of REP2-035 of 24,242 guillemots from the FFC SPA at risk of displacement for all projects excluding Hornsea 3 and Hornsea 4. For the Natural England recommended rates of 30-70% displacement and 1-10% mortality, the number of predicted additional in-combination mortalities **excluding** Hornsea 3 and Hornsea 4 is between 73 (30% displacement and 1% mortality) and 1,697 (70% displacement and 10% mortality) guillemots from the FFC SPA. This equates to 1.43-33.43% of baseline mortality for the colony. Even at the Applicant's preferred rates of 50% displacement and 1% mortality, the predicted additional mortalities equate to more than 1% of baseline mortality (Table 20). This is significant and therefore requires further consideration.

We agree with the annual in-combination totals calculated by the Applicant in Table 4.6 of REP2-035 of 43,391 guillemots from the FFC SPA at risk of displacement for all projects including Hornsea 3 and Hornsea 4. For the Natural England recommended rates of 30-70% displacement and 1-10% mortality, the number of predicted additional in-combination mortalities **including** Hornsea 3 and Hornsea 4 is between 130 (30% displacement and 1% mortality) and 3,037 (70% displacement and 10% mortality) guillemots from the FFC SPA. This equates to 2.56-59.84% of baseline mortality for the colony. Even at the Applicant's preferred rates of 50% displacement and 1% mortality, the predicted additional mortalities equate to more than 1% of baseline mortality (Table 20). As with the in-combination figure excluding Hornsea 3 and Hornsea 4, this is significant and therefore requires further consideration.

Table 20 Predicted annual displacement mortalities for in-combination impact levels for excluding and including Hornsea 3 (H3) and Hornsea 4 (H4) for guillemot for FFC SPA. Pink shaded cells indicate predicted mortalities that exceed 1% of baseline mortality – baseline mortality calculated using adult only colony size (designated size of 83,214 adults) and adult mortality rate (6.1% from Horswill & Robinson 2015) – 1% baseline mortality = 51 birds.

Guillemot in-combination mortality figures, EXCLUDING H3 and H4		% mortality			
FFC adults mean of population		1	2	5	10
% displacement	30	73	145	364	727
	40	97	194	485	970
	50	121	242	606	1,212
	60	145	291	727	1,455
	70	170	339	848	1,697
Guillemot in-combination mortality figures, INCLUDING H3 & H4		% mortality			
FFC adults mean of population		1	2	5	10
% displacement	30	130	260	651	1,302
	40	174	347	868	1,736
	50	217	434	1,085	2,170
	60	260	521	1,302	2,603
	70	304	608	1,519	3,037

As the maximum mortality of 1,600 per year modelled in the updated FFC SPA guillemot PVA undertaken during the Hornsea 3 examination (Hornsea Project Three Offshore Wind Farm 2019) was insufficient for the current predicted worst case maximum of 3,037, we welcome that the Applicant has undertaken an updated PVA model using the Natural England commissioned Seabird PVA tool (https://github.com/naturalengland/Seabird_PVA_Tool). As noted in our submission ahead of the Issue Specific Hearing (ISH) 4, updates to the tool are being undertaken and we advised the Applicant waited on running the models to make sure that the change is finalised before outputs for Norfolk Boreas were generated. As the models have been run before the updates were completed, we advise that the models are re-run when the updated version of the tool is available and we request that assessments present the metrics calculated across the whole population (the new version of the tool will have this as a new option that can be selected as an output type). We also advise that the Applicant includes information the outputs from the models in terms of the growth rates predicted by the models for the un-impacted scenarios in order to assess whether the models are suggesting a reasonably sensible trajectory for the populations with no offshore wind farm impacts. Natural England are aiming to make the updates to the tool available in the next 1-2 weeks

We note that the guillemot models have been run for only 500 simulations. The Seabird PVA Tool report (Searle et al. 2019) states that *'it is not recommended to use small values of sim.n (number of simulations) because PVAs based on small numbers of simulations are likely to be unreliable (using a value of less than 1,000 will generate a warning message in the tool, but in practice the minimum number of simulations may need to be substantially higher than this in order to achieve reliable results)'*. Natural England considers that a larger number of simulations than 500 would be needed to generate reliable results.

Therefore, whilst Natural England has considered the outputs from these models in our advice, as they nevertheless currently represent the best available evidence on which to base an assessment, this should not be taken as a Natural England endorsement or 'acceptance' of the model outputs and we reserve the right to revise the advice provided here based on the best available evidence presented. However, we note that Natural England has re-run the density independent PVA through the tool in order to consider the predicted counterfactual metrics across the full range of predicted impacts across 30-70% displacement and 1-10% mortality. We have done this using the same input parameters for guillemot at the FFC SPA as presented by the Applicant in Appendix 3 of REP2-035. However, we note that we have been able to run the model for 5,000 simulations rather than the 500 simulations as done by the Applicant.

There is no clear evidence to support the application of any particular form or magnitude of density dependence in the modelling; therefore Natural England has based its advice on the outputs of the density independent PVA model (as these make no assumptions about the form or strength of any density dependent effects).

The FFC SPA guillemot colony increased by 2.8% per annum between 1987-2008 and the designated population size is 83,214 breeding adults. The 2017 colony count indicated approximately 121,754 breeding adults across the site (Aitken et al. 2017). It is not clear whether the colony will continue to grow at the current rate for the next 30 years and this should be considered when judging the significance of predicted impacts against the conservation objectives for the feature. The Conservation Objective for the guillemot population of the FFC SPA is to maintain the size of the breeding population at a level which is above 41,607 breeding pairs, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.

If the additional mortality from the windfarm is 1,700-3,050 birds per annum (closest PVA outputs available to predicted 1,697 mortalities for the in-combination total excluding

Hornsea 3 and Hornsea 4 at 70% displacement and 10% mortality and to the 3,037 in-combination total including Hornsea 3 and Hornsea 4 at 70% displacement and 10% mortality) then the population of FFC SPA after 30 years will be 51.05-72.56% lower (see Table 4.8 of REP2-035) than it would have been in the absence of the additional mortality. The population growth rate would be reduced by 2.28-4.08% (see Table 4.8 of REP2-035). This level of impact would be considered significant in the context of the current colony population trend.

