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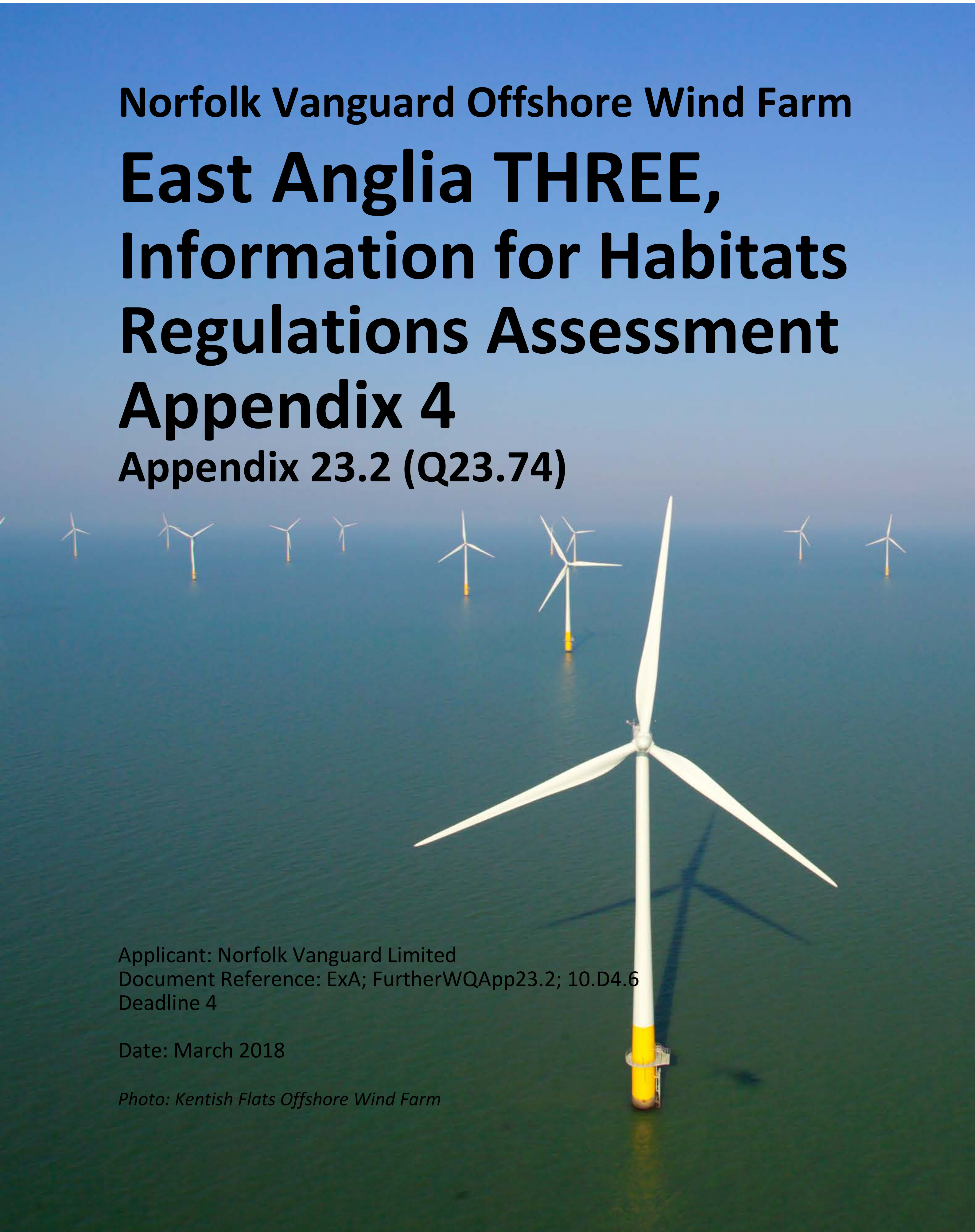

Norfolk Vanguard Offshore Wind Farm

East Anglia THREE, Information for Habitats Regulations Assessment Appendix 4

Appendix 23.2 (Q23.74)

