

Norfolk Vanguard Offshore Wind Farm Offshore Ornithology Auk Displacement Assessment Update for Deadline 8

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Executive Summary

This note provides updated assessments of the potential displacement impacts on puffin, razorbill and guillemot that may arise from the proposed Norfolk Vanguard Offshore Wind Farm (the project) both alone and in-combination with other plans and projects with respect to the Flamborough and Filey Coast (FFC) Special Protection Area (SPA) as part of the Habitats Regulations Assessment (HRA). This note updates the equivalent sections as presented at Deadline 6 (ExA; AS; 10.D6.17), following advice provided by Natural England in their Deadline 7 submission.

The apportioning rates recommended by Natural England for estimating the proportion of birds from the FFC SPA presented on other wind farm projects during the breeding season have been used in this update, and this leads to the inclusion of wind farms located beyond the species' mean maximum foraging ranges and is therefore considered to add a layer of additional precaution. Consequently, the estimated in-combination total number of auks potentially affected has increased compared with those submitted at Deadline 6 (ExA; AS; 10.D6.17). However, it should also be noted that the Applicant and Natural England are in agreement that there is no breeding season connectivity between the FFC SPA and Norfolk Vanguard and therefore the contributions to the in-combination totals from Norfolk Vanguard have decreased for each species:

- For puffin it is estimated that 0.02% of the in-combination total is attributable to Norfolk Vanguard (compared with 0.08% presented at Deadline 6, ExA; AS; 10.D6.17);
- For razorbill it is estimated that 1.4% of the in-combination total is attributable to Norfolk Vanguard (compared with 3.3% presented at Deadline 6, ExA; AS; 10.D6.17); and,
- For guillemot it is estimated that 0.9% of the in-combination total is attributable to Norfolk Vanguard (compared with 3.1% presented at Deadline 6, ExA; AS; 10.D6.17).

Following these updates, the conclusions of the assessment remain the same as those presented in the original HRA and in the Deadline 6 submission: for all three auk species the operational displacement assessment concludes there will be no adverse effect on integrity (AEOI) of the Flamborough and Filey Coast SPA due to either the project alone or in-combination with other projects.

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Glossary

BDMPS	Biologically Defined Minimum Population Scale
EIA	Environmental Impact Assessment
ES	Environmental Statement
FFC	Flamborough and Filey Coast
HRA	Habitats Regulations Assessment
NE	Natural England
NV	Norfolk Vanguard
SPA	Special Protection Area

1. INTRODUCTION

1. This report provides an update of the project alone and in-combination assessment of potential displacement impacts on guillemot, razorbill and puffin from the Flamborough and Filey Coast Special Protection Area (SPA) submitted at Deadline 6 (ExA; AS; 10.D6.17). This has been produced to address comments and concerns raised by Natural England in their Deadline 7 submission¹.
2. An updated displacement assessment for auks was provided in Appendix 3.3 at Deadline 1 (Appendix 3.3, document reference ExA; WQApp3.3; 10.D1.3) and this was further updated at Deadline 6 (ExA; AS; 10.D6.17) to address Natural England's comments. Based on the assessments to date, Natural England has previously agreed that the Project alone displacement impacts (from an Environmental Impact Assessment (EIA) point of view) for all three species were not significant, although Natural England requested that errors in the assignment of seasons for razorbill should be addressed, Natural England 2019; and these are included in this update. These errors and other comments made by Natural England¹ which are addressed in this note are provided in Table 1.
3. It should be noted that only those sections of the assessment for which an update was requested by Natural England have been provided in this document (i.e. Habitats Regulations Assessment (HRA) project alone and HRA in-combination). For those sections not included here (i.e. EIA project alone and cumulatively), the assessments submitted at Deadline 6 (ExA; AS; 10.D6.17) remain valid.

Table 1. Natural England (2019) comments on the auk assessment at Deadline 7 and the Applicant's response.

Comment	Section where addressed
<p>As has been advised previously, we recommend that for apportionment of impacts in the non-breeding season to relevant colonies is that the data presented in the tables in Appendix A of Furness (2015) for the relevant species BDMPS for each season (e.g. migration, winter etc.) are used. Whether the colony figure in the BDMPS tables used is the adult figure or that for all ages depends on any Population Viability Analysis (PVA) model and outputs to be used. It does not appear that this approach has been taken by the Applicant in the assessments in REP6-021. Therefore, we advise that the assessment are updated using the following non-breeding season apportionment rates:</p> <ul style="list-style-type: none"> • Puffin: 0.41% for non-breeding season (1.5% used by the Applicant) • Razorbill: <ul style="list-style-type: none"> ○ 3.4% for autumn/post-breeding season ○ 2.7% for winter/non-breeding season ○ 3.4% for spring/pre-breeding season • Guillemot: 4.4% for non-breeding season (5.14% used by Applicant) 	<p>The rates advised by Natural England have been applied in the updated assessment provided in this note.</p>

¹ Norfolk Vanguard Offshore Wind Farm Planning Inspectorate Reference: EN010079 Natural England's Comments by species on Vanguard Deadline 6 (REP6-021) and Deadline 6.5 (AS-043) information 02 May 2019
Norfolk Vanguard Offshore Wind Farm

