

# Norfolk Vanguard Offshore Wind Farm

# Migrant non-seabird

# Collision Risk

# Modelling

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*Photo: Kentish Flats Offshore Wind Farm*



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## **Executive Summary**

This note provides collision risk modelling for migrant non-seabirds which may cross the Norfolk Vanguard offshore wind farm sites in response to a request for this assessment received from Natural England in their Relevant Representation.

The note provides collision estimates for the Norfolk Vanguard project alone and cumulatively with the adjacent East Anglia THREE Offshore Wind Farm. In all cases the potential impacts of collisions on the relevant migratory populations, both overall and for Special Protection Areas identified for consideration by Natural England, were concluded as very small and not significant.

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## Glossary

CRM	Collision Risk Model
ES	Environmental Statement
GIS	Geographical Information System
NE	Natural England
NV	Norfolk Vanguard
PCH	Potential Collision Height
SNH	Scottish Natural Heritage
SOSSMAT	Strategic Ornithological Support Services Migration Assessment Tool
SPA	Special Protection Area

## 1 INTRODUCTION

1. This note provides a collision risk assessment for migrant non-seabird species which are considered to have the potential to cross the Norfolk Vanguard (NV) offshore wind farm sites on migration. This assessment was requested by Natural England (NE) in their Relevant Representation following their review of the Norfolk Vanguard Environmental Statement (ES). The species assessed are those suggested by NE in their Relevant Representation (point 4.3), which are the same as those assessed for the nearby East Anglia THREE offshore wind farm with the addition (at NE’s request) of avocet and Bewick’s swan. The assessment considers the potential effects on the total migratory populations and, for relevant species, on the Breydon Water Special Protection Area (SPA), Broadland SPA and North Norfolk Coast SPA populations. The assessment uses the data and methods provided in Wright et al. (2012) combined with the migrant extension of the Band (2012) collision risk model (CRM).
2. The detailed comments provided by NE with respect to this analysis are provided in Table 1.

**Table 1 Comments on the requirement for migrant non-seabird collision risk modelling provided by Natural England (2018) in their relevant representation.**

Paragraph	Comment
4.3	<p>Non-seabird migrant collision risk</p> <p>Natural England does not consider it appropriate that no further work on non-seabird migration modelling and hence CRM has been undertaken since East Anglia 3. Whilst the sites may be of a similar area to the East Anglia 3 site, there are coastal SPAs with wintering waterbirds that are qualifying species that are in the shadow of the Vanguard sites – particularly Broadland and Breydon SPAs and potentially also the North Norfolk Coast SPA.</p> <p>Whilst a number of the qualifying features of these sites were covered by the modelling undertaken at East Anglia 3 (non-breeding dark-bellied brent goose, wigeon, gadwall, shoveler, golden plover, lapwing, knot and breeding marsh harrier and bittern), there are some qualifying features that were not covered by the East Anglia 3 modelling where the main flight paths do encompass the Vanguard sites (e.g. Bewick’s swan and avocet). Whilst these species may have been considered in the screening undertaken at East Anglia 3, they were screened out based on being modelled and assessed at East Anglia 1 with very low collisions being predicted and hence deemed to have no material impact. Therefore they were not modelled for East Anglia 3 and consequently also for Vanguard. Given the size of the sites and that Norfolk Vanguard is located approximately 55-60km north of East Anglia 1 and that there are SPAs with Bewick’s swan and avocet as qualifying features located on the Norfolk Coast that are in the shadow of Vanguard, we would suggest that these species are considered for migration modelling and CRM.</p> <p>We would also again suggest that for the species modelled at East Anglia 3, the CRM is undertaken again using the Vanguard turbine specifications and site locational information.</p> <p>There may also be a need to consider cumulative CRM impacts on non-seabird migrants as Vanguard East is located immediately north of East Anglia 3 and so birds migrating north and south may encounter both sites. Also if Vanguard is built across both Vanguard East and Vanguard West then birds migrating east-west as could encounter both sites.</p>

