

1. Apportioning and the assessment of cumulative effects

1. Methods of apportioning effects to SPAs are provided in the Addendum HRA at section 4.1. This Annex provides the supporting tables.

1.1 Apportioning effects during the breeding season

2. The methodology for apportioning effects to seabird breeding colonies including both Special Protection Area (SPA) and non-SPA colonies during the breeding season is described in detail in the HRA section 4.1.2 paragraphs 22 to 28. In summary, it followed a two-step approach:
 - Stage I used a Geographical Information System (GIS) to identify all breeding colonies within mean-maximum foraging range of the edge of the optimised Seagreen Project as the closest point. Colony size was determined using Seabird 2000 data as this was the last year in which a contemporaneous count of all colonies was available. Each colony was weighted according to its distance from the geometric centre of the site (as a representative distance for the whole site) and the proportion of sea available within foraging range. From this, the proportion of SPA to non-SPA colonies was established.
 - Stage II took the SPA proportion derived in Stage I and reapportioned it to the relevant SPA colonies using the latest population counts provided by SNH.
3. The apportioning tables derived using this approach for: gannet, kittiwake, guillemot, razorbill and puffin are shown in Tables 1.1-1.5 below. For auk species (guillemot, razorbill and puffin), apportioning during the breeding and non-breeding season follows the same methodology and the same table applies to both seasons.

1.2 Calculation of 'change adjusted' regional populations

4. The calculation of the regional breeding populations used as the reference population for EIA is described in the EIA section 2.4 which states that it: *'was calculated by summing the counts for each colony within mean maximum foraging range of the perimeter of the Seagreen Phase 1 area e.g. for kittiwake, the number of breeding individuals at all colonies within 60 km was summed. The counts were based on Seabird 2000 data ensuring that they were contemporaneous for all species. In acknowledgement of the fact that seabird populations may have changed significantly since that time, the regional breeding populations were then trend adjusted by applying a simple formula based on the change in SPA colony size between Seabird 2000 and recent counts'*. Table 1.6 shows how the trend adjustment was made using the latest SPA population counts provided by SNH and taken from Stage II of the apportioning process described above at 1.1.

Annex 4 Apportioning



1.3 Apportioning effects during the non-breeding season

5. Methods of apportioning effects to SPAs during the non-breeding season differ between species and are fully explained in the HRA section 4.1.3 paragraphs 29 to 39.
6. For gannet, Table 1.7 shows how non-breeding season collisions at other wind farms in the North Sea and Channel were apportioned to Forth Islands SPA to calculate cumulative collision risk.
7. For kittiwake, Tables 1.8 – 1.13 show how:
 - The SPA population was calculated as a proportion of the wider North Sea population for each of the relevant SPAs (Forth Islands SPA, Fowlsheugh SPA and St. Abb's Head to Fast Castle SPA; and
 - How that proportion was used to calculate cumulative non-breeding season collision effects on that SPA population from other wind farms in the UK North Sea.

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Table 1-1 Apportioning of breeding gannet population

Gannet Colony Name	Pop (pairs)	Distance (km)	Distance ^2	Proportion Sea	1-Psea	Colpop/sumpop	Sum dist2/col dist2	colsea/sumsea	SNH Weighting	SNH prop	SPA prop
Forth Islands	88220	79.62	6339.72	0.40	0.60	0.98	4.46	0.66	2.88	0.996	0.996
Gamrie and Pennan	2170	148.14	21945.59	0.69	0.31	0.02	1.29	0.34	0.01	0.004	0.004
	90390	227.76	28285.32	1.10	0.90	1.00	5.75	1.00	2.89	1.00	