Comment	Section where addressed
<p>As with the HRA CRM assessments for Vanguard alone:</p> <p>a. Baseline mortality rates for HRA assessments have been based on using an all age colony count and all age survival/mortality rate to calculate baseline mortality. We again advise again that assessments should be done using baseline mortality calculations using the adult colony figures and adult mortality rates.</p> <p>b. Displacement predictions in the HRA assessments have been adjusted to adult only currency by using the proportion of adults based on the age structure model in BDMPs report (Furness 2015) that was created in order to assess the numbers of immature birds that are associated with breeding populations. We are uncertain as to the appropriateness of assuming that the proportion of adults from this model will be representative of the proportion of adults recorded in the Vanguard areas. We recommend that this would be better undertaken based on the proportion of adults recorded in the baseline survey data for each season from Vanguard.</p> <p>c. The HRA assessments of CRM impacts from Vanguard alone only consider the predictions for the central input parameters (i.e. using mean densities, recommended avoidance rates, maximum likelihood flight height distribution data and the currently recommended nocturnal activity factors). No consideration has been given to the uncertainty/variability in the input parameters. Consideration should also be given in the assessment to the range of CRM predictions from using the upper and lower 95% CIs of bird density (as these account for the greatest variation).</p>	<p>The assessment has been updated to ensure that all calculations are on a common currency (in this case adults) using the population sizes in Furness (2015) and the apportioning rates advised by Natural England (above). As a consequence, there is no further adult adjustment required.</p> <p>Presentation of precautionary predictions using the 95% confidence intervals (of density) for Norfolk Vanguard has also been provided.</p>
<p>Puffin, FFC SPA</p> <p>a. The Applicant's non-breeding season apportionment rate of 1.5% for puffin can be considered to be precautionary (higher than Natural England advised rate of 0.41%) and we agree with 0% apportionment in the breeding season for Vanguard. Therefore, the Applicant's calculated additional FFC SPA puffin mortalities at the worst case of 70% displacement and 10% mortality of 0.12 birds (see Section 2.6.1.3 of REP6-021) equates to 0.06% of baseline mortality of the colony, based on using an adult colony size of 1,960 adults (at designation) and an adult mortality rate of 9.4% (from Horswill & Robinson 2015). Based on this figure, no AEOI for the puffin feature of the seabird assemblage feature FFC SPA from Vanguard alone could be concluded. However, the Applicant still needs to consider the predicted figures based on the upper and lower 95% CIs of the bird abundance/density data in order to consider the uncertainty/variability. Therefore, Natural England reserves the right to revise the integrity judgement provided here based on the best available evidence presented.</p>	<p>The Applicant welcomes Natural England's agreement with this assessment and has provided the additional estimates as requested.</p>
<p>Razorbill, FFC SPA</p> <p>a. Before any conclusions can be reached regarding the potential impact of operational displacement from Vanguard alone to the FFC SPA razorbill qualifying feature, we advise that the Applicant considers the issues Natural England has noted in 1.4 above regarding the mix up of the seasonal figures presented for Vanguard alone, as we assume that the seasonal apportionment rates used by the Applicant have been potentially applied to the incorrect seasonal abundances.</p>	<p>The razorbill table and estimates have been checked and the assessment has been revised accordingly. This has also incorporated the other updates as noted above.</p>
<p>Guillemot, FFC SPA</p> <p>a. From Table 27 of REP6-021, it would appear that the Applicant has used an apportionment rate of 5.14% for guillemot in the non-breeding season and that this has been applied to the abundances of guillemot in the non-breeding season at all of the OWFs included in the in-combination assessment. The Applicant's non-breeding season apportionment rate of</p>	<p>The Applicant welcomes Natural England's agreement with this assessment and has provided the additional estimates as requested.</p>

Comment	Section where addressed
5.14% for guillemot can be considered to be precautionary (higher than Natural England advised rate of 4.4%) and we agree with 0% apportionment in the breeding season for Vanguard. Therefore, the Applicant's calculated additional FFC SPA guillemot mortalities at the worst case of 70% displacement and 10% mortality of 17 birds (see Section 2.8.1.3 of REP6-021) equates to 0.34% of baseline mortality of the colony, based on using an adult colony size of 83,214 adults (at designation) and an adult mortality rate of 6.1% (from Horswill & Robinson 2015). Based on this figure no AEOI for the guillemot feature of the FFC SPA from Vanguard alone could be concluded. However, the Applicant still needs to consider the predicted figures based on the upper and lower 95% CIs of the bird abundance/density data in order to consider the uncertainty /variability. Therefore, Natural England reserves the right to revise the integrity judgement provided here based on the best available evidence presented.	
In-combination breeding season apportioning rates for other projects.	The rates for other wind farms have been updated using those advised by Natural England.
Assessments should again be undertaken against baseline mortality for the colony calculated using adult colony sizes and adult mortality rates, and the it should be assumed that the in-combination totals are for adult birds (which we acknowledge will be precautionary).	The assessment has been updated following this advice.

1.1 Puffin

- Table 2 presents the abundance of puffins in all wind farms included in the cumulative assessment, including Norfolk Vanguard. The peak abundance on Norfolk Vanguard during the nonbreeding season was a mean maximum of 112 individuals. The total populations at risk on North Sea wind farms and also apportioned to the Flamborough and Filey Coast SPA using rates advised by Natural England (Deadline 7) are presented in Table 2. In the breeding season: 100% for projects within mean maximum foraging range (Humber Gateway, Teesside, Westernmost Rough and Triton Knoll), 38% for Hornsea Projects One and Two and 50% for Hornsea Project Three; 30% for Dogger Bank Creyke Beck and Dogger Bank Teesside. In the nonbreeding season a rate of 0.41% has been applied to all projects.