## 2 METHODS

3. The species considered in this assessment are listed in Table 2.

**Table 2. Migrant non-seabird species assessed for collision risk**

Common name	Scientific name
Bewick's swan	<i>Cygnus columbianus bewickii</i>
Dark-bellied brent goose	<i>Branta bernicla bernicla</i>
Wigeon	<i>Anas penelope</i>
Gadwall	<i>Anas strepera</i>
Teal	<i>Anas crecca</i>
Pintail	<i>Anas acuta</i>
Shoveler	<i>Anas clypeata</i>
Pochard	<i>Aythya ferina</i>
Tufted duck	<i>Aythya fuligula</i>
Common scoter	<i>Melanitta nigra</i>
Goldeneye	<i>Bucephala clangula</i>
Marsh harrier	<i>Circus aeruginosus</i>
Oystercatcher	<i>Haematopus ostralegus</i>
Avocet (nonbreeding)	<i>Recurvirostra avosetta</i>
Ringed plover	<i>Charadrius hiaticula</i>
Golden plover	<i>Pluvialis apricaria</i>
Grey plover	<i>Pluvialis squatarola</i>
Lapwing	<i>Vanellus vanellus</i>
Knot	<i>Calidris canutus</i>
Sanderling	<i>Calidris alba</i>
Dunlin	<i>Calidris alpina</i>
Bar-tailed godwit	<i>Limosa lapponica</i>
Curlew	<i>Numenius arquata</i>
Redshank	<i>Tringa totanus</i> (including each sub-species)
Turnstone	<i>Arenaria interpres</i>

4. Relevant population sizes and migration routes were obtained from the Strategic Ornithological Support Services (SOSS) Migration Assessment Tool (hereafter referred to as SOSSMAT; Wright et al. 2012). The SOSSMAT Geographical Information System tool enables estimation of the proportion of migrating populations which could encounter offshore wind farms. The species-specific migration routes were derived by Wright et al. (2012) from a review of literature, and the tool enables identification of those routes which cross user-defined wind farm footprints. The following steps were taken for this assessment:



- a) The Norfolk Vanguard sites (East and West) were used to filter the SOSSMAT migration routes to identify those which crossed the wind farm sites.
  - b) The sections of the European coastline defined in the SOSSMAT tool were reviewed and the relevant ones selected (i.e. for Norfolk Vanguard these were ones which included a start or end point which bordered the southern North Sea).
  - c) Following the above, for each species the SOSSMAT tool generated a prediction of the percentage of each population which could encounter the wind farm on migration. It should be noted that for each species this is an estimate of the percentage of the total number of potential migration paths which could cross the wind farms and therefore the same value applies to both the total migratory population and the SPA sub-populations.
  - d) The total migrant population for each species considered at risk was obtained from Wright et al. (2012) and was multiplied by the percentage at risk (obtained at step c) to estimate the number of individuals which could cross the wind farm sites in each migration period. This was the at-risk population used as input to the collision risk model.
  - e) For all the relevant species it was assumed that there were two migration periods per year (e.g. spring and autumn) and therefore in order to assess risks annually the at-risk number was doubled.
5. Natural England requested that the non-seabird migrant collision assessment should consider potential impacts on the wider populations of each species as well as the populations at the Breydon Water SPA, Broadland SPA and North Norfolk Coast SPA.
  6. Collision mortality was calculated using the migrant extension of the Band (2012) CRM. To estimate the proportion of the total collisions which could affect the SPA populations, it was assumed this would be in proportion to the size of the SPA population relative to the total population (i.e. if the SPA population was 50 from a total population of 200 it would be assumed that 25% of the collisions could be attributed to the SPA).
  7. Parameters for the CRM, such as the proportion at collision height (PCH) and flight speed were obtained from a review of the relevant literature. The total migrant population for each species and for those SPA species considered likely to pass through the wind farm sites are provided in Table 3 and the species-specific collision parameters are listed in Table 4.