Table 1-2 Apportioning of breeding kittiwake population

Kittiwake Colony Name	Pop (pairs)	Distance (km)	Distance ^2	Proporti on Sea	1-Psea	Colpop/sumpop	Sum dist2/col dist2	colsea/sumsea	SNH Weighting	SNH prop	SPA prop
Forth Islands	5797	67.63	4574.03	0.52	0.48	0.09	8.61	0.07	0.06	0.06	0.092
Fowlsheugh	18800	46.48	2160.64	0.50	0.50	0.31	18.23	0.08	0.43	0.40	0.419
St Abb's Head to Fast Castle	16222	79.85	6375.54	0.55	0.45	0.27	6.18	0.07	0.11	0.10	0.044
SPA Total	24597										0.56
Burn of Daff	450	54.92	3015.74	0.50	0.50	0.01	13.06	0.08	0.01	0.01	
Catterline to Inverbervie	3068	43.04	1852.27	0.51	0.49	0.05	21.27	0.08	0.08	0.07	
Crawton – Stonehaven(Fowlsheugh)	5806	47.76	2281.24	0.51	0.49	0.09	17.27	0.08	0.12	0.11	
Crawton to Catterline	4739	44.79	2006.46	0.29	0.71	0.08	19.64	0.11	0.17	0.15	
Findon Ness - Hare Ness	1142	57.64	3321.89	0.53	0.47	0.02	11.86	0.07	0.02	0.01	
Girdle Ness to Hare Ness	1395	60.62	3674.66	0.53	0.47	0.02	10.72	0.07	0.02	0.02	
Lunan Bay to Arbroath	2542	47.70	2275.62	0.52	0.48	0.04	17.31	0.08	0.05	0.05	
Montrose to Lunan Bay	384	45.74	2091.95	0.55	0.45	0.01	18.83	0.07	0.01	0.01	
Newton Hill	8	53.15	2824.99	0.53	0.47	0.00	13.95	0.07	0.00	0.00	
Newtonhill - Hall Bay	788	54.26	2943.68	0.53	0.47	0.01	13.38	0.07	0.01	0.01	
Non-SPA Total	20322										0.44
	61141	703.57	39398.72	6.56	6.44	1.00	190.33	1.00	1.10	1.00	

CURRENT COUNTS

Kittiwake Colony Name	Pop (pairs)	Distance	Distance ^2	Proporti on Sea	1-Psea	Colpop/sumpop	Sum dist2/col dist2	colsea/sumsea	SNH Weighting	SNH prop
Forth Islands	4663	67.63	4574.03	0.52	0.48	0.26	2.87	0.34	0.26	0.17
Fowlsheugh	9655	46.48	2160.64	0.50	0.50	0.55	6.07	0.35	1.16	0.75
ST Abb's Head to Fast Castle	3334	79.85	6375.54	0.55	0.45	0.19	2.06	0.32	0.12	0.08
	17652.00	193.96	13110.21	1.57	1.43	1.00	10.99	1.00	1.53	1.00

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Table 1-3 Apportioning of breeding and non-breeding guillemot population

Guillemot Colony Name	Pop (Individs)	Distance (km)	Distance ^2	Proportion Sea	1-Psea	Colpop/sumpop	Sum dist2/col dist2	colsea/sumsea	SNH Weighting	SNH prop	SPA prop
Forth Islands	36369	67.63	4574.03	0.45	0.55	0.23	12.38	0.09	0.24	0.18	0.176
Fowlsheugh	68526	46.48	2160.64	0.55	0.45	0.43	26.22	0.07	0.80	0.59	0.586
St Abb's Head to Fast Castle	43744	79.85	6375.54	0.53	0.47	0.27	8.88	0.07	0.18	0.13	0.135
SPA Total	148639									0.90	
Berwick to Scottish Border	45	90.08	8115.09	0.57	0.43	0.00	6.98	0.07	0.00	0.00	
Burn of Daff	37	54.92	3015.74	0.56	0.44	0.00	18.78	0.07	0.00	0.00	
Catterline to Inverbervie	2884	43.04	1852.27	0.53	0.47	0.02	30.58	0.07	0.04	0.03	
Crawton - Stonehaven (Fowlsheugh)	4763	47.76	2281.24	0.54	0.46	0.03	24.83	0.07	0.05	0.04	
Crawton to Catterline	2002	44.79	2006.46	0.54	0.46	0.01	28.23	0.07	0.03	0.02	
Eyemouth to Burnmouth	892	84.08	7069.21	0.56	0.44	0.01	8.01	0.07	0.00	0.00	
Findon Ness - Hare Ness	422	57.64	3321.89	0.58	0.42	0.00	17.05	0.07	0.00	0.00	
Girdle Ness to Hare Ness	75	60.62	3674.66	0.59	0.41	0.00	15.42	0.06	0.00	0.00	
Lunan Bay to Arbroath	1002	47.70	2275.62	0.47	0.53	0.01	24.89	0.08	0.01	0.01	
Newtonhill - Hall Bay	61	54.26	2943.68	0.55	0.45	0.00	19.24	0.07	0.00	0.00	
Sands of Forvie NNR (Cliff Nesters)	10	83.54	6979.27	0.65	0.35	0.00	8.12	0.05	0.00	0.00	
Non-SPA Total	12193									0.10	
	160832	862.39	56645.35	7.68	6.32	1.00	249.63	1.00	1.36	1.00	
CURRENT COUNTS											
Guillemot Colony Name	Pop (Individs)	Distance	Distance ^2	Proportion Sea	1-Psea	Colpop/sumpop	Sum dist2/col dist2	colsea/sumsea	SNH Weighting	SNH prop	
Forth Islands	28786 ¹	67.63	4574.03	0.45	0.55	0.24	2.87	0.37	0.26	0.20	
Fowlsheugh	55507 ¹	46.48	2160.64	0.55	0.45	0.46	6.07	0.31	0.86	0.65	
St Abb's Head to Fast Castle	36206 ²	79.85	6375.54	0.53	0.47	0.30	2.06	0.32	0.20	0.15	
	120499	193.96	13110.21	1.53	1.47	1.00	10.99	1.00	1.31	1.00	