Table 2. Cumulative and in-combination puffin numbers on wind farms in the North Sea.

Project	Total		Natural England advised apportioning rate (%)		Apportioned to the FFC SPA	
	Breeding season	Non-breeding season	Breeding season	Non-breeding season	Breeding season	Non-breeding season
Aberdeen	42.0	81.7	0	0.041	0	0.3
Beatrice	2858.0	2434.8	0		0	10.0
Blyth Demonstration	235.0	122.8	0		0	0.5
Dogger Bank Creyke Beck A	37.0	295.2	30		11.1	1.2

Project	Total		Natural England advised apportioning rate (%)		Apportioned to the FFC SPA	
	Breeding season	Non-breeding season	Breeding season	Non-breeding season	Breeding season	Non-breeding season
Dogger Bank Creyke Beck B	102.0	742.9	30		30.6	3.0
Dogger Bank Teesside A	34.0	273.0	30		10.2	1.1
Dogger Bank Teesside B	35.0	328.7	30		10.5	1.3
Dudgeon	1.0	3.2	0		0	0.0
East Anglia ONE	16.0	32.0	0		0	0.1
East Anglia THREE	181.0	307.0	0		0	1.3
Galloper	0.0	0.8	0		0	0.0
Greater Gabbard	0.0	0.9	0		0	0.0
Hornsea Project One	1070.0	1257.0	38		406.6	5.2
Hornsea Project Two	468.0	2039.0	38		177.8	8.4
Hornsea Project Three	253.0	127.0	50		126.5	0.5
Humber Gateway	15.0	9.6	100		15.0	0.0
Hywind	119.0	85.0	0		0	0.3
Inch Cape	2956.0	2688.0	0		0	11.0
Kincardine	19.0	0	0		0	0.0
Lincs and LID6	3.0	6.0	0		0	0.0
London Array I & II	0.0	0.6	0		0	0.0
Moray East	2795.0	656.4	0		0	2.7
Moray West	1115	3966	0		0	16.3
Neart na Gaoithe	2562.0	2103.4	0		0	8.6
Race Bank	1.0	9.6	0		0	0.0
Seagreen A	2572.0	1526.0	0		0	6.3
Seagreen B	3582.0	3863.0	0		0	15.8
Sheringham Shoal	4.0	25.8	0		0	0.1
Teesside	35.0	18.0	100		35	0.1
Thanet	0.0	0.1	0		0	0.0
Thanet Extension	0.0	0.0	0		0	0.0
Triton Knoll	23.0	70.7	100		23.0	0.3
Westermest Rough	61.0	35.0	100		61.0	0.1
Seasonal Total (Ex. NV)	21194	23109	-	-	907.3	94.7
Annual Total (Ex. NV)		44482				1002.1
Norfolk Vanguard East	67	112	0	0.041	0	0.3
Norfolk Vanguard West	0	0	0		0	0
Seasonal Total (Inc. NV)	21261	23221	-	-	907.3	95.0
Annual Total (Inc. Hornsea Project Three)		44482	-	-		1002.4
Annual Total (ex. Hornsea Project Three)		44102	-	-		875.4

2. Natural England does not consider a single combination of displacement and mortality in their assessment of impact, instead advising presentation of a range from 30% to 70% displaced and 1% to 10% mortality. However, evidence in support of the use of a precautionary displacement rate of 50% within the wind farm, 30% within the 1 km buffer and 0% thereafter, combined with a 1% mortality rate for guillemot and razorbill (ExA; WQAppx 3.3;10.D1.3) is also considered appropriate for puffin (although it should be noted this assessment has not applied the variable rate but rather 50% across the wind farm and 2 km buffer, adding precaution to this approach). Table 3 provides estimates of the displacement mortality at Norfolk Vanguard and all UK North Sea wind farms included in the cumulative assessment and also apportioned to the Flamborough and Filey Coast SPA.

Table 3. Puffin abundance estimates on Norfolk Vanguard and summed across all UK North Sea and Channel wind farms, and number apportioned to Flamborough and Filey Coast SPA and estimates of displacement mortality.

Site	Season	Total population at risk of displacement	Total impact, displacement & mortality rates:			Population apportioned to FFC SPA	FFC SPA impact, displacement & mortality rates:		
			30% - 1%	50% - 1%	70%- 10%		30% - 1%	50% - 1%	70%- 10%
Norfolk Vanguard East	Breeding	67	0.2	0.3	4.7	0	0	0	0
	Nonbreeding	112	0.3	0.6	7.8	0.3	<0.01	<0.01	0.02
	Annual	179	0.5	0.9	12.5	0.3	<0.01	<0.01	0.02
Norfolk Vanguard West	Breeding	0	0	0	0	0	0	0	0
	Nonbreeding	-	0	0	0	0	0	0	0
	Annual	0	0	0	0	0	0	0	0
All North Sea wind farms East & West	Breeding	21261	64	106	1488	907.3	2.7	4.5	63.5
	Nonbreeding	23221	70	116	1625	95.0	0.3	0.5	6.7
	Annual	44482	133	222	3114	1002.4	3.0	5.0	70.2