Applicant: Norfolk Vanguard Limited
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Date: March 2018

Photo: Kentish Flats Offshore Wind Farm

East Anglia Offshore Wind

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East Anglia THREE

Information for Habitats Regulations Assessment

Appendix 4 : Apportioning of the Flamborough Head and Filey Coast pSPA Kittiwake Population among North Sea Offshore Wind Farms

Document Reference – 5.4 (4)

Author – MacArthur Green
East Anglia THREE Limited

Date – November 2015

East Anglia Offshore Wind

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1 INTRODUCTION

1. This report provides an estimation of the percentage of the Flamborough and Filey Coast (FFC) pSPA kittiwake population at risk of collision effects in North Sea offshore wind farms. This report follows the methods used for previous assessments (MacArthur Green 2014, 2015).

2 ESTIMATION OF UK NORTH SEA & CHANNEL WATERS KITTIWAKE BDMPS AND FFC PSPA PROPORTION

2. Due to variations in the timing of migration among individuals both within and between colonies and also between different age classes there is considerable overlap in the kittiwake seasons for the UK (Furness 2015; *Table 2.1*).

Table 2.1. Kittiwake seasons in UK waters from Furness (2015).

Season	J	F	M	A	M	J	J	A	S	O	N	D
Non-breeding (core)	■											■
Non-breeding (full)	■	■							■	■	■	■
Spring migration (UK waters)	■	■	■	■								
UK Breeding season (full)			■	■	■	■	■	■				
UK Breeding season (core)					■	■	■					
Autumn migration (UK waters)								■	■	■	■	■

3. Despite the brief core winter period with little migration, the BDMPS report concluded that it was more appropriate to define two nonbreeding seasons for kittiwake; autumn migration and spring migration, rather than separating a third 'winter' season (Furness 2015). For this assessment the following descriptions of the seasons are considered to be appropriate:

- Spring migration (January – April)
- UK breeding (May – July)
- Autumn migration (august - December).

2.1 Migration periods

4. During the migration periods kittiwakes from different breeding colonies mix together to varying extents. *Table 2.2* presents the population size for all British kittiwake SPA colonies plus those populations further north which are thought to contribute to UK North Sea passage and wintering populations. It should be noted that only approximately half of the British kittiwake population breeds at SPAs for this species. The proportions of each of the populations considered which is predicted to pass through the North Sea have been derived from Furness (2015).

5. The most recent estimates for the two large SPA colonies in Caithness (North Caithness Cliffs SPA and East Caithness Cliffs SPA) date from 1999 and 2000. Therefore, it has been suggested that since these counts were undertaken these populations may have declined by a similar margin (e.g. up to 50%) as reported for other colonies in northern Scotland (Furness 2015). However, there is evidence to

suggest that this is not likely to have been the case. Site condition monitoring (SCM) of the East Caithness Cliffs SPA (Swann 2012) reported that the kittiwake population within monitoring plots had in fact increased by 65% between 1999 and 2005, in contrast to the declines reported elsewhere (Mavor et al. 2005). It is thus far from certain that the East Caithness Cliffs SPA population has declined. There is no published SCM for the North Caithness Cliffs SPA, however this site is close to East Caithness and therefore it is reasonable to assume similar trends at both. Furthermore, since it makes a comparatively small contribution to the total apportioning calculations it was considered more appropriate to retain the reported census from 2000 rather than make assumptions about an unknown trend.

Table 2.2. Total population estimates for major breeding populations (using adult percentage of 53.2 from Furness 2015) and proportion and number estimated to pass through or remain in, UK North Sea waters during migration.