¹ Unadjusted counts of individuals given in SNH updated App A (ii) Nov 2014

² Updated count derived from MS/SNH update email May 2018 (48516/1.34).

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Table 1-4 Apportioning of breeding and non-breeding razorbill population

Razorbill Colony Name	Pop (Individs)	Distance (km)	Distance ^2	Proportion Sea	1-Psea	Colpop/sumpop	Sum dist2/col dist2	colsea/sumsea	SNH Weighting	SNH prop	SPA prop
Forth Islands	4678	67.63	4574.03	0.40	0.60	0.31	7.22	0.10	0.23	0.21	0.220
Fowlsheugh	6362	46.48	2160.67	0.53	0.47	0.42	15.28	0.08	0.51	0.48	0.467
SPA Total	6362									0.69	
Burn of Daff	54	54.92	3015.74	0.52	0.48	0.00	10.95	0.08	0.00	0.00	
Catterline to Inverbervie	1962	43.04	1852.27	0.54	0.46	0.13	17.83	0.08	0.18	0.17	
Crawton - Stonehaven (Fowlsheugh) ²	578	47.76	2281.24	0.53	0.47	0.04	14.48	0.08	0.04	0.04	
Crawton to Catterline	398	44.79	2006.46	0.55	0.45	0.03	16.46	0.08	0.03	0.03	
Findon Ness - Hare Ness	337	57.64	3321.89	0.53	0.47	0.02	9.94	0.08	0.02	0.02	
Girdle Ness to Hare Ness	56	60.62	3674.66	0.53	0.47	0.00	8.99	0.08	0.00	0.00	
Lunan Bay to Arbroath	558	47.70	2275.62	0.50	0.50	0.04	14.51	0.09	0.05	0.04	
Montrose to Lunan Bay	4	45.74	2091.95	0.50	0.50	0.00	15.79	0.09	0.00	0.00	
Newton Hill	58	53.15	2824.99	0.52	0.48	0.00	11.69	0.08	0.00	0.00	
Newtonhill - Hall Bay	112	54.26	2943.68	0.52	0.48	0.01	11.22	0.08	0.01	0.01	
Non-SPA Total	4117									0.31	
	15157	623.73	33023.21	6.15	5.85	1.00	154.35	1.00	1.08	1.00	
CURRENT COUNTS											
Razorbill Colony Name	Pop (Individs)	Distance (km)	Distance ^2	Proportion Sea	1-Psea	Colpop/sumpop	Sum dist2/col dist2	colsea/sumsea	SNH Weighting	SNH prop	
Forth Islands	5815 ¹	67.63	4574.03	0.40	0.60	0.44	1.47	0.56	0.36	0.32	
Fowlsheugh ³	7426 ¹	46.48	2160.64	0.53	0.47	0.56	3.12	0.44	0.77	0.68	
	13241	114.11	6734.67	0.93	1.07	1.00	4.59	1.00	1.13	1.00	

¹ Unadjusted counts of individuals given in SNH updated App A (ii) Nov 2014.