1.1.1. HRA Project alone

3. Of the puffins recorded on the Norfolk Vanguard site (only in Norfolk Vanguard East), 0.3 were apportioned to the Flamborough and Filey Coast SPA population (0-1.7 using the 95% confidence intervals on density), and applying the most precautionary displacement rates this was estimated to result in 0.02 additional mortalities (a maximum of 0.12 using the upper 95% confidence interval). This would increase the background mortality rate of the population by less than 0.01%, which is much lower (100x) than the threshold for detectable effects, defined as a 1% increase. Even if the highly precautionary upper 95% density estimate is used the increase would only be 0.02%, still 50x lower than 1%). Therefore, there is no risk of an adverse effect on the integrity of the SPA due to this extremely small effect at Norfolk Vanguard.

1.1.2. HRA in-combination

4. The number of puffins apportioned to the Flamborough and Filey Coast SPA population at risk of displacement on North Sea wind farms was estimated to be 907 in the breeding season (of which over 64% were recorded on the Hornsea Projects 1 and 2 wind farms and none on Norfolk Vanguard) and 95 in the nonbreeding season (of which 0.3 were recorded on Norfolk Vanguard). Overall, of the 1,002 puffins (including Hornsea Project Three) at risk of displacement annually, 0.03% were birds on Norfolk Vanguard. Without Hornsea Project Three this total is reduced to 875.
5. Therefore, irrespective of the potential for an in-combination effect on the SPA population, it is evident that Norfolk Vanguard's contribution to this will make no difference. Given this extremely small contribution, it is therefore arguable that there is no requirement for the Applicant to undertake an in-combination assessment.
6. It is important to note that puffins are extremely difficult to census because they nest in burrows, the back of holes in cliffs and under boulders. The number of puffins visible at colonies fluctuates from hour to hour and day to day (Furness 2015). As a consequence, it is highly probable that the Flamborough and Filey Coast SPA population is significantly underestimated, since this site is largely inaccessible and extremely challenging to census. It is therefore very likely that the magnitude of effect calculated above is also over-estimated.
7. It should also be noted that the HRA for Hornsea Project Two concluded: *"The Secretary of State recognises the methodological disagreements between the parties. He has considered the representations made by the Applicant, NE and the RSPB and the recommendation as made by the ExA. The Secretary of State agrees with the recommendations of the ExA, NE and the Applicant and is satisfied that the potential increased auk species displacement mortality as a result of the Project in-combination would not represent an adverse effect upon the integrity of the FFC pSPA. For this conclusion he places particular weight on the advice of NE that predicted mortalities for the Project in-combination would not exceed a level whereby the growth rate of the populations would be reduced by more than 0.4% p.a. for guillemot, 0.5% p.a. for razorbill, and 0.25% p.a. for puffin."*
8. On the basis of the precautionary assumptions, the Secretary of State's conclusion in relation to Hornsea Project Two, and consideration of the additional puffins at risk of displacement annually since Hornsea Project Two was consented, it can be concluded that Norfolk Vanguard adds 0.3% to the total mortality. Therefore, there is no risk of an adverse effect on the integrity of the FFC SPA from impacts on puffin due to the proposed Norfolk Vanguard project in-combination with other plans and projects.

1.2 Razorbill

9. Table 4 presents the abundance of razorbills in all wind farms included in the cumulative assessment, including Norfolk Vanguard. The annual total of razorbills at risk of displacement on the Norfolk Vanguard site (combined across the breeding season and all the nonbreeding seasons and both Norfolk Vanguard East and West) was a mean maximum of 3,508 individuals (Table 4).
10. The totals at risk on other North Sea wind farms and apportioned to the Flamborough and Filey Coast SPA are also presented in Table 4. These have been calculated using the rates advised by Natural England¹. In the breeding season: 100% for projects within mean maximum foraging range (Westermest Rough), 48.2% for Hornsea One and Two; 30% for Dogger Bank Creyke Beck and Dogger Bank Teesside. In the autumn 3.4%, midwinter 2.7% and spring 3.4%.

Table 4. Cumulative and in-combination razorbill numbers on wind farms in the North Sea.