However, while there is some empirical evidence to support the displacement levels for auks we do not know what the likely mortality impacts of displacement are. We therefore consider it appropriate to consider a range of mortalities from 1-10%. However, on the basis that the projects that have been scoped into the assessment lie in areas of the North Sea that represent low to medium levels of guillemot density during both the breeding (where relevant) and non-breeding seasons (Seabird Sensitivity Mapping Tool), it is assumed that areas of low/medium density will be less important/desirable feeding areas and therefore mortality impacts of displacement from lower quality areas would be lower than displacement from optimal/important areas. Therefore, we do not anticipate that mortality rates to be at the top of the range considered. We do not expect the mortality to exceed a level where the population growth rate would decline by more than approximately 0.5% per annum (Table 21).

Table 21 Predicted % reductions in population growth rates[9] from Norfolk Boreas in-combination with other plans and projects for excluding and including Hornsea 3 (H3) and Hornsea 4 (H4). Shaded cells are those where the reduction in growth rate exceeds 0.5%, 1% or 2%).

Guillemot growth rate figures*, EXCLUDING H3 and H4		% mortality			
FFC adults in-combination		1	2	5	10
% displacement	30	0.1	0.2	0.5	1.0
	40	0.1	0.3	0.7	1.3
	50	0.2	0.3	0.9	1.7
	60	0.2	0.4	1.0	2.0
	70	0.3	0.5	1.1	2.3
Guillemot growth rate figures*, INCLUDING H3 and H4		% mortality			
FFC adults in-combination		1	2	5	10
% displacement	30	0.2	0.4	0.9	1.8
	40	0.3	0.5	1.2	2.3
	50	0.3	0.6	1.5	2.9
	60	0.4	0.7	1.8	3.5
	70	0.5	0.9	2.1	4.1

* Guillemot counterfactuals of population growth rate after 30 years, produced by Natural England using the NE Seabird PVA Tool for 5,000 density independent simulations, using same input data as Applicant has provided in Appendix 3 of REP2-035

[9] Reductions in population growth rate relate to the nearest mortality level output from the PVA model that lies above the predicted in-combination displacement mortality in
above. So for example if the predicted displacement is 110 birds and PVA outputs are given in 50 bird increments, the reduction in growth rate in the matrix is that for the 150 birds mortality level.

Based on the current population trend for the colony and the restore conservation objective, and on the basis of predicted displacement mortality for the project in-combination with other plans and projects resulting in a decline in growth rate of no more than 0.4%, **Natural England advises that an adverse effect on integrity (AEOI) on the guillemot feature of the FFC SPA can be ruled out from displacement in-combination with other plans and projects if Hornsea 3 and Hornsea 4 are excluded from the in-combination total**.

However, due to Natural England's significant concerns regarding the incomplete baseline surveys for the Hornsea 3 project, and the associated level of uncertainty as regards the potential impacts of that project, together with the inevitable uncertainty associated with the figures for Hornsea 4 from the PEIR and are subject to change, Natural England therefore is not in a position to advise that an AEOI can be ruled out for the guillemot feature of the FFC SPA for displacement in-combination with other plans and projects when the Hornsea 3 and Hornsea 4 projects are included in the in-combination total.

FLAMBOROUGH & FILEY COAST (FFC) SPA: RAZORBILL

4.1 Impacts from Norfolk Boreas alone: displacement

As noted in our response to ExA Question 8.10.4 in REP2-080, **we advise that an adverse effect on integrity (AEOI) of the razorbill feature of the FFC SPA can be ruled out for displacement impacts from Norfolk Boreas alone** (see REP2-080 for full details and justification for this advice).

4.2 Impacts from Norfolk Boreas in-combination with other plans and projects: operational displacement

We welcome that the Applicant has used the apportionment rates advised by Natural England during the Norfolk Vanguard examination for the breeding season for Westermost Rough (100%), Hornsea 1 (48.2%), Hornsea 2 (48.2%), Dogger Bank Creyke Beck A (30%), Dogger Bank Creyke Beck B (30%), Dogger Bank Teesside A (30%) and Dogger Bank Teesside B (30%).

We also welcome that the Applicant has apportioned 3.4% in spring and autumn and 2.7% in winter of razorbill abundances at all of the offshore wind farms to the FFC SPA, as recommended by Natural England during the Norfolk Vanguard examination.

We agree with the annual in-combination totals calculated by the Applicant in Table 4.11 of REP2-035 of 5,986 razorbills from the FFC SPA at risk of displacement for all projects excluding Hornsea 3 and Hornsea 4. For the Natural England recommended rates of 30-70% displacement and 1-10% mortality, the number of predicted additional in-combination mortalities **excluding** Hornsea 3 and Hornsea 4 is between 18 (30% displacement and 1% mortality) and 419 (70% displacement and 10% mortality) razorbills from the FFC SPA. This equates to 0.81-18.88% of baseline mortality for the colony. Even at the Applicant's preferred rates of 50% displacement and 1% mortality, the predicted additional mortalities equate to more than 1% of baseline mortality (Table 22). This is significant at the upper level of the displacement/mortality range that the SNCBs advise for auks (70% displacement and 10% mortality) and therefore requires further consideration.

We agree with the annual in-combination totals calculated by the Applicant in Table 4.11 of REP2-035 of 7,098 razorbills from the FFC SPA at risk of displacement for all projects including Hornsea 3 and Hornsea 4. For the Natural England recommended rates of 30-70% displacement and 1-10% mortality, the number of predicted additional in-combination

mortalities **including** Hornsea 3 and Hornsea 4 is between 21 (30% displacement and 1% mortality) and 497 (70% displacement and 10% mortality) razorbills from the FFC SPA. This equates to 0.96-22.38% of baseline mortality for the colony. Even at the Applicant's preferred rates of 50% displacement and 1% mortality, the predicted additional mortalities equate to more than 1% of baseline mortality (Table 22). As with the in-combination figure excluding Hornsea 3 and Hornsea 4, this is significant at the upper level of the displacement/mortality range that the SNCBs advise for auks (70% displacement and 10% mortality) and therefore requires further consideration.