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Table 1-5 Apportioning of breeding puffin population

Puffin Colony Name	Pop (pairs)	Distance (km)	Distance ^2	Proportion Sea	1-Psea	Colpop/sumpop	Sum dist2/col dist2	colsea/sumsea	SNH Weighting	SNH prop	SPA prop
Forth Islands	70434	67.63	4574.03	0.41	0.59	0.54	15.45	0.09	0.73	0.81	0.807
SPA Total	70434									0.81	
Farne Islands	55674	106.79	11403.55	0.63	0.37	0.43	6.20	0.06	0.15	0.16	
Fowlsheugh ²	49	46.48	2160.64	0.59	0.41	0.00	32.71	0.06	0.00	0.00	
Boddam to Collieston	1242	92.55	8566.34	0.73	0.27	0.01	8.25	0.04	0.00	0.00	
Burn of Daff	20	54.92	3015.74	0.60	0.40	0.00	23.44	0.06	0.00	0.00	
Catterline to Inverbervie	344	43.04	1852.27	0.56	0.44	0.00	38.16	0.07	0.01	0.01	
Crawton - Stonehaven (Fowlsheugh)	214	47.76	2281.25	0.58	0.42	0.00	30.98	0.06	0.00	0.00	
Crawton to Catterline	90	44.79	2006.46	0.57	0.43	0.00	35.23	0.06	0.00	0.00	
Eyemouth to Burnmouth	21	84.08	7069.21	0.54	0.46	0.00	10.00	0.07	0.00	0.00	
Findon Ness - Hare Ness	103	57.64	3321.89	0.62	0.38	0.00	21.28	0.06	0.00	0.00	
Forth Islands - Bass Rock to Haystack	1681	112.74	12711.03	0.21	0.79	0.01	5.56	0.12	0.01	0.01	
Girdle Ness to Hare Ness	3	60.62	3674.66	0.63	0.37	0.00	19.23	0.05	0.00	0.00	
Lunan Bay to Arbroath	190	47.70	2275.62	0.44	0.56	0.00	31.06	0.08	0.00	0.00	
Newton Hill	17	53.15	2824.99	0.59	0.41	0.00	25.02	0.06	0.00	0.00	
Newtonhill - Hall Bay	3	54.26	2943.68	0.60	0.40	0.00	24.01	0.06	0.00	0.00	
Non-SPA Total	59651									0.19	
	130085	974.15	70681.36	8.30	6.7	1	326.59	1	0.91	1.0	

CURRENT COUNTS

Puffin Colony Name	Pop (pairs)	Distance	Distance ^2	Proportion Sea	1-Psea	Colpop/sumpop	Sum dist2/col dist2	colsea/sumsea	SNH Weighting	SNH prop
Forth Islands	45005	67.63	4574.03	0.41	0.59	1.00	1.00	1.00	1.00	1.00
	45005	67.63	4574.03	0.41	0.59	1.00	1.00	1.00	1.00	1.00

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Table 1-6 Calculation of regional populations

Species	Mean prop change at SPA between SB2000 and recent SNH counts	increase/decline	As %	JNCC trends (http://jncc.defra.gov.uk/page-3201) - generally use older data.
Gannet	1.706	0.706	70.6%	Trend for Bass rock is +53% (2003-04 to 2014 data) - overall UK trend based on 2013-14 census is +34%
Kittiwake	0.508	0.492	-49.20%	Trend for Fowlheugh (-49%), St Abb's (-62%) and Forth Islands (+15%) since seabird 2000. Scottish trend is -21%, UK trend is -25% since SB2000.
Guillemot	0.790	0.210	-21.00%	Trend for Fowlsheugh (-11%), Forth Islands (-32%), St Abb's (-19%). trend for Scotland since SB2000 is +24%. UK trend is +31% since SB2000.
Razorbill	1.205	0.205	20.50%	Trend for Fowlsheugh (+17%), Forth Islands (+4%) and St Abb's (-18%) based on older data - overall UK trend since SB2000 is +21%
Puffin	0.639	0.361	-63.90%	Trend for Forth Islands is not detailed but the declines are noted in text. Trend in Scotland since SB2000 is +13%, UK trend is +19%

Estimated regional populations using the SPA change adjustment

Species	Regional population	Previous estimate from Ornithology Technical Report ¹
Gannet	157,923	58,212
Kittiwake	55,944	77,664
Guillemot	170,922	219,623
Razorbill	24,391	41,009
Puffin	166,240	373,138