Project	Total				Apportioned to the FFC SPA			
	Breeding	Autumn	Winter	Spring	Breeding	Autumn	Winter	Spring
Aberdeen	161.0	64.4	7.3	25.7	0.0	2.2	0.2	0.9
Beatrice	873.0	833.0	555.3	833.0	0.0	28.3	15.0	28.3
Blyth Demonstration	121.0	90.9	60.6	90.9	0.0	3.1	1.6	3.1
Dogger Bank Creyke Beck A	1250.0	1576.0	1728.0	4149.0	375.0	53.6	46.7	141.1
Dogger Bank Creyke Beck B	1538.0	2097.0	2143.0	5118.7	461.4	71.3	57.9	174.0
Dogger Bank Teesside A	834.0	310.3	958.5	1919.0	250.2	10.6	25.9	65.2
Dogger Bank Teesside B	1153.0	592.3	1426.0	2953.3	345.9	20.1	38.5	100.4
Dudgeon	256.0	346.1	745.4	346.1	0.0	11.8	20.1	11.8
East Anglia ONE	16.0	26.0	154.5	336.0	0.0	0.9	4.2	11.4
East Anglia THREE	1807.0	1122.0	1499.0	1524.0	0.0	38.1	40.5	51.8
Galloper	44.0	43.0	105.5	394.0	0.0	1.5	2.8	13.4
Greater Gabbard	0.0	0.0	387.3	83.8	0.0	0.0	10.5	2.8
Hornsea Project One	1109.0	4812.3	1517.5	1802.8	534.5	163.6	41.0	61.3
Hornsea Project Two	2511.0	4220.5	719.5	1668.0	1210.3	143.5	19.4	56.7
Hornsea Project Three	630.0	2020.0	3649.0	1236.0	0.0	68.7	98.5	42.0
Humber Gateway	27.0	20.0	13.4	20.0	0.0	0.7	0.4	0.7
Hywind	30.0	719.0	10.0		0.0	24.4	0.3	0.0
Inch Cape	1436.0	2870.0	651.0		0.0	97.6	17.6	0.0
Kincardine	22.0				0.0	0.0	0.0	0.0
Lincs and LID6	45.0	33.5	22.3	33.5	0.0	1.1	0.6	1.1
London Array I & II	14.0	20.4	13.6	20.4	0.0	0.7	0.4	0.7
Moray East	2423.0	1102.6	30.2	168.3	0.0	37.5	0.8	5.7
Moray West	2808	3544	184	3585	0.0	120.5	5.0	121.9
Neart na Gaoithe	331.0	5492.4	507.8		0.0	186.7	13.7	0.0

Project	Total				Apportioned to the FFC SPA			
	Breeding	Autumn	Winter	Spring	Breeding	Autumn	Winter	Spring
Race Bank	28.0	42.0	28.0	42.0	0.0	1.4	0.8	1.4
Seagreen A	5876.0		1003.0		0.0	0.0	27.1	0.0
Seagreen B	3698.0		1272.0		0.0	0.0	34.3	0.0
Sheringham Shoal	106.0	1343.0	211.3	30.2	0.0	45.7	5.7	1.0
Teesside	16.0	61.5	1.9	20.0	0.0	2.1	0.1	0.7
Thanet	3.0	0.0	13.6	20.9	0.0	0.0	0.4	0.7
Thanet Extension		6.0	56.0	124.0	0.0	0.2	1.5	4.2
Triton Knoll	40.0	253.7	854.5	116.7	0.0	8.6	23.1	4.0
Westermest Rough	91.0	121.3	151.6	90.9	91.0	4.1	4.1	3.1
Seasonal Total (Ex. NV)	29297	33783	20681	26752	3268.3	1148.6	558.7	909.4
Annual Total (Ex. NV)	110513				5885			
Norfolk Vanguard East	599	491	491	752	0.0	16.7	13.3	25.6
Norfolk Vanguard West	280	375	348	172	0.0	12.8	9.4	5.8
Seasonal Total (Inc. NV)	30176	34649.2	21519.6	27676.1	3268.3	1178.0	581.4	940.8
Annual Total (Inc. Hornsea Project Three)	114021				5958.5			
Annual Total (ex. Hornsea Project Three)	106486				5759.3			

11. Natural England advises presentation of a range of displacement rates of between 30% and 70% displacement and 1% and 10% mortality. However, evidence was presented in support of the use of a precautionary displacement rate of 50% within the wind farm, 30% within the 1 km buffer and 0% thereafter, combined with a 1% mortality rate for guillemot and razorbill (ExA; WQAppx 3.3;10.D1.3; although note that the variable buffer has not been applied in this assessment, with the 50% rate applied across both the wind farm and 2km buffer , adding precaution to this approach). Predictions using these alternative rates are presented in Table 5.

Table 5. Razorbill abundance estimates on Norfolk Vanguard and summed across all UK North Sea and Channel wind farms, number apportioned to Flamborough and Filey Coast SPA and estimates of displacement mortality.

Site	Season	Total population at risk of displacement	Total impact, displacement & mortality rates:			Population apportioned to FFC SPA	FFC SPA impact, displacement & mortality rates:		
			30% - 1%	50% - 1%	70%- 10%		30% - 1%	50% - 1%	70%- 10%
Norfolk Vanguard East	Breeding	599	1.8	3.0	41.9	0	0.0	0.0	0.0
	Autumn	491	1.5	2.5	34.4	16.7	0.1	0.1	1.2
	Midwinter	491	1.5	2.5	34.4	13.3	0.0	0.1	0.9
	Spring	752	2.3	3.8	52.6	25.6	0.1	0.1	1.8
	Annual	2333	7.1	11.8	163.3	55.5	0.2	0.3	3.9
Norfolk Vanguard West	Breeding	280	0.8	1.4	19.6	0	0.0	0.0	0.0
	Autumn	375	1.1	1.9	26.3	12.8	0.0	0.1	0.9
	Midwinter	348	1.0	1.7	24.4	9.4	0.0	0.0	0.7
	Spring	172	0.5	0.9	12.0	5.8	0.0	0.0	0.4
	Annual	1175	3.4	5.9	82.3	28.0	0.1	0.1	2.0
Norfolk Vanguard East and West Combined	Breeding	879	2.6	4.4	61.5	0	0.0	0.0	0.0
	Autumn	866	2.6	4.3	60.6	29.4	0.1	0.1	2.1
	Midwinter	839	2.5	4.2	58.7	22.7	0.1	0.1	1.6
	Spring	924	2.8	4.6	64.7	31.4	0.1	0.2	2.2
	Annual	3508	10.5	17.5	245.5	83.5	0.3	0.4	5.8
UK North Sea and Channel wind farms	Breeding	30176	90.5	150.9	2112.3	3268.3	9.8	16.3	228.8
	Autumn	34649	103.9	173.2	2425.4	1178.0	3.5	5.9	82.5
	Midwinter	21520	64.6	107.6	1506.4	581.4	1.7	2.9	40.7
	Spring	27676	83.0	138.4	1937.3	940.8	2.8	4.7	65.9
	Annual	114021	342.1	570.1	7981.5	5968.5	17.9	29.8	417.8