Breeding colony (year of count)	AON	No. adults	No. immatures	Proportion and number in UK North Sea waters during autumn migration				Proportion and number in UK North Sea waters during spring migration			
				Adults		Immatures		Adults		Immatures	
				Prop.	No.	Prop.	No.	Prop.	No.	Prop.	No.
Russia (c. 2000)	140000	280000	246400	0.1	28000	0.1	24640	0.05	14000	0.07	17248
Norway (c. 2000)	700000	1400000	1232000	0.1	140000	0.1	123200	0.05	70000	0.07	86240
Faeroes (2012)	200000	400000	352000	0.1	40000	0.1	35200	0.05	20000	0.07	24640
Germany (2010)	6000	12000	10560	0.1	1200	0.1	1056	0.15	1800	0.25	2640
France (2010)	4000	8000	7040	0.05	400	0.05	352	0.05	400	0.1	704
Ireland (2000)	20000	40000	35200	0.05	2000	0.05	1760	0.01	400	0.01	352
Hermaness, Saxavord & Valla (2009)	391	782	688	0.6	469	0.40	275	0.6	469	0.30	206
Foula (2013)	327	654	576	0.6	392	0.40	230	0.6	392	0.30	173
Noss (2010)	507	1014	892	0.6	608	0.40	357	0.6	608	0.30	268
Sumburgh Head (2013)	210	420	370	0.6	252	0.40	148	0.6	252	0.30	111
Fair Isle (2013)	771	1542	1357	0.6	925	0.40	543	0.6	925	0.30	407
West Westray (2007)	12055	24110	21217	0.6	14466	0.40	8487	0.6	14466	0.30	6365
Calf of Eday (2006)	747	1494	1315	0.6	896	0.40	526	0.6	896	0.30	394
Marwick Head (2013)	526	1052	926	0.6	631	0.40	370	0.6	631	0.30	278
Rousay (2009)	1764	3528	3105	0.6	2117	0.40	1242	0.6	2117	0.30	931
Copinsay (2012)	666	1332	1172	0.6	799	0.40	469	0.6	799	0.30	352
Hoy (2007)	397	794	699	0.6	476	0.40	279	0.6	476	0.30	210
North Caithness Cliffs (2000)	10150	20300	17864	0.6	12180	0.40	7146	0.6	12180	0.30	5359
East Caithness Cliffs (1999)	40410	80820	71122	0.6	48492	0.40	28449	0.6	48492	0.30	21336
Troup, Pennan and Lion's Heads (2007)	14896	29792	26217	0.6	17875	0.40	10487	0.6	17875	0.30	7865
Buchan Ness to Collieston Coast (2007)	12542	25084	22074	0.6	15050	0.40	8830	0.6	15050	0.30	6622
Fowlsheugh (2012)	9337	18674	16433	0.6	11204	0.40	6573	0.6	11204	0.30	4930
Forth Islands (2013)	3100	6200	5456	0.6	3720	0.40	2182	0.6	3720	0.30	1637
St Abb's Head to Fast Castle (2013)	3403	6806	5989	0.6	4084	0.40	2396	0.6	4084	0.30	1797
Farne Islands (2013)	3443	6886	6060	0.6	4132	0.40	2424	0.6	4132	0.30	1818

Flamborough and Filey Coast (2008)	**37617**	**75234**	**66206**	**0.6**	**45140**	**0.40**	**26482**	**0.6**	**45140**	**0.30**	**19862**
UK North Sea non-SPA colonies (2000)	70000	140000	123200	0.6	84000	0.40	49280	0.6	84000	0.30	36960
Cape Wrath (2000)	10344	20688	18205	0.01	207	0.05	910	0.01	207	0.02	364
North Rona and Sula Sgeir (2012)	1253	2506	2205	0.01	25	0.05	110	0.01	25	0.02	44
Handa (2013)	1872	3744	3295	0.01	37	0.05	165	0.01	37	0.02	66
St Kilda (2008)	957	1914	1684	0.01	19	0.05	84	0.01	19	0.02	34
Flannan Isles (1998)	1392	2784	2450	0.01	28	0.05	122	0.01	28	0.02	49
Shiant Isles (2008)	549	1098	966	0.01	11	0.05	48	0.01	11	0.02	19
Canna and Sanday (2013)	820	1640	1443	0.01	16	0.05	72	0.01	16	0.02	29
Rum (2000)	788	1576	1387	0.01	16	0.05	69	0.01	16	0.02	28
Mingulay and Berneray (2009)	2228	4456	3921	0.01	45	0.05	196	0.01	45	0.02	78
North Colonsay & Western Cliffs (2000)	5563	11126	9791	0.01	111	0.05	490	0.01	111	0.02	196
Ailsa Craig (2013)	489	978	861	0.01	10	0.05	43	0.01	10	0.02	17
Rathlin Island (2011)	7922	15844	13943	0.01	158	0.05	697	0.01	158	0.02	279
Skomer and Skokholm (2013)	1045	2090	1839	0.01	21	0.05	92	0.01	21	0.02	37
UK western non-SPA colonies (2000)	30000	60000	52800	0.01	600	0.05	2640	0.01	600	0.02	1056
Total	1365384	2730768	2403075		489096		353981		384096		255646