¹Note that some of the previous counts included SPAs e.g. Buchan Ness to Collieston Coast, which have now been excluded from assessment and that latest counts used in technical report were very old

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Table 1-7 Calculation of non-breeding season collision effects on gannet at Forth Islands SPA from wind farms in the UK North Sea and Channel (after Macarthur Green 2015a)

Wind farm	Collision estimate - autumn passage						Collision estimate - spring passage					
	Passage population estimate	Proportion from Forth Islands SPA	Total collisions as consented	TCE adjustment factor	Season adjustment factor	Total collisions	Passage population estimate	Proportion from Forth Islands SPA	Total collisions as consented	TCE adjustment factor	Season adjustment factor	Total collisions
Beatrice Demonstrator	296629	0.34	0.9	1	0.67	0.2	333298	0.6	0.7	1	0.875	0.4
Greater Gabbard	395934	0.43	8.8	1	0.67	2.5	199601	0.37	4.8	1	0.875	1.6
Gunfleet Sands	395934	0.43	0	1	0.67	0.0	199601	0.37	0	1	0.875	0.0
Kentish Flats Extension	395934	0.43	0.8	0.8039	0.67	0.2	199601	0.37	1.1	0.8039	0.875	0.3
Lincs	395934	0.43	1.3	1	0.67	0.4	199601	0.37	1.7	1	0.875	0.6
London Array	395934	0.43	1.5	0.3956	0.67	0.2	199601	0.37	1.5	0.3956	0.875	0.2
Lynn and Inner Dowsing	395934	0.43	0.1	1	0.67	0.0	199601	0.37	0.2	1	0.875	0.1
Scroby Sands	395934	0.43	0	1	0.67	0.0	199601	0.37	0	1	0.875	0.0
Sheringham Shoal	393559	0.44	3.4	0.9675	0.67	1.0	197226	0.37	0	0.9675	0.875	0.0
Teesside	373539	0.46	1.7	0.6789	0.67	0.4	197226	0.37	0	0.6789	0.875	0.0
Thanet	395934	0.43	0.3	0.568	0.67	0.0	199601	0.37	0.35	0.568	0.875	0.1
Thanet extension	395934	0.43	0	1	0.67	0.0	199601	0.37	10.8	1	0.875	3.5
Humber Gateway	393559	0.44	1.1	0.4969	0.67	0.2	197226	0.37	1.5	0.4969	0.875	0.2
Westermost Rough	393559	0.44	0.1	1	0.67	0.0	197226	0.37	0.2	1	0.875	0.1
Beatrice	296629	0.34	48.8	0.6069	0.67	6.7	333298	0.6	9.5	0.6069	0.875	3.0
Blyth Demonstrator	373539	0.46	2.1	1	0.67	0.6	197226	0.37	2.8	1	0.875	0.9
Creyke Beck A	373539	0.46	5.5	1	0.67	1.7	197226	0.37	3.6	1	0.875	1.2
Creyke Beck B	373539	0.46	7.2	1	0.67	2.2	197226	0.37	4.7	1	0.875	1.5
Dudgeon	393559	0.44	38.9	0.4626	0.67	5.3	197226	0.37	19.1	0.4626	0.875	2.9
East Anglia ONE	395934	0.43	198	0.4483	0.67	25.6	199601	0.37	10	1	0.875	3.2
EOWDC	296629	0.34	5.1	0.8241	0.67	1.0	322547	0.62	0.1	0.8241	0.875	0.0
Galloper	395934	0.43	30.9	0.4341	0.67	3.9	199601	0.37	12.6	0.4341	0.875	1.8
Hornsea P1	393559	0.44	31.4	0.5776	0.67	5.3	197226	0.37	22.9	0.5576	0.875	4.1