1.1.3. HRA Project alone

12. Natural England considered that a LSE on the razorbill population of the Flamborough and Filey Coast SPA due to displacement from the Norfolk Vanguard wind farm could not be ruled out. Apportioning the Norfolk Vanguard displacement mortality to the SPA on the basis of no connectivity in the breeding season (as the wind farm is located more than four times the mean maximum foraging range for this species) and an even distribution in the nonbreeding season (on the assumption that the SPA population is evenly distributed within the nonbreeding BDMPS population) concludes that the worst case mortality due to Norfolk Vanguard was 5.8 adults (using the 95% confidence intervals on density the range of mortalities is 2.4 to 9.9). This would increase the baseline mortality (of 2,220, calculated using adult mortality of 0.105, Horswill and Robinson 2015) by 0.2% (using the 95% confidence intervals the range is 0.1% to 0.4%), which is below the 1% threshold of detectability. Therefore, displacement of razorbill from Norfolk Vanguard would not have an adverse effect on the integrity of the SPA.

1.1.4. HRA In-combination

13. Given the extremely small mortality due to Norfolk Vanguard it is clear that the project will make an extremely small contribution to an in-combination impact. Nonetheless, on the basis of the totals in Table 5 the combined displacement mortality across the whole year was estimated to be in the range of 18 to 418 adults. These would increase the baseline mortality rate of the population (adults) by 0.8% to 19%, while assessed using the evidence based displacement and mortality rates, the increase would be 1.3%.
14. These increases in background mortality suggest there is potential for an adverse effect on the razorbill population due to in-combination displacement effects. However, the contribution to the total impact from Norfolk Vanguard is very small, estimated to comprise 1.3%.
15. Outputs from a PVA model for this population were presented for Hornsea Project Three (MacArthur Green 2018). This modelling was an update of similar models produced for Hornsea Project Two, with the addition of a matched-run approach for calculating counterfactual outputs and an extended simulation period (up to 35 years). Simulations were conducted with and without density dependence and were summarised as the counterfactual of population size and population growth rate. The outputs from these models for mortality levels of 50, 250, 300 and 400 (the nearest values to the project alone and in-combination predictions) are provided in Table 6.

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

Model	Mortality	Counterfactual metric (after 30 years)		Source table (MacArthur Green 2018)
		Growth rate	Population size	
Rate set 1, density independent	50	0.998	0.934	Table A2 13.1 & 13.3
	250	0.988	0.708	
	300	0.986	0.660	
	400	0.981	0.574	
Rate set 1, density dependent	50	1.00	0.978	Table A2 14.1 & 14.3
	250	0.998	0.891	
	300	0.997	0.870	
	400	0.996	0.825	
Rate set 2, density independent	50	0.998	0.933	Table A2 15.1 & 15.3
	250	0.988	0.760	
	300	0.986	0.660	
	400	0.981	0.574	
Rate set 2, density dependent	50	0.998	0.949	Table A2 16.1 & 16.3
	250	0.991	0.760	
	300	0.989	0.716	
	400	0.985	0.636	

16. The maximum reduction in the population growth rate, at a mortality of 50 (which is more than 8 times the Norfolk Vanguard alone displacement mortality of 5.8 estimated using the worst case displacement and mortality rates), using the more precautionary density independent model was 0.2% (0.998). On the basis of the observed rate at which this population has grown, between 2000 and 2008 (7.2%) and between 2008 and 2017 (7.2%) (RSPB unpubl. Report 2017), a reduction of 0.2% to this rate represents a negligible risk for the population.
17. The maximum reduction in the population growth rate, at a mortality of 400 (which is the nearest modelled value to the in-combination adult total of 418), using the more precautionary density independent model was 1.9% (0.981). On the basis of the observed rate at which this population has grown, between 2000 and 2008 (7.2%) and between 2008 and 2017 (7.2%) (RSPB unpubl. Report 2017), a reduction of 1.9% to this rate, due to the worst case displacement predictions, would still permit population growth at over 5.3% per year.
18. The razorbill breeding numbers at the Flamborough and Filey Coast SPA have shown strong growth over the last 20 years and are continuing to increase so the population is therefore clearly in favourable conservation status. The relevant conservation objective is to maintain favourable conservation status of the razorbill population, subject to natural change.
19. On the basis of the population model outputs the number of predicted in-combination razorbill displacement mortalities attributed to the Flamborough & Filey Coast SPA is not at a level which would trigger a risk of population decline, but would only result in a small reduction in the growth rate currently seen at this colony, and so would not have an adverse effect on integrity of the SPA.
20. Therefore, it can be concluded that there will be no adverse effect on the integrity of Flamborough & Filey Coast SPA from impacts on razorbill due to the proposed Norfolk Vanguard project in-combination with other plans and projects.