2.2 Breeding season

6. The mean maximum foraging range estimate for kittiwake is 60 km and the maximum range is estimated to be 120km (Thaxter et al. 2012). Since the East Anglia THREE site is 257km from the pSPA it is concluded there is no probability of any breeding adults from FFC being present on the wind farms during the breeding season. Birds recorded at this time are therefore assumed to be failed or non-breeders (including immature birds).

7. Determination of the colonies to which these non-breeding birds are associated can only be undertaken on the basis of assumptions about their movements. If it is assumed that these birds are derived equally from all North Sea colonies ('Hermaness' to 'UK North Sea non-SPA colonies', listed in *Table 2.2*) and that these birds mix uniformly throughout the North Sea this gives a percentage attributable to the FFC pSPA of 16.8% (75234 / 446518); note that although this percentage has been calculated using AON values, under the assumption of equivalent SPA contributions they apply equally to other age classes). However, these totals do not include immature birds from breeding populations farther north (Norwegian Sea and Barents Sea): immature birds move away from their natal colonies after fledging and then spend several years moving gradually closer to their natal breeding colonies (Wernham et al. 2002, Coulson 2011). Thus, immature birds from north Atlantic populations are likely to be present in the North Sea as a component of the overall population. Therefore, the value of 19.3%, attributable to the FFC pSPA population, derived solely on the basis of UK breeding populations, can be considered highly likely to be an overestimate. Given the large size of the Norwegian, Faeroes and Barents Sea kittiwake populations, including immature birds from these locations in the same manner as above (i.e. based on the equivalence of AON and immature birds) generates a revised percentage of 3.3% for FFC (75234 / (446518 + 1830400)). This is likely to overestimate the presence of immature north Atlantic birds in the North Sea, but does provide lower limits to bracket the range of likely percentages: 3.3% – 16.8%.

3. Estimation of the percentage of the FFC pSPA kittiwake population at risk of collision effects in UK North Sea waters offshore wind farms

8. On the basis of the estimated distribution of kittiwakes through UK waters, seasonal definitions and regional definitions (MacArthur Green 2014), the percentage of kittiwakes within named North Sea offshore wind farms which originate from the FFC pSPA colony has been calculated (*Table 2.3*). For wind farms located within 60 km of the FFC pSPA colony (Westermost Rough and Humber Gateway) it has been assumed that between 16.8 and 100% of the birds seen on site during the breeding

season originate from this population. For all others the breeding season percentage was assumed to be the precautionary North Sea breeding season value calculated above (19.3%).

9. During migration the number of British SPA birds travelling through UK North Sea waters has been summed using the population estimates and proportions in *Table 2.2*. This British total was then added to the numbers estimated to pass through UK North Sea waters which originate from Russian and Norwegian colonies. Having estimated the total flux of kittiwakes on passage, the FFC pSPA percentage of this was then calculated for each wind farm in *Table 2.3*.

10. The following examples illustrate the method used to calculate the number of birds from the FFC pSPA which pass through OWFs in each region of UK North Sea waters. The calculations use the population estimates and the proportions predicted to pass through the North Sea listed in *Table 2.2*.

11. On the assumption that during migration kittiwakes within UK North Sea waters originate from all contributing colonies in proportion to colony size, the migration period percentage estimated to originate from the FFC pSPA population on the wind farms listed in *Table 2.3* was calculated as the colony's proportion of the total (adults plus immatures).