Table 22 Predicted annual displacement mortalities for in-combination impact levels for excluding and including Hornsea 3 (H3) and Hornsea 4 (H4) for razorbill for FFC SPA. Pink shaded cells indicate predicted mortalities that exceed 1% of baseline mortality – baseline mortality calculated using adult only colony size (designated size of 21,140 adults) and adult mortality rate (10.5% from Horswill & Robinson 2015) – 1% baseline mortality = 22 birds.

Razorbill in-combination mortality figures, EXCLUDING H3 and H4		% mortality			
FFC adults mean of population		1	2	5	10
% displacement	30	18	36	90	180
	40	24	48	120	239
	50	30	60	150	299
	60	36	72	180	359
	70	42	84	210	419
Razorbill in-combination mortality figures, INCLUDING H3 & H4		% mortality			
FFC adults mean of population		1	2	5	10
% displacement	30	21	43	107	213
	40	28	57	142	284
	50	36	71	177	355
	60	43	85	213	426
	70	50	99	248	497

We welcome that the Applicant has considered the predicted in-combination displacement impact figures with the outputs from the updated FFC SPA razorbill PVA undertaken during the Hornsea 3 examination (Hornsea Project Three Offshore Wind Farm 2019). As noted above, we had outstanding concerns with the Hornsea 3 PVAs which were not resolved by the close of the Examination. However, this nevertheless represents the best available evidence on which to base an assessment, though this should not be taken as an endorsement or 'acceptance' of the model.

There is no clear evidence to support the application of any particular form or magnitude of density dependence in the modelling; therefore Natural England has based its advice on the outputs of the density independent PVA model (as these make no assumptions about the form or strength of any density dependent effects). Therefore, Natural England has focused our conclusions on the PVA outputs from the density independent model for demographic rate set 2 (the rates Natural England considers to be the most appropriate) using a matched runs approach (as per Natural England advice).

The FFC SPA razorbill colony increased by 3% per annum 1987-2008 and the designated population size is 21,140 breeding adults. The 2017 colony count indicated approximately 40,506 breeding adults across the site, indicating continued increases (Aitken et al. 2017). It

is not clear whether the colony will continue to grow at the current rate for the next 30 years and this should be considered when judging the significance of predicted impacts against the conservation objectives for the feature. However, colony productivity is higher than the national average. The Conservation Objective for the razorbill population of the FFC SPA is to maintain the size of the breeding population at a level which is above 10,570 breeding pairs whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.

If the additional mortality from the windfarm is 450-500 birds per annum (closest PVA outputs available in Hornsea Project Three Offshore Wind Farm 2019 to predicted 419 mortalities for the in-combination total excluding Hornsea 3 and Hornsea 4 at 70% displacement and 10% mortality and to the 497 in-combination total for including Hornsea 3 and Hornsea 4 at 70% displacement and 10% mortality) then the population of FFC SPA after 30 years will be 46.5-50.1% lower (see Table A2_15.1 of Hornsea Project Three Offshore Wind Farm 2019) than it would have been in the absence of the additional mortality. The population growth rate would be reduced by 2.1-2.4% (see Table A2_15.3 of Hornsea Project Three Offshore Wind Farm 2019). This level of impact would be considered significant in the context of the current colony population trend.

However, while there is some empirical evidence to support the displacement levels for auks we do not know what the likely mortality impacts of displacement are. We therefore consider it appropriate to consider a range of mortalities from 1-10%. However, on the basis that the projects that have been scoped into the assessment lie in areas of the North Sea that represent low to medium levels of razorbill density during both the breeding (where relevant) and non-breeding seasons[10], it is assumed that areas of low/medium density will be less important/desirable feeding areas and therefore mortality impacts of displacement from lower quality areas would be lower than displacement from optimal/important areas. Therefore, we do not anticipate razorbill mortality rates to be at the top of the range considered. We do not expect the mortality to exceed a level where the population growth rate would decline by more than approximately 0.5% per annum, as shown in Table 23. This would approximate to the population being approximately 13% lower after 30 years when compared to the un-impacted population (based on 100 birds annual adult mortality) (based on the counterfactual of final population size in Table A2_15.1 of Hornsea Project Three Offshore Wind Farm 2019).

[10] NE/MMO Seabird Sensitivity Mapping Tool. http://www.gis.naturalengland.org.uk/pubs/gis/GIS_register.asp

Table 23 Predicted % reductions in population growth rates[11] from Norfolk Boreas in-combination with other plans and projects for excluding and including Hornsea 3 (H3) and Hornsea 4 (H4). Shaded cells are those where the reduction in growth rate exceeds 0.5%, 1% or 2%).

Razorbill growth rate figures*, EXCLUDING H3 and H4		% mortality			
FFC adults in-combination		1	2	5	10
% displacement	30	0.2	0.2	0.5	0.9
	40	0.2	0.2	0.7	1.2
	50	0.2	0.5	0.7	1.4
	60	0.2	0.5	0.9	1.9
	70	0.2	0.5	1.2	2.1
Razorbill growth rate figures*, INCLUDING H3 and H4		% mortality			
FFC adults in-combination		1	2	5	10
% displacement	30	0.2	0.2	0.7	1.2
	40	0.2	0.5	0.7	1.4
	50	0.2	0.5	0.9	1.7
	60	0.2	0.5	1.2	2.1
	70	0.2	0.5	1.2	2.4

* Razorbill, demographic rate set 2, counterfactuals of population growth rate after 35 years, estimated using a matched runs method, from 1000 density independent simulations. See Table A2_15.3 in Hornsea Project Three Offshore Wind Farm (2019b). Whilst Norfolk Boreas's lifespan is 30 years, data on counterfactuals of growth rate are only available in Hornsea Project Three Offshore Wind Farm (2019) for after 35 years.

Based on the current population trend and productivity levels for the colony, and on the basis of predicted displacement mortality for the project in-combination with other plans and projects resulting in a decline in growth rate of less than 0.5% per annum, **Natural England advises that an adverse effect on integrity (AEOI) on the razorbill feature of the FFC SPA can be ruled out from displacement in-combination with other plans and projects if Hornsea 3 and Hornsea 4 are excluded from the in-combination total**.

However, due to Natural England's significant concerns regarding the incomplete baseline surveys for the Hornsea 3 project, and the associated level of uncertainty as regards the potential impacts of that project, together with the inevitable uncertainty associated with the figures for Hornsea 4 from the PEIR and are subject to change, Natural England therefore is not in a position to advise that an AEOI can be ruled out for the razorbill feature of the FFC SPA for displacement in-combination with other plans and projects when the Hornsea 3 and Hornsea 4 projects are included in the in-combination total.