8. Table 3 provides an estimate of the total population likely to cross the southern North Sea. For all species it has been assumed this is 100%, on the basis of the information in Wright et al. (2012). The percentage of the total population estimated to cross the Norfolk Vanguard Wind Farm (East and West sites combined) is also listed in Table 3. These percentages were generated as an output from the SOSSMAT tool which provides GIS files to enable selection of routes which cross specified areas (in this case the wind farm polygons).

**Table 3. Percentage of non-seabird migrant routes with potential to cross the Norfolk Vanguard Wind Farm sites (obtained from SOSSMAT) and relevant total and SPA population sizes.**

Species	SOSSMAT % crossing NV East and/or West	Total migrants (Wright et al. 2012)	Population sizes		
			Breydon Water SPA	Broadland SPA	North Norfolk Coast SPA
Avocet	19.17	7,500	33	-	153
Bar-tailed godwit	10.88	54,280	-	-	1,236
Bewick's swan	16.91	7,380	391	320	-
Common scoter	9.85	123,190	-	-	-
Curlew	10.96	140,000	-	-	-
Dark-bellied brent goose	18.09	91,000	-	-	11,512
Dunlin	16.08	438,480	2,870	-	-
Gadwall	13.1	25,630	-	605	-
Golden plover	13.37	566,700	5,040	-	2,667
Goldeneye	10.72	2,9665	-	-	-
Grey plover	10.11	49,315	-	-	-
Knot	9.9	338,970	-	-	10,801
Lapwing*	10.11	465,000	24,940	-	-
Marsh harrier	0	402	-	21	14
Oystercatcher	10.27	320,000	-	-	-
Pintail	9.85	30,235	-	-	1,139
Pochard	13.43	75,780		1,230	-
Redshank (britannica)	13.02	38,800	-	-	-
Redshank (robusta)	12.49	150,000	-	-	2,998
Redshank (totanus)	10.57	2,5000	-	-	-
Ringed plover	10.32	48,580	-	-	1,256
Sanderling	9.9	22,680	-	-	-
Shoveler	13.43	20,545	140	401	-
Teal	9.85	255,010	-	3,869	-
Tufted duck	9.8	146,610	-	1,336	-
Turnstone	9.83	48,000	-	-	-
Wigeon	9.83	522,370	4,320	6,435	14,039

\*APEM (2014) present calculation of migrant lapwing numbers derived from Wright et al. (2012)

**Table 4. Species-specific biometrics and collision model parameters. Note that the probability of collision for a single rotor transit (p.collision) was calculated using the ‘single transit collision risk’ tab of the Band (2012) CRM spreadsheet. Biometric estimates were those reported in APEM (2014).**

Species	Length (m)	Wingspan (m)	Flight speed (ms-1)	PCH	Probability of collision for single transit (p.collision)
Avocet	0.44	0.79	11.10	25	0.0841
Bar-tailed godwit	0.38	0.75	18.30	25	0.0635
Bewick's swan	1.27	2.11	18.50	50	0.0921
Common scoter	0.58	1.15	17.70	30	0.0713
Curlew	0.49	0.84	22.10	1	0.0633
Dark-bellied brent goose	0.55	0.90	13.90	25	0.0781
Dunlin	0.18	0.40	15.30	25	0.0603
Gadwall	0.51	0.90	16.90	15	0.0697
Golden plover	0.28	0.72	17.90	25	0.0612
Goldeneye	0.46	0.72	21.20	15	0.0628
Grey plover	0.28	0.77	17.90	25	0.0615
Knot	0.24	0.59	20.10	25	0.0579
Lapwing*	0.30	0.84	11.90	25	0.0746
Marsh harrier	0.52	1.22	12.00	50	0.0848
Oystercatcher	0.42	0.83	13.90	25	0.0730
Pintail	0.66	0.95	20.60	15	0.0689
Pochard	0.46	0.77	21.20	15	0.0630
Redshank	0.28	0.62	18.30	25	0.0604
Ringed plover	0.19	0.52	10.60	25	0.0738
Sanderling	0.20	0.42	17.70	25	0.0580
Shoveler	0.48	0.77	16.90	15	0.0684
Teal	0.36	0.61	16.90	15	0.0643
Tufted duck	0.44	0.70	21.20	15	0.0622
Turnstone	0.23	0.54	17.70	25	0.0593
Wigeon	0.48	0.80	17.10	15	0.0682