1.3 Guillemot

21. Table 7 presents the abundance of guillemots in all wind farms included in the cumulative assessment, including Norfolk Vanguard. The annual total of guillemots at risk of displacement on the Norfolk Vanguard site (combined across the breeding season and the nonbreeding season and both Norfolk Vanguard East and West) was a mean maximum of 9,096 individuals (Table 7).
22. The totals at risk on other North Sea wind farms and apportioned to the Flamborough and Filey Coast SPA are also presented in Table 7. These have been calculated using the rates advised by Natural England. In the breeding season: 100% for projects within mean maximum foraging range (Teesside, Humber Gateway,

Triton Knoll, Westernmost Rough), 46.3% for Hornsea One and Two; 35% for Dogger Bank Creyke Beck and Dogger Bank Teesside. In the nonbreeding season 4.4%.

Table 7. Cumulative and in-combination guillemot numbers on wind farms in the North Sea.

Project	Total		FFC	
	Breeding	Nonbreeding	Breeding	Nonbreeding
Aberdeen	547.0	225.0	0.0	9.9
Beatrice	13610.0	2755.0	0.0	121.2
Blyth Demonstration	1220.0	1321.0	0.0	58.1
Dogger Bank Creyke Beck A	5407.0	6142.0	1892.5	270.2
Dogger Bank Creyke Beck B	9479.0	10621.0	3317.7	467.3
Dogger Bank Teesside A	3283.0	2268.0	1149.1	99.8
Dogger Bank Teesside B	5211.0	3701.0	1823.9	162.8
Dudgeon	334.0	542.0	0.0	23.8
East Anglia ONE	274.0	640.0	0.0	28.2
East Anglia THREE	1744.0	2859.0	0.0	125.8
Galloper	305.0	593.0	0.0	26.1
Greater Gabbard	345.0	548.0	0.0	24.1
Hornsea Project One	9836.0	8097.0	4554.1	356.3
Hornsea Project Two	7735.0	13164.0	3581.3	579.2
Hornsea Project Three	13374.0	17772.0	0.0	782.0
Humber Gateway	99.0	138.0	99.0	6.1
Hywind	249.0	2136.0	0.0	94.0
Inch Cape	4371.0	3177.0	0.0	139.8
Kincardine	632.0		0.0	0.0
Lincs and LID6	582.0	814.0	0.0	35.8
London Array I & II	192.0	377.0	0.0	16.6
Moray East	9820.0	547.0	0.0	24.1
Moray West	24426.0	38174.0	0.0	1679.7
Neart na Gaoithe	1755.0	3761.0	0.0	165.5
Race Bank	361.0	708.0	0.0	31.2
Seagreen A	13606.0	4688.0	0.0	206.3
Seagreen B	11118.0	4112.0	0.0	180.9
Sheringham Shoal	390.0	715.0	0.0	31.5
Teesside	267.0	901.0	267.0	39.6
Thanet	18.0	124.0	0.0	5.5
Thanet Extension	12.0	1105.0	0.0	48.6
Triton Knoll	425.0	746.0	425.0	32.8
Westernmost Rough	347.0	486.0	347.0	21.4
Seasonal Total (Ex. NV)	141374	133957	17456.6	5894.2
Annual Total (Ex. NV)	275331		23351	
Norfolk Vanguard East	2931	2197	0	96.7
Norfolk Vanguard West	1389	2579	0	113.5
Seasonal Total (Inc. NV)	145694	138733	17456.4	6104.3
Annual Total (inc. Hornsea Project Three)	284427		23561	

Project	Total			FFC	
	Breeding	Nonbreeding		Breeding	Nonbreeding
Annual Total (ex. Hornsea Project Three)		253281			22779

23. Natural England advises presentation of a range of displacement rates of between 30% and 70% displacement and 1% and 10% mortality. However, evidence was presented in support of the use of a precautionary displacement rate of 50% within the wind farm, 30% within the 1km buffer and 0% thereafter, combined with a 1% mortality rate for guillemot and razorbill (ExA; WQAppx 3.3;10.D1.3; although note that the variable buffer has not been applied in this assessment, with the 50% rate applied across both the wind farm and 2km buffer). Predictions using these alternative rates are presented in Table 8.

Table 8. Guillemot abundance estimates on Norfolk Vanguard and summed across all UK North Sea and Channel wind farms, number apportioned to Flamborough and Filey Coast SPA and estimates of displacement mortality.