[11] Reductions in population growth rate relate to the nearest mortality level output from the PVA model that lies above the predicted in-combination displacement mortality in
above. So for example if the predicted displacement is 110 birds and PVA outputs are given in 50 bird increments, the reduction in growth rate in the matrix is that for the 150 birds mortality level.

FLAMBOROUGH & FILEY COAST (FFC) SPA: ASSEMBLAGE

5.1 Impacts from Norfolk Boreas alone

We welcome that an assessment of impacts from Norfolk Boreas alone on the assemblage qualifying feature of the FFC SPA has now been included by the Applicant in REP2-035. We agree with the Applicant that the individual listed component species of the assemblage that are also qualifying features in their own right (gannet, kittiwake, razorbill and guillemot) have been individually assessed, and that the remaining species (fulmar, puffin, herring gull, shag and cormorant) are considered to either have no likelihood of connectivity due to limited foraging ranges or coastal preferences, and are not considered to be at risk of impacts at wind farms or were recorded in such low numbers that there is no risk of an impact on the population.

Therefore, based on our advice/conclusions above for the individual assessments for Norfolk Boreas alone for the four qualifying features of the FFC SPA, **Natural England advises that an adverse effect on integrity (AEOI) of the seabird assemblage feature of the FFC SPA can be ruled out for collision and displacement impacts from Norfolk Boreas alone.**

5.2 Impacts from Norfolk Boreas in-combination with other plans and projects

We welcome that the Applicant has considered in-combination impacts on the assemblage qualifying feature of the FFC SPA in REP2-035.

We note that the Applicant has concluded that: *'since their conclusions are that Norfolk Boreas will not have in-combination AEOI on any of the individual components of the seabird assemblage feature for which individual assessments have been undertaken (gannet, kittiwake, guillemot and razorbill) and the additional species (herring gull, fulmar, puffin, shag and cormorant) are not considered to be at risk of adverse effects, it can therefore be concluded that there will not be an adverse effect on the integrity of the FFC SPA due to an in-combination effect on the seabird assemblage feature'*. However, we note that Natural England does not agree with the Applicant's conclusions of no AEOI for in-combination collision risk for the kittiwake feature of the FFC SPA irrespective of whether Hornsea 3 and Hornsea 4 are included in the in-combination totals. Additionally, we are also not in a position to rule out an AEOI for in-combination collisions or displacement for the gannet, guillemot and razorbill features of the SPA.

The impacts to the assemblage qualifying feature of the FFC SPA should be assessed against the conservation objectives for abundance and diversity of the feature, namely:

- Abundance: to maintain the overall abundance of the assemblage at a level which is above 216,730 individuals whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.
- Diversity: to maintain the diversity of the assemblage – the total number of species (nine: kittiwake, gannet, guillemot, razorbill, fulmar, puffin, herring gull, shag and cormorant) comprising the seabird assemblage should not reduce over time.

Natural England notes that there are a number of ongoing issues with interpreting assemblage features that still need to be resolved. However, using expert judgement Natural England considers that the abundance target of the assemblage will be met and that the assemblage diversity is not at risk from the in-combination collision and displacement impacts from offshore wind farms. Therefore, Natural England advises **that an adverse effect on integrity (AEOI) of the seabird assemblage feature of the FFC SPA can be ruled out for collision and displacement impacts in-combination with other plans and projects when the Hornsea 3 and Hornsea 4 projects are excluded from the in-**

combination totals. We note that this is a change from the advice provided at Norfolk Vanguard. However, Natural England is looking in to assemblages as features in more detail so this advice may be subject to change in the future.

However, due to Natural England's significant concerns regarding the incomplete baseline surveys for the Hornsea 3 project, and the associated level of uncertainty as regards the potential impacts of that project, together with the inevitable uncertainty associated with the figures for Hornsea 4 from the PEIR and are subject to change, Natural England therefore is not in a position to advise that an AEOI can be ruled out for the assemblage feature of the FFC SPA for collision and displacement in-combination with other plans and projects when the Hornsea 3 and Hornsea 4 projects are included in the in-combination total.

ALDE-ORE ESTUARY SPA: LESSER BLACK-BACKED GULL (LBBG)

6.1 Impacts from Norfolk Boreas alone: operational collision risk

We understand from ongoing discussions with the Applicant that there was an error in their estimated preferred apportioning calculation for the breeding season (which is based on the SNH apportionment tool, SNH 2018) which meant that the Applicant's preferred Norfolk Boreas rate for the breeding season was reported as 12% in APP-201, but this should have been 21% (due to an error in the apportioning calculations). We note that this has been corrected by the Applicant in Table 3.12 and the assessment in REP2-035. Therefore, the Applicant has considered a range of breeding season apportionment rates in REP-035 of 21% and 30%, which covers the upper range of up to 30% breeding season apportionment recommended by Natural England.

Whilst the Applicant's calculated apportionment rates for the non-breeding seasons of 3.3% in the migration seasons (autumn and spring) and 5% in mid-winter have not been calculated from Natural England's standard approach (as set out in our Relevant Representations at Norfolk Vanguard[12]), the Applicant's approach does not appear to make a significant difference to the apportionment figures that result from taking the Natural England recommended approach and therefore, we are content with the rates used by the Applicant for the non-breeding seasons in REP2-035.

We welcome that the Applicant has also considered in Table 3.12 of REP2-035 the uncertainty/variability in the input data through considering in the assessment the range of collision predictions based on using the 95% confidence intervals around the bird density data and that the full breeding season with adjusted migration seasons has been considered in the assessment.

All of the information provided by the Applicant in APP-201 indicates just how variable the ecology of this species can be, both between individuals within a colony and between seasons and years. As a result, it is difficult to have much confidence in pinning down an actual figure for use in apportionment. Therefore, we have based our calculations of impact from Norfolk Boreas alone in
Table **24** on use of a range of breeding season apportionment rates of 10-30%, including the Applicant's preferred rate corrected breeding season apportionment rate of 21% and the

[12] Natural England (2018) Norfolk Vanguard Wind Farm: Relevant Representations of Natural England. Available from: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010079/EN010079-002065-EN010079%20250654%20Natural%20England's%20Norfolk%20Vanguard%20Relevant%20Representations%20&%20Appendices.pdf

Applicant's calculated non-breeding season rates of 3.3% in spring and autumn and 5% in mid-winter.