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Wind farm	Collision estimate - autumn passage						Collision estimate - spring passage					
	Passage population estimate	Proportion from Forth Islands SPA	Total collisions as consented	TCE adjustment factor	Season adjustment factor	Total collisions	Passage population estimate	Proportion from Forth Islands SPA	Total collisions as consented	TCE adjustment factor	Season adjustment factor	Total collisions
Moray Firth	296629	0.34	35.4	1	0.67	8.1	333298	0.6	8.9	1	0.875	4.7
Race Bank	393559	0.44	11.7	0.5329	0.67	1.8	197226	0.37	4.1	0.5329	0.875	0.7
Rampion	395934	0.43	63.5	0.6918	0.67	12.7	199601	0.37	2.1	0.6918	0.875	0.5
Teesside A	373539	0.46	8	1	0.67	2.5	197226	0.37	8.6	1	0.875	2.8
Teesside B	373539	0.46	0.6	1	0.67	0.2	197226	0.37	0.7	1	0.875	0.2
Triton Knoll	393559	0.44	64.1	0.3246	0.67	6.1	197226	0.37	30.1	0.3246	0.875	3.2
Hornsea P2	393559	0.44	14	1	0.67	4.1	197226	0.37	5.6	1	0.875	1.8
Hornsea P3	393559	0.44	6.2	1	0.67	1.8	197226	0.37	12.8	1	0.875	4.1
East Anglia THREE	395934	0.43	33.2	1	0.67	9.6	199601	0.37	9.6	1	0.875	3.1
				Autumn	TOTAL (All)	104				Spring	Total (All)	47
		Proportion adult 0.55			Adults	57			Proportion adult 0.55		Adults	26

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Table 1-8 Calculation of non-breeding proportion of Forth Islands SPA kittiwakes in the Biologically Defined Minimum Population Scale (BDMPS)

	Forth Islands SPA	SPA population		BDMPS population
		Adults	Sub-adults	All birds
		9,326	8,270	
Autumn: Adults 60% Forth Islands SPA population in BDMPS sub-adults 40% ¹	Autumn: Forth Islands SPA birds in BDMPS	5,596	3,308	
Spring: Adults 60% Forth Islands SPA population in BDMPS sub-adults 30% ¹	Spring: Forth Islands SPA birds in BDMPS	5,596	2,481	
BDMPS autumn ¹		480,815	349,028	829,843
BDMPS spring ¹		375,815	251,944	627,759
Autumn proportion		0.007	0.004	
Spring proportion		0.009	0.004	

¹From Furness (2015) Tables 47 and 49

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Table 1-9 Calculation of non-breeding season collision effects on kittiwake at Forth Islands SPA from wind farms in the UK North Sea (after Macarthur Green 2015b)

Wind farm	Estimated collisions: autumn passage1						Estimated collisions: spring passage1					
	Consented design	TCE factor	Built design	After seasonal adjustment (0.75)	Forth Islands		Consented design	TCE factor	Built design	After seasonal adjustment (0.875)	Forth Islands	
					Adult	Sub-adult					Adult	Sub-adult
Greater Gabbard	15.00	1.064	15.96	11.97	0.084	0.048	11.40	1.064	12.13	10.62	0.096	0.042
Gunfleet Sands	0.00	1.000	0.00	0.00	0.000	0.000	0.00	1.000	0.00	0.00	0.000	0.000
Kentish Flats Extension	0.00	1.000	0.00	0.00	0.000	0.000	0.00	1.000	0.00	0.00	0.000	0.000
Lincs	1.20	1.043	1.25	0.94	0.007	0.004	0.90	1.043	0.94	0.82	0.007	0.003
London Array	2.30	0.391	0.90	0.67	0.005	0.003	1.80	0.391	0.70	0.62	0.006	0.002
Lynn and Inner Dowsing	0.00	1.055	0.00	0.00	0.000	0.000	0.00	1.055	0.00	0.00	0.000	0.000
Scroby Sands	0.00	1.000	0.00	0.00	0.000	0.000	0.00	1.000	0.00	0.00	0.000	0.000
Sheringham Shoal	0.00	0.981	0.00	0.00	0.000	0.000	0.00	0.981	0.00	0.00	0.000	0.000
Teesside	25.00	0.675	16.86	12.65	0.089	0.051	15.00	0.675	10.12	8.85	0.080	0.035
Thanet	0.40	0.445	0.18	0.13	0.001	0.001	0.40	0.445	0.18	0.16	0.001	0.001
Humber Gateway	3.20	0.394	1.26	0.95	0.007	0.004	2.60	0.394	1.02	0.90	0.008	0.004
Westermost Rough	0.20	0.819	0.16	0.12	0.001	0.000	0.20	0.819	0.16	0.14	0.001	0.001
Beatrice	10.70	0.550	5.89	4.42	0.031	0.018	39.80	0.550	21.90	19.16	0.172	0.077
Blyth Demonstrator	2.30	1.000	2.30	1.73	0.012	0.007	1.80	1.000	1.80	1.58	0.014	0.006
Creyke Beck A	58.50	1.000	58.50	43.88	0.307	0.176	154.00	1.000	154.00	134.75	1.213	0.539
Creyke Beck B	78.20	1.000	78.20	58.65	0.411	0.235	205.70	1.000	205.70	179.99	1.620	0.720
Dudgeon	0.00	1.000	0.00	0.00	0.000	0.000	0.00	1.000	0.00	0.00	0.000	0.000
East Anglia ONE	136.90	0.449	61.47	46.10	0.323	0.184	71.00	0.449	31.88	27.89	0.251	0.112
EOWDC	5.90	0.763	4.50	3.38	0.024	0.014	1.10	0.763	0.84	0.73	0.007	0.003
Galloper	27.80	0.419	11.65	8.73	0.061	0.035	31.80	0.419	13.32	11.66	0.105	0.047
Hornsea P1	54.20	0.594	32.22	24.16	0.169	0.097	24.70	0.594	14.68	12.85	0.116	0.051
Moray Firth	2.10	1.000	2.10	1.58	0.011	0.006	35.00	1.000	35.00	30.63	0.276	0.123
Race Bank	23.90	0.591	14.12	10.59	0.074	0.042	5.60	0.591	3.31	2.90	0.026	0.012
Rampion	37.40	0.685	25.61	19.21	0.134	0.077	29.70	0.685	20.34	17.79	0.160	0.071