### 3 RESULTS

#### 3.1 Collision risk estimates: Norfolk Vanguard East and West

9. Collision mortality estimates are presented for all species with a range of avoidance rates from 98% to 99.8%, with the appropriate precautionary rate for each species highlighted in the grey cells (Table 5). This was 98% for all but two species (higher rates have been proposed by Scottish Natural Heritage (SNH) for collision assessment of Bewick’s swan, 99.5% and dark-bellied brent goose, 99.8%; SNH 2013, 2017).

**Table 5. Migrant non-seabird annual collision risks. These include two migrations for each species (i.e. spring and autumn). Grey cells indicate the mortality for the Statutory Natural Conservation Bodies-recommended species-specific precautionary avoidance rate.**

Species	Collision Mortality Estimates (for these % avoidance rates)				Collisions as percentage of total population	Number of collisions assigned to:		
	98	99	99.5	99.8		Breydon Water SPA	Broadland SPA	North Norfolk Coast SPA
Avocet	0.8	0.4	0.2	0.1	0.0107	0.0035		0.0164
Bar-tailed godwit	2.5	1.2	0.6	0.2	0.0046			0.0568
Bewick's swan	1.5	0.8	0.4	0.2	0.0052	0.0202	0.0166	
Common scoter	0.2	0.1	0.1	0.0	0.0002			
Curlew	6.5	3.2	1.6	0.6	0.0046			
Dark-bellied brent goose	10.3	5.1	2.6	1.0	0.0011			0.1297
Dunlin	28.2	14.1	7.1	2.8	0.0064	0.1848		
Gadwall	0.9	0.5	0.2	0.1	0.0036	0.0000	0.0110	
Golden plover	30.8	15.4	7.7	3.1	0.0054	0.2740		
Goldeneye	0.8	0.4	0.2	0.1	0.0027			0.1450
Grey plover	2.0	1.0	0.5	0.2	0.0041			
Knot	12.9	6.5	3.2	1.3	0.0038			0.4116
Lapwing*	23.3	11.6	5.8	2.3	0.0050	1.2495		
Marsh harrier	0.0	0.0	0.0	0.0	0.0000			
Oystercatcher	15.9	8.0	4.0	1.6	0.0050			
Pintail	0.8	0.4	0.2	0.1	0.0027			0.0308
Pochard	2.6	1.3	0.6	0.3	0.0034		0.0207	
Redshank ( <i>britannica</i> )	2.0	1.0	0.5	0.2	0.0052			
Redshank ( <i>robusta</i> )	7.5	3.8	1.9	0.8	0.0050			0.1502
Redshank ( <i>totanus</i> )	1.1	0.5	0.3	0.1	0.0042			
Ringed plover	2.5	1.2	0.6	0.2	0.0051			0.0636
Sanderling	0.9	0.4	0.2	0.1	0.0038			
Shoveler	0.8	0.4	0.2	0.1	0.0037	0.0051	0.0073	

Species	Collision Mortality Estimates (for these % avoidance rates)				Collisions as percentage of total population	Number of collisions assigned to:		
	98	99	99.5	99.8		Breydon Water SPA	Broadland SPA	North Norfolk Coast SPA
Teal	6.4	3.2	1.6	0.6	0.0025		0.0488	
Tufted duck	3.6	1.8	0.9	0.4	0.0024		0.0162	
Turnstone	1.9	0.9	0.5	0.2	0.0039			
Wigeon	14.0	7.0	3.5	1.4	0.0027	0.1154	0.0860	0.3751