Table 24 Percentage of baseline mortality for impact levels for LBBG for the Alde-Ore Estuary SPA, using a range of breeding season apportionment rates from 10-30% advised by Natural England and the Applicant's apportionment rates in the non-breeding seasons of 3.3% in autumn and spring and 5% in winter. Baseline mortality calculated using adult colony size and adult mortality rate (11.5% from Horswill & Robinson 2015). Grey shaded cells represent scenarios equating to more than 1% baseline mortality

		Impact collisions per annum to Alde-Ore SPA	% of baseline mortality of Alde-Ore SPA population of 2,000 pairs as used by Applicant *
Based on CRM figs in Table 3.12 of REP2-035, calculated using 10% breeding season apportionment	Lwr 95% CI density	0.4	0.09
	Central	2.5	0.55
	Upr 95% CI density	6.7	1.46
Based on CRM figs in Table 3.12 of REP2-035, using 21% breeding season apportionment	Lwr 95% CI density	0.8	0.18
	Central	4.4	0.97
	Upr 95% CI density	11.4	2.47
Based on CRM figs in Table 3.12 of REP2-035, using 30% breeding season apportionment	Lwr 95% CI density	1.2	0.26
	Central	6.0	1.30
	Upr 95% CI density	15.2	3.31

* 2,000 pairs (2007-2014), 4,000 adults. 1% baseline mortality = 4.6 birds

Based on the above, considering the apportionment of LBBG collisions to the Alde-Ore Estuary SPA from Norfolk Boreas alone using a precautionary upper apportioning rate in the breeding season of 30% together with the Applicant's rates of 3.3% in autumn and spring and 5% in winter, results in annual total of **6 LBBG collisions (range of 1-15 based on 95% CIs of density data) to the Alde-Ore Estuary SPA**. These figures equate to 1.30% (range 0.26-3.31%) of baseline mortality of the Alde-Ore Estuary SPA LBBG colony using a colony population of approximately 2,000 pairs (2007-2014) as used by the Applicant and an adult mortality rate of 11.5% (Horswill & Robinson 2015). Therefore, the potential impacts on the SPA require further consideration.

If the Applicant's rate of 21% apportionment in the breeding season is used with the non-breeding season rates, the predicted impacts are a total of **4 LBBG collisions (range of 1-11 based on 95% CIs of density data) to the Alde-Ore Estuary SPA**. These figures equate to 0.97% (range 0.18-2.47%) of baseline mortality of the Alde-Ore Estuary SPA LBBG colony. Whilst the central value equates to just less than 1% of baseline mortality, the collision predictions based on the upper 95% confidence interval of the density data does equate to more than 1% of baseline mortality of the Alde-Ore Estuary SPA colony.

We welcome that the Applicant has considered in REP2-035 the predicted collision figures for Norfolk Boreas alone with the outputs from the Alde-Ore SPA LBBG PVA undertaken

during the Norfolk Vanguard examination (MacArthur Green 2019). As noted in our Relevant Representations for Norfolk Boreas [RR-099], we had outstanding concerns with the Vanguard PVA which were not resolved by the close of the Examination, relating to the adjustment of the productivity to take account of the proportion of birds that miss breeding each year; and that we were unable to check the baseline growth rate predicted by the model from the outputs of counterfactuals presented (see our Deadline 8 response to the Norfolk Vanguard examination[13]). This nevertheless represents the best available evidence on which to base an assessment, though this should not be taken as an endorsement or 'acceptance' of the model.

Given that there is no evidence of density dependence operating on the LBBG Alde-Ore Estuary colony or of how it is operating, Natural England has focused our conclusions on the PVA outputs from the density independent model.

Table 25 Predicted population impacts on the LBBG population of the Alde-Ore Estuary SPA for the range of mortality impacts predicted for Norfolk Boreas alone using 10-30% apportionment in the breeding season and agreed rates of 3.3% in autumn and spring and 5% in winter. PVA impact metrics are as provided in MacArthur Green (2019). The range of predicted project alone figures are indicated in pink. The darker shaded cells represent the level of impact closest to the central values of the prediction for the range of apportionment scenarios considered above

LBBG – ALDE-ORE ESTUARY SPA NORFOLK BOREAS ALONE			
Additional mortality	% Baseline Mortality using population size of 4,000 adults (2007-2014), as used by the Applicant	Density Independent Model	
		Counterfactual of Final Population Size (CPS) after 30yrs – see Table 2 of MacArthur Green (2019)	Counterfactual of Growth rate (CGR) after 30yrs – see Table 3 of MacArthur Green (2019)*
5	1.09	0.966 (0.893-1.046)	0.999 (0.996-1.002)
10	2.17	0.930 (0.858-1.006)	0.997 (0.994-1.000)
15	3.26	0.897 (0.828-0.969)	0.996 (0.993-0.999)

* During the Norfolk Vanguard examination, the Applicant has confirmed that the headings for the median and lower CIs are the wrong way around in MacArthur Green (2019). So, we have presented the figures the correct way around above

If the additional mortality from Norfolk Boreas alone is 5-10 adults per annum (closest PVA outputs available in MacArthur Green 2019 to Applicant's apportionment approach of 4 predicted adult mortalities and to the Natural England precautionary apportionment approach of 6 predicted adult mortalities, based on the mean density CRM predictions) then the population of the Alde-Ore Estuary SPA after 30 years will be 3.4-7% lower than it would have been in the absence of the additional mortality using the density independent model outputs. The population growth rate would be reduced by 0.1-0.3% using the density independent model (Table 25).