12. Thus, the FFC proportion in UK North Sea waters present during autumn migration was estimated to be:

$$(75234 * 0.6) / (480812 + 349121) = 0.054$$

13. A similar calculation was conducted for the FFC spring migration period which gave an estimate of 0.072.

Table 2.3. Percentage of breeding adult kittiwakes in offshore wind farms during the breeding season (BS), autumn migration (Aut.) and spring migration (Spr.) periods which are estimated to originate from the FFC pSPA population.

<table>
<tr><th rowspan="2">Project</th><th rowspan="2">UK Round</th><th rowspan="2">Status</th><th colspan="3">Period</th></tr>
<tr><th>BS</th><th>Aut.</th><th>Spr.</th></tr>
<tr><td>Beatrice</td><td>Scottish</td><td>Consent Authorised</td><td rowspan="14">16.8</td><td rowspan="28">5.4</td><td rowspan="28">7.2</td></tr>
<tr><td>Blyth Demonstration Site</td><td>-</td><td>Consent Authorised</td></tr>
<tr><td>Dogger Bank Creyke Beck A & B</td><td>3</td><td>Consent Authorised</td></tr>
<tr><td>Dogger Bank Teesside A & B</td><td>3</td><td>Consent Authorised</td></tr>
<tr><td>Dogger Bank Teesside C & D</td><td>3</td><td>Concept / Early Planning</td></tr>
<tr><td>Dudgeon</td><td>2</td><td>Consent Authorised</td></tr>
<tr><td>East Anglia ONE</td><td>3</td><td>Consent Authorised</td></tr>
<tr><td>East Anglia THREE</td><td>3</td><td>Consent Application Submitted</td></tr>
<tr><td>European Offshore Wind Development Centre</td><td></td><td>Consent Authorised</td></tr>
<tr><td>Firth of Forth Alpha and Bravo (Seagreen)</td><td>Scottish</td><td>Consent Authorised</td></tr>
<tr><td>Galloper</td><td>2 – extn.</td><td>Consent Authorised</td></tr>
<tr><td>Greater Gabbard</td><td>2</td><td>Fully Commissioned</td></tr>
<tr><td>Hornsea Project One</td><td>3</td><td>Consent Authorised</td></tr>
<tr><td>Hornsea Project Two</td><td>3</td><td>Consent Application Submitted</td></tr>
<tr><td>Humber Gateway</td><td>2</td><td>Consent Authorised</td><td>16.8 - 100</td></tr>
<tr><td>Inch Cape</td><td>Scottish</td><td>Consent Authorised</td><td rowspan="12">16.8</td></tr>
<tr><td>Lincs</td><td>2</td><td>Partial Generation / Construction</td></tr>
<tr><td>London Array</td><td>2</td><td>Fully Commissioned</td></tr>
<tr><td>Moray</td><td>Scottish</td><td>Consent Authorised</td></tr>
<tr><td>Navitus Bay</td><td>3</td><td>Consent Application Submitted</td></tr>
<tr><td>Neart na Gaoithe</td><td>Scottish</td><td>Consent Authorised</td></tr>
<tr><td>Race Bank</td><td>2</td><td>Consent Authorised</td></tr>
<tr><td>Rampion</td><td>3</td><td>Consent Authorised</td></tr>
<tr><td>Sheringham Shoal</td><td>2</td><td>Fully Commissioned</td></tr>
<tr><td>Teesside</td><td>1</td><td>Fully Commissioned</td></tr>
<tr><td>Thanet</td><td>2</td><td>Fully Commissioned</td></tr>
<tr><td>Triton Knoll</td><td>2</td><td>Consent Authorised</td></tr>
<tr><td>Westermost Rough</td><td>2</td><td>Partial Generation / Construction</td><td>16.8 - 100</td></tr>
</table>

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APPENDIX 1: FACTORS AFFECTING SEABIRD FORAGING RANGES FROM BREEDING COLONIES