10. Ten species were estimated to be at risk of 1 or fewer collisions per year: avocet, Bewick’s swan, common scoter, dark-bellied brent goose, gadwall, goldeneye, marsh harrier, pintail, sanderling and shoveler.
11. Eight species were estimated to be at risk of between 1 and 10 collisions per year: bar-tailed godwit, curlew, grey plover, pochard, ringed plover, teal, tufted duck and turnstone.
12. The remaining seven species with predicted annual collisions of 10 or more were dunlin (28), golden plover (31), knot (13), lapwing (23), oystercatcher (16), redshank (11, summed across all races) and wigeon (14).
13. The only species for which the total annual collisions exceeded 0.01% of the migratory population was avocet, which was just above this level with 0.011%. In relation to the SPA populations, only one (lapwing) was predicted to result in more than one collision for the relevant SPA (1.25 from the Breydon Water SPA population of almost 25,000).
14. Although it is acknowledged that there may be connectivity with designated populations at other SPAs along the English east coast, given the extremely low numbers at risk, overall the number of individuals from other SPAs that this could include, and hence the proportion of the migrant populations this would represent, are likely to be very small and therefore it is appropriate that only the three named SPAs have been considered.
15. For all species, the background mortality rate would only be increased by more than 1% (the threshold beneath which additional mortality is considered to have an undetectable effect) due to the predicted annual collision risks if natural mortality was less than 2% (i.e. the annual survival rate would need to be at least 98%). This is much lower than the natural mortality rates for any of the species assessed, most have natural mortality of at least 10% per year. Thus, the effects would only be

expected to exceed the 1% threshold if collision risk was more than five times higher, and even then that would only be the case for those species with natural mortality rates at the lower end of the range, such as geese and swans.

16. Consequently, the collision risk predictions for all the migrant non-seabird species included in the assessment have resulted in negligible magnitude impacts which are therefore of minor or negligible significance. Due to the low numbers of collisions apportioned to the relevant SPA populations, no likely significant effects are predicted for the Breydon Water SPA, Broadland SPA and North Norfolk Coast SPA due to migrant collisions at the Norfolk Vanguard Wind Farm.

### 3.2 Cumulative collision risk estimates: Norfolk Vanguard and East Anglia THREE

17. NE requested that migrant collision risk should consider the potential combined mortality from the Norfolk Vanguard and East Anglia THREE offshore wind farms. Collision mortalities for East Anglia THREE were taken from APEM (2014).
18. The combined mortality (Table 6) is only very slightly higher than that in Table 5 for Norfolk Vanguard alone and therefore the addition of potential mortality at the East Anglia THREE Offshore Wind Farm does not alter the conclusions reported for Norfolk Vanguard alone: the increase in background mortality would be undetectable (i.e. less than 1%) for all species as a result of the combined total annual collisions, and the qualitative conclusions with respect to Breydon Water SPA, Broadland SPA and North Norfolk Coast SPA are also unchanged from those for the project alone.

**Table 6. Migrant non-seabird annual collision risks at Norfolk Vanguard and East Anglia THREE.**

Species	Norfolk Vanguard	East Anglia THREE	Combined total
Avocet	0.8	N/A	0.8
Bar-tailed godwit	2.5	0	2.5
Bewick's swan	0.4	N/A	0.4
Common scoter	0.2	0	0.2
Curlew	6.5	1	7.5
Dark-bellied brent goose	1.0	1*	2.0
Dunlin	28.2	12	40.2
Gadwall	0.9	0	0.9
Golden plover	30.8	9	39.8
Goldeneye	0.8	0	0.8
Grey plover	2.0	1	3
Knot	12.9	1	13.9
Lapwing*	23.3	4	27.3

Species	Norfolk Vanguard	East Anglia THREE	Combined total
Marsh harrier	0.0	0	0
Oystercatcher	15.9	2	17.9
Pintail	0.8	0	0.8
Pochard	2.6	0	2.6
Redshank	10.6	0	10.6
Ringed plover	2.5	1	3.5
Sanderling	0.9	0	0.9
Shoveler	0.8	1	1.8
Teal	6.4	0	6.4
Tufted duck	3.6	0	3.6
Turnstone	1.9	1	2.9
Wigeon	14.0	1	15.0

\* For East Anglia THREE Offshore Wind Farm an avoidance rate of 98% was used for all species. The dark-bellied brent goose collision has therefore been adjusted to that expected with an avoidance rate of 99.8% (i.e. multiplied by 0.1).

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