Taking account of uncertainty/variability in the CRM input parameters (using the upper 95% confidence intervals of the bird density data, as this accounts for the greatest variability in the predictions), if the additional mortality is 10-15 adults per annum (closest PVA outputs

[13] Natural England (2019) Norfolk Vanguard Offshore Wind Farm: Natural England's Responses for Deadline 8 – Natural England's Comments on Norfolk Vanguard Ltd. Deadline 7 and Deadline 7.5 submissions in relation to Offshore Ornithology Related Matters. Available from: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010079/EN010079-003121-DL8%20-%20Natural%20England%20-%20Deadline%20Submission.pdf

available in MacArthur Green 2019 to Applicant's apportionment approach of 11 predicted adult mortalities and to the Natural England precautionary apportionment approach of 15 predicted adult mortalities, based on the upper 95% CI of density CRM predictions) then the population of the Alde-Ore Estuary SPA after 30 years will be 7-10.3% lower than it would have been in the absence of the additional mortality using the density independent model outputs. The population growth rate would be reduced by 0.3-0.4% using the density independent model (Table 25).

These values would be of some concern. However, Natural England does acknowledge that a breeding season apportionment rate of 30% is likely to be overly precautionary, given the proportion of the East Anglian LBBG population that the Alde-Ore Estuary SPA currently holds, and that there are other colonies (town colonies) located closer to Norfolk Boreas than the Alde-Ore. We note also note that even using the precautionary rate of 30% results in a collision prediction that just exceeds 1% of baseline mortality (1.30%). On this basis, **Natural England advises that an adverse effect on integrity (AEOI) of the LBBG feature of the Alde-Ore Estuary SPA can be ruled out for collision impacts from Norfolk Boreas alone.**

6.2 Impacts from Norfolk Boreas in-combination with other plans and projects: operational collision risk

We consider the approach taken by the Applicant for LBBG from the Alde-Ore Estuary SPA in paragraph 81 of REP2-035 for reaching an apportionment rate for in-combination in the non-breeding season of 4% is acceptable.

We also welcome that the Applicant has considered all offshore wind farms within 141km from the Alde-Ore in the breeding season assessment. In submission document APP-201, the Applicant had applied a generic rate of 30% apportionment to the total breeding season collision predictions from all the wind farms within 141km of the Alde-Ore to apportion total in-combination collisions in the breeding season, which we considered to be an overly simplistic approach, as it does not consider the distance of each of these wind farms from the Alde-Ore SPA, the other colonies within foraging range of each of these offshore wind farms, the size of each of the other offshore wind farms etc. This approach would potentially overestimate the contribution of some of the other projects and underestimate the contribution of others and the extent to which this underestimation of values is cancelled out by any overestimated values in the calculated overall total was not known. As a result, the Applicant has now used the SNH apportionment method[14] to calculate breeding season apportionment rates for the relevant offshore wind farms. We welcome that the Applicant has considered this approach and note that the SNH tool uses the term $1/distance^2$ as a weighting factor. This approach means that for a colony of a given size, the further it is away from the development site, the lower its overall weighting factor will be and so too will its estimated contribution to the birds present at the development site, which makes sense. However, the underlying assumption here is that the likelihood of an individual travelling 1km from its colony or 181km (in the case of maximum foraging range of LBBG) is identical, such that the density of birds declines with increasing distance from the colony solely because within each concentric 1km ring around a colony the area within it will increase as a linear function of its distance from the colony. This fails to take account of the fact that seabirds are central place foragers that must forage away from their nest but return to it to feed their chicks. This places strong advantages in terms of reducing both time spent away from the nest and energy expended in foraging if birds can forage as close to their colony as possible. As such, the likelihood of each individual foraging closer to their colony than further away will

[14] https://www.nature.scot/sites/default/files/2018-11/Guidance%20-%20Apportioning%20impacts%20from%20marine%20renewable%20developments%20to%20breeding%20seabird%20populations%20in%20SPAs_0.pdf

not be equal and so the density of birds is likely to decline more rapidly with increasing distance from a colony than the simple geometric relationship based on the square of distance would suggest. However, as the approach now taken by the Applicant does consider the distance of each of the relevant offshore wind farms from the Alde-Ore SPA and the other colonies within foraging range of the wind farms, this is considered more appropriate than the blanket apportionment approach previously taken.

We welcome that the Applicant has considered in REP2-035 the predicted collision figures for Norfolk Boreas alone with the outputs from the Alde-Ore SPA LBBG PVA undertaken during the Norfolk Vanguard examination (MacArthur Green 2019), but note the comments raised with regard to this PVA in the section on impacts from Norfolk Boreas alone above.

The in-combination collision total calculated by the Applicant in REP2-035 using the Applicant's calculated breeding season apportionment rates using the SNH tool of 21% for Norfolk Boreas and 17% for Norfolk Vanguard is 57 LBBGs from the Alde-Ore Estuary SPA per annum. Whilst if the precautionary upper figure of the range advised by Natural England of 30% apportionment for the breeding season is applied for both Norfolk Boreas and Norfolk Vanguard, then the in-combination total is 61 LBBGs from the Alde-Ore Estuary SPA per annum. Natural England notes that no collisions were apportioned to the Alde-Ore from Hornsea 3 or Hornsea 4, which we are content with as both sites are outside of the 141km foraging range of the Alde-Ore and no LBBG collisions are predicted in the non-breeding season for either project. Both sets of in-combination figures equate to more than 1% of baseline mortality of the colony (see Table 26).

Table 26 Percentage of baseline mortality for in-combination collision impacts for LBBG for the Alde-Ore Estuary SPA. Baseline mortality calculated using adult only colony size and adult mortality rate (11.5% from Horswill & Robinson 2015). Note no collisions apportioned to Hornsea 3 or Hornsea 4 in the in-combination assessment

LBBG PREDICTED IN-COMBINATION CRM MORTALITY, HRA: ALDE-ORE ESTUARY SPA		
	Mortality prediction	% of baseline mortality of Alde-Ore SPA* (2,000 pairs 2007-14, as used by Applicant)
Applicant's in-combination CRM, based on figures from Table 3.14 of REP2-035 (i.e. using 21% breeding season apportionment for Norfolk Boreas and 17% for Vanguard)	57	12.41
In-combination CRM, based on using 30% apportionment rate for breeding season for both Norfolk Boreas and Vanguard	61	13.26

* 4,000 adults, 1% baseline mortality = 5 birds

Natural England has again focused our conclusions on the PVA outputs from the density independent model (Table 27).