14. Foraging trip durations and maximum foraging ranges of many species are longer when prey abundance is reduced (Hamer et al. 1993, Lewis et al. 2006, Riou et al. 2011, Thaxter et al. 2012, Wade et al. 2014). In addition to that effect, they also tend to increase as a function of colony size, presumably due to intra-specific competition for prey resources at sea (Lewis et al. 2001, Forero et al. 2002, Ainley et al. 2003, Wakefield et al. 2013). Davies et al. (2013) showed that gannet foraging trips increased in duration and distance with colony size, but were considerably higher in a year when food abundance was thought to be lower than they were in a year of high food abundance. Furthermore, the slope of the relationship between colony size and foraging range was much higher in the year of lower food availability, suggesting a much stronger density-dependent effect when food resources are reduced. These results support the idea that foraging range relates to density-dependent competition, with larger ranges around colonies where per capita food resource is lower. The data also suggest that, over the range of values experienced, the effect of food abundance is greater than the effect of colony size, and that colony size effects may not be evident if food abundance is high.

15. These results predict that foraging range will tend to be small at colonies where food abundance allows high breeding success, but will be greater at colonies where breeding success is reduced by low food abundance. This suggests that long foraging ranges observed in kittiwakes and auks at some colonies in northern Scotland where breeding success is consistently poor due to lack of forage fish (in that example, sandeels), are not applicable to colonies in east England, where such shortages and poor breeding success have not normally been recorded during the JNCC monitoring period of 1986 to 2013 (see summary in Table A1).

Table A.1. Productivity (mean number of chicks per nest) for seabirds at colonies monitored in the JNCC Seabird Monitoring Programme in eastern England and in eastern Scotland (Shetland to Berwickshire) as reported in Annual Reports published by JNCC for the years 1986 to 2006.

Species	Productivity (data from JNCC Annual Reports 1986-2006)		Excess in productivity in E England compared to E Scotland (mean chicks per pair)	Excess in E England productivity as % of E Scotland baseline
	E England Mean (n)	E Scotland Mean (n)		
Gannet	0.77 (8)	0.66 (60)	+0.11	17%
Kittiwake	0.95 (21)	0.67 (84)	+0.28	42%
Common guillemot	0.74 (5)	0.65 (123)	+0.09	14%
Razorbill	0.69 (11)	0.64 (52)	+0.05	8%
Puffin	0.76 (17)	0.62 (49)	+0.14	23%

16. Daunt et al. (2002) point out that seabirds, as central place foragers, will have an upper limit set to their potential foraging range from the colony that is set by time constraints; they assess this to be a limit of 73 km for the kittiwake based on foraging flight speed and time required to catch food as observed for birds from the Isle of May. Kittiwakes would be unable to consistently travel more than 73 km from the colony and provide enough food to keep chicks alive. Hamer et al. (1993) recorded a foraging range exceeding 40 km in 1990 when sandeel stock biomass was very low and breeding success at the study colony in Shetland was 0.0 chicks per nest, but <5 km in 98% of trips in 1991 when sandeel abundance was higher and breeding success was 0.98 chicks per nest. Kotzerka et al. (2010) reported a maximum foraging range of 59 km, with a mean range of around 25 km for a kittiwake colony in Alaska. RSPB's FAME studies have shown some extremely long foraging ranges for seabirds, but those extreme values tend to occur at colonies where food supply is extremely poor and breeding success is low (for example Orkney and Shetland).

17. Data for some seabirds in Shetland show that foraging ranges are now much greater (Wade et al. 2014) than they were in the decades when the sandeel stock at Shetland was large (1970s, early 1980s), and that breeding seabirds make fewer but longer foraging trips and fail to keep chicks alive as a consequence (Heubeck and Parnaby 2012), further indicating the importance of food abundance in determining foraging ranges of breeding seabirds. Chivers et al. (2012) found this same relationship between foraging range from the colony, food abundance and breeding success in kittiwakes at colonies in Northern Ireland. Brown and Grice (2005) report that few common guillemots from the Flamborough colony bring fish back from more than 30 km distant from the colony, consistent with the high breeding success and growing breeding numbers at that colony.

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