Site	Season	Total population at risk of displacement	Total impact, displacement & mortality rates:			Population apportioned to FFC SPA	FFC SPA impact, displacement & mortality rates:		
			30% - 1%	50% - 1%	70%- 10%		30% - 1%	50% - 1%	70%- 10%
Norfolk Vanguard East	Breeding	2931	9	15	205	0	0.0	0.0	0.0
	Nonbreeding	2197	7	11	154	96.7	0.3	0.5	6.8
	Annual	5128	16	26	359	96.7	0.3	0.5	6.8
Norfolk Vanguard West	Breeding	1389	4	7	97	0	0.0	0.0	0.0
	Nonbreeding	2579	8	13	181	113.5	0.3	0.6	7.9
	Annual	3968	12	20	278	113.5	0.3	0.6	7.9
Norfolk Vanguard East and West Combined	Breeding	4320	13	22	302	0	0.0	0.0	0.0
	Nonbreeding	4776	14	24	334	210.1	0.6	1.1	14.7
	Annual	9096	27	46	636	210.1	0.6	1.1	14.7
UK North Sea and Channel wind farms	Breeding	145694	437	728	10199	17456.4	52.4	87.3	1221.9
	Nonbreeding	138733	416	694	9711	6104.3	18.3	30.5	427.3
	Annual	284427	853	1422	19910	23561	70.7	117.8	1649.3

1.1.5. HRA Project alone

24. Natural England considered that a likely significant effect on the guillemot population of the Flamborough and Filey Coast SPA, due to displacement from Norfolk Vanguard, could not be ruled out. Apportioning the Norfolk Vanguard displacement mortality to the SPA on the basis of no connectivity in the breeding season (as the wind farm is located more than four times the mean maximum

foraging range for this species) and an even distribution in the nonbreeding season (on the assumption that the SPA population is evenly distributed within the nonbreeding BDMPS population), the worst case mortality due to Norfolk Vanguard was 15 adults (using the 95% confidence intervals on density the range is 8 to 23.2). This would increase the baseline mortality (of 5,051 calculated using the adult mortality rate of 0.0607, Horswill and Robinson 2015) by 0.3% (for the 95% confidence range these are 0.15% to 0.46%), which would be undetectable. Therefore, displacement of guillemot from Norfolk Vanguard would not have an adverse effect on the integrity of the SPA.

1.1.6. HRA In-combination

25. Given the extremely small mortality due to Norfolk Vanguard it is clear that the Project will make an extremely small contribution to an in-combination impact. Nonetheless, on the basis of the totals presented in Table 8 the combined displacement mortality across the whole year was estimated to be in the range 71 to 1,649 individuals. These would increase the baseline mortality rate of the population by 1.3% to 32%. Assessed using the evidence based displacement and mortality rates, the increase would be 2.3%.
26. On this basis, using the worst case approach (70% displacement and 10% mortality) there is potential for an adverse effect on the guillemot population due to in-combination displacement effects, however the contribution from Norfolk Vanguard is very small, estimated to comprise 0.8% (15 from a total of 1,650).
27. Outputs from a PVA model for this population were presented for the Hornsea Project Three wind farm (MacArthur Green 2018). This modelling was an update of similar models produced for Hornsea Project Two, with the addition of a matched-run approach for calculating counterfactual outputs and an extended simulation period (up to 35 years). Simulations were conducted with and without density dependence and were summarised as the counterfactual of population size and population growth rate. The outputs from these models for mortality levels of 50 and 100 and 1,600 (the nearest values to the project alone and in-combination predictions) are provided in Table 9.

Table 9. Guillemot FFC SPA population modelling results from MacArthur Green (2018).

Model	Mortality	Counterfactual metric (after 30 years)		Source table (MacArthur Green 2018)
		Growth rate	Population size	
Rate set 1, density independent	50	0.999	0.983	Table A2 9.1 & 9.3
	100	0.999	0.966	
	1600	0.981	0.570	

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Model	Mortality	Counterfactual metric (after 30 years)		Source table (MacArthur Green 2018)
		Growth rate	Population size	
Rate set 1, density dependent	50	1.000	0.992	Table A2 10.1 & 10.3
	100	1.000	0.983	
	1600	0.992	0.752	
Rate set 2, density independent	50	0.999	0.983	Table A2 11.1 & 11.3
	100	0.999	0.966	
	1600	0.981	0.570	
Rate set 2, density dependent	50	1.000	0.991	Table A2 12.1 & 12.3
	100	1.000	0.982	
	1600	0.991	0.729	

28. The maximum reduction in the population growth rate, at a mortality of 50 (which is three times the Norfolk Vanguard alone adult displacement mortality), using the more precautionary density independent model was 0.1% (0.999). On the basis that the observed rate at which this population grew between 2000 and 2008 (3.0%) and between 2008 and 2017 (4.0%) (RSPB unpubl. Report 2017), a reduction of 0.1% to this rate represents a negligible risk for the population.
29. The maximum reduction in the population growth rate, at a mortality of 1600 (which is the nearest modelled value to the in-combination total of 1649), using the more precautionary density independent model was 1.9% (0.981). On the basis that the observed rate, at which this population has grown between 2000 and 2008 (3.0%) and between 2008 and 2017 (4.0%) (RSPB unpubl. Report 2017), a reduction of 1.9% to this rate represents a minor risk for the population.
30. The guillemot breeding numbers at the Flamborough and Filey Coast SPA have shown strong growth over the last 20 years and the population is therefore clearly in favourable conservation status. The relevant conservation objective is to maintain favourable conservation status of the guillemot population, subject to natural change.
31. On the basis of population model outputs the number of predicted in-combination guillemot displacement mortalities attributed to the Flamborough & Filey Coast SPA is not at a level which would trigger a risk of population decline, but would only result in a small reduction in the growth rate currently seen at this colony. Therefore, favourable conversation status would be maintained and this would not have an adverse effect on integrity of the SPA.

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

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