Table 27 Predicted population impacts on the LBBG population of the Alde-Ore Estuary SPA for the range of mortality impacts predicted for Norfolk Boreas in-combination with other plans and projects. PVA impact metrics are as provided in MacArthur Green (2019). The shaded cells represent the level of impact closest to the in-combination predictions in Table 26.

LBBG – ALDE-ORE ESTUARY SPA			
Additional mortality	% Baseline Mortality using population size of 4,000 adults (2007-2014), as used by the Applicant	Density Independent Model	
		Counterfactual of Final Population Size (CPS) after 30yrs – see Table 2 of MacArthur Green (2019)	Counterfactual of Growth rate (CGR) after 30yrs – see Table 3 of MacArthur Green (2019)*
60	13.04	0.645 (0.592-0.703)	0.985 (0.982-0.988)
65	14.13	0.622 (0.571-0.678)	0.984 (0.981-0.987)

* The Norfolk Vanguard Applicant confirmed that the headings for the median and lower CIs are the wrong way around in MacArthur Green (2019). So, we have presented the figures the correct way around above

The Conservation Objective for the LBBG population of the Alde-Ore Estuary SPA is to restore the size of the breeding population to a level which is above 14,074 whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.

If the additional mortality from the windfarm is 60-65 adults per annum (closest PVA outputs available in MacArthur Green (2019) to predicted 57 mortalities for the in-combination total using Applicant's calculated breeding season apportionment rates for Norfolk Boreas and Vanguard and to the 61 in-combination total using 30% breeding season apportionment for both Norfolk Boreas and Vanguard) then the population of the Alde-Ore Estuary SPA after 30 years will be 35.5-37.8% lower than it would have been in the absence of the additional mortality. The population growth rate would be reduced by 1.5-1.6% (Table 27). If it is assumed that the population is stable then this would mean that the population would be 35.5.5-37.8% lower than the current population size. This would be counter to the restore conservation objective for this feature of the site.

It is not known what the growth rate of the colony will be over the next 30 years and this should be considered when judging the significance of predicted impacts against the conservation objectives for the feature.

As the Alde-Ore LBBG population is at best currently stable and the PVA undertaken for Norfolk Vanguard (MacArthur Green 2019) suggests a baseline growth rate of -2% for the density independent model we have considered these levels of growth rates per annum. We have also considered a range of 1-5% growth rates per annum for if the colony may potentially grow in the future, although at present there seems considerable uncertainty regarding whether this can be achieved.

If we assume a -2% per annum growth rate, a stable population or a 1% per annum growth rate then 60 or 65 additional mortalities per annum would result in the population declining below its current level and let alone be able to reach the target population of the conservation objective.

If we assume a 2% per annum growth rate then 60-65 additional mortalities per annum would result in the population being approximately 2,500-3,000 birds lower than without the additional mortality after 30 years and it would take over an additional 180-250 years to reach the target population compared to the no windfarm mortality scenario.

If the LBBG population were to grow at a rate of 3% per annum over the next 30 years, then additional mortality of 60-65 per annum would result in the population being approximately 3,500-4,000 birds lower than without the additional mortality after 30 years and it would take over an additional 40-50 years to reach the target population compared to the no windfarm mortality scenario.

There is no evidence to suggest that the future population trend will be significantly different from the current trend, which is most likely to be stable, in which case there is a risk that the population could decline due to predicted mortality levels. Furthermore, given that the population is likely to be hindered from restoration to target levels even when more optimistic assumptions about the population trend of the colony are made, Natural England also considers that it is not possible to rule out AEOI even if the population starts to show modest growth.

Therefore, as this feature has a restore conservation objective, and because there are indications that the population might even decline from current levels, Natural England advises that it is not possible to rule out an adverse effect on integrity (AEOI) of the LBBG feature of the Alde-Ore Estuary SPA for from in-combination collision impacts with other plans and projects.

GREATER WASH SPA: LITTLE GULL

The little gull is a non-breeding feature of the Greater Wash SPA. It is clear that the population of little gulls in the Area of Search in winter is likely to be at least twice as large as the figures presented in the Departmental Brief due to many records of small gulls not being identified to species level (Natural England and JNCC 2016) and probably exceeds 4,000 individuals. Further, the population during peak migration is likely to be at least 5 times as many (based on sea watching data) which does to some extent take into account turnover and it is likely that tens of thousands of birds actually pass through the pSPA annually. We have little information about the passage period other than sea watching records.

Natural England therefore considers that it is not feasible to make judgements relating to off-site SPA little gulls by apportioning/attributing SPA status to these birds as we have no contextual information regarding either the wider population or areas outside the site that may be utilised by SPA birds. Little gull as an SPA feature is, in effect, distributed across the entire Area of Search so the assumption should be that any birds recorded through EIA survey work could be SPA birds.

Stienen *et al.* (2007) estimated a flyway population of 75,000 individuals, which was derived from Seys (2001) and this figure has already been referenced in previous casework (and is referenced by the Applicant in REP2-035). Based on the mortality rate of 20% as used by the Applicant (calculated from the adult survival rate in Horswill & Robinson 2015 of 0.8, although it should be notes that this figures is based on published estimates of adult survival based on similar species), 1% baseline mortality for 75,000 southern North Sea flyway population is 150 individuals.

7.1 Impacts from Norfolk Boreas alone: operational collision risk

We welcome that the Applicant has considered in REP2-035 the uncertainty/variability in the input data through considering in the assessment the range of collision predictions based on using the 95% confidence intervals around the bird density data.

The predicted annual EIA collision impacts for little gull for Boreas alone are **4 (1-14)** collisions per annum (from REP2-035). This equates to 0.03% (range 0.01-0.09%) of baseline mortality of the 75,000 southern North Sea flyway population (using a mortality rate

of 20%). On the basis of the above information on little gull and these figures, **Natural England advises that an adverse effect on integrity (AEOI) of the little gull feature of the Greater Wash SPA can be ruled out for collision impacts from Norfolk Boreas alone.**

7.2 Impacts from Norfolk Boreas in-combination with other plans and projects: operational collision risk

We welcome that the figures included in the in-combination assessment were reviewed by the Applicant in Table 3.19 of REP2-035. We agree that the CRM figures presented for the various sites in Table 3.19 of REP2-035 have been updated for an avoidance rate of 99.2%. We do not consider it is appropriate to adjust the figures for the other offshore wind farms based on build out capacities unless the reduction is legally secured and CRM re-run.

The Applicant has included Triton Knoll, Race Bank, Sheringham Shoal, Hornsea 1, Hornsea 2, Hornsea 3, Norfolk Vanguard and Norfolk Boreas in Table 3.19 of REP2-035 as offshore wind farms considered to have connectivity with the Greater Wash SPA. No figures have been included by the Applicant for the East Anglia One North and East Anglia Two projects in Table 3.19 of REP2-035. We note that predicted collision figures are available for this species from the submission documents for these projects and the predicted figures are 1.1 collisions from East Anglia One North and 1.7 from East Anglia Two. Therefore, the cumulative collision totals for little gull become 66 birds excluding Hornsea 3 and Hornsea 4 and 67 including all projects (based on the consented project layout scenarios). However, we do welcome that the Applicant has noted that that not all wind farms with potential connectivity to this population have presented collision estimates for little gull (e.g. Dudgeon, and other sites within the former East Anglia Zone: East Anglia One and East Anglia Three).

The predicted cumulative collision impacts for little gull of 66 (excl. Hornsea 3 and Hornsea 4) to 67 (incl. Hornsea 3 and Hornsea 4) collisions per annum equates to 0.37-0.38% of baseline mortality of the 75,000 southern North Sea flyway population (using a mortality rate of 20%). On the basis of the information regarding little gull above and these figures, **Natural England advises that an adverse effect on integrity (AEOI) of the little gull feature of the Greater Wash SPA can be ruled out for in-combination collision impacts.** The in-combination assessment includes all appropriate and publicly available collision estimates for other wind farms. However, as there is no publically available information regarding some potentially relevant projects, our confidence in this conclusion is somewhat reduced.

GREATER WASH SPA: RED-THROATED DIVER (RTD)

8.1 Offshore export cable construction: displacement

As set out in our responses to Examining Authority Questions 8.9.1 and 8.93 [see REP2-080], the predicted level of additional mortality to RTDs from the Greater Wash SPA from offshore export cable construction from Norfolk Boreas alone may not have resulted in no adverse effect on site integrity to this feature of the SPA. However, the Applicant has committed to the mitigation regarding *'cable installation for Work No. 4A and Work No. 4B must only take place with one main cable laying vessel'*, which is included in the Outline Project Environmental Management Plan [APP-705] and the final version of which is secured through Condition 14 (1) (d) (vi) of Schedules 9 and 10 of the updated draft DCO version 2 [AS019]. Therefore, based on this commitment from the Applicant, **we agree that an adverse effect on integrity (AEOI) from displacement due to construction activities from Norfolk Boreas alone and in-combination can be ruled out for the RTD feature of the Greater Wash SPA.**

8.2 Operation and maintenance vessel movements: displacement

As set out in our responses to Examining Authority Questions 8.9.2 [see REP2-080], the same mitigation agreed for the operation and maintenance phase of Norfolk Vanguard has been adopted for Norfolk Boreas. This mitigation is included in the Outline Project Environmental Management Plan [APP-705] and the final version of which is secured through Condition 14 (1) (d) (vi) of Schedules 9 and 10 of the updated draft DCO version 2 [AS019]. Therefore, based on the adoption of best practice vessel operations to minimise disturbance to RTD, **we agree that an adverse effect on integrity (AEOI) from operation and maintenance vessel movements can be ruled out for RTD feature of the Greater Wash SPA.**

GREATER WASH SPA: COMMON SCOTER

9.1 Impacts from Norfolk Boreas alone: construction displacement

We agree with the Applicant's calculations in paragraph 300 of REP2-035 that for a maximum density of 0.7 birds/km^2 in the offshore export cable corridor area passing through the SPA, that for a worst case scenario of a maximum of two cable laying vessels up to 18 common scoter may be at risk of displacement. Based on this for 100% displacement and 10% mortality a maximum of 2 additional mortalities are predicted, which equates to 0.27% of baseline mortality of the SPA designated population.

Based on the above, **Natural England advises that an adverse effect on integrity (AEOI) of the common scoter feature of the Greater Wash SPA can be ruled out for offshore export cable construction from Norfolk Boreas alone.**

9.2 Impacts from Norfolk Boreas in-combination with other plans and projects: construction displacement

We agree with the Applicant's assessment of offshore cable laying at Norfolk Boreas in-combination with cable laying at Norfolk Vanguard and Hornsea 3. As no displacement of common scoter was predicted for Hornsea 3 and the level of displacement predicted for Norfolk Vanguard would be identical to that predicted for Norfolk Boreas (as the offshore cable routes through the SPA are identical for the two projects), the in-combination total additional mortalities for the worst case scenario would be a maximum of 4 for 100% displacement and 10% mortality, which equates to 0.54% of baseline mortality of the SPA designated population.

Based on the above, **Natural England advises that an adverse effect on integrity (AEOI) of the common scoter feature of the Greater Wash SPA can be ruled out for offshore export cable construction in-combination with other plans and projects.** In addition, we note that the mitigation for red-throated diver regarding *'cable installation for Work No. 4A and Work No. 4B must only take place with one main cable laying vessel'*, which is included in the Outline Project Environmental Management Plan [APP-705] and the final version of which is secured through Condition 14 (1) (d) (vi) of Schedules 9 and 10 of the updated draft DCO version 2 [AS019] would also be of benefit to the common scoter feature and would certainly mean no AEOI for the common scoter feature of the Greater Wash SPA.

OUTER THAMES ESTUARY SPA: RED-THROATED DIVER (RTD)

10.1 Operation and maintenance vessel movements: displacement

As set out in our responses to Examining Authority Questions 8.9.2 [see REP2-080], the same mitigation agreed for the operation and maintenance phase of Norfolk Vanguard has been adopted for Norfolk Boreas. This mitigation is included in the Outline Project

Environmental Management Plan [APP-705] and the final version of which is secured through Condition 14 (1) (d) (vi) of Schedules 9 and 10 of the updated draft DCO version 2 [AS019]. Therefore, based on the adoption of best practice vessel operations to minimise disturbance to RTD, **we agree that an adverse effect on integrity (AEOI) from operation and maintenance vessel movements can be ruled out for RTD feature of the Outer Thames Estuary SPA.**