Annex 4



Wind farm	Estimated collisions: autumn passage1						Estimated collisions: spring passage1					
	Consented design	TCE factor	Built design	After seasonal adjustment (0.75)	Forth Islands		Consented design	TCE factor	Built design	After seasonal adjustment (0.875)	Forth Islands	
					Adult	Sub-adult					Adult	Sub-adult
Teesside A	65.10	1.000	65.10	48.83	0.342	0.195	39.90	1.000	39.90	34.91	0.314	0.140
Teesside B	100.10	1.000	100.10	75.08	0.526	0.300	61.40	1.000	61.40	53.73	0.484	0.215
Triton Knoll	138.90	0.340	47.16	35.37	0.248	0.141	50.20	0.340	17.04	14.91	0.134	0.060
Hornsea P2	8.40	1.000	8.40	6.30	0.044	0.025	19.00	1.000	19.00	16.63	0.150	0.067
East Anglia THREE	69.00	1.000	69.00	51.75	0.362	0.207	49.00	1.000	49.00	42.88	0.386	0.172
				TOTAL	3.2	1.8				TOTAL	5.6	2.5

Table 1-10 Calculation of non-breeding proportion of Fowlsheugh SPA kittiwakes in the BDMPS

	Fowlsheugh SPA	SPA population		BDMPS population
		Adults	Sub-adults	All birds
		19,310	17,124	
Autumn: Adults 60% Fowlsheugh SPA population in BDMPS sub-adults 40% ¹	Autumn: Fowlsheugh SPA birds in BDMPS	11,586	6,850	
Spring: Adults 60% Fowlsheugh SPA population in BDMPS sub-adults 30% ¹	Spring: Fowlsheugh SPA birds in BDMPS	11,586	5,137	
BDMPS autumn ¹		480,815	349,028	829,843
BDMPS spring ¹		375,815	251,944	627,759
Autumn proportion		0.014	0.008	
Spring proportion		0.018	0.008	

¹From Furness (2015) Tables 47 and 49

Annex 4



Table 1-11 Calculation of non-breeding season collision effects on kittiwake at Fowlsheugh SPA from wind farms in the UK North Sea (after Macarthur Green 2015b)

Wind farm	Estimated number of collisions during autumn passage1							Estimated number of collisions during spring passage1					
	Consented design	TCE factor	Built design	Seasonal adjustment	After seasonal adjustment	Fowlsheugh		Consented design	TCE factor	Built design	After seasonal adjustment (0.875)	Fowlsheugh	
						Adult	Sub-adult					Adult	Sub-adult
Greater Gabbard	15.00	1.06	15.96	0.75	12.0	0.168	0.096	11.40	1.064	12.13	10.62	0.191	0.085
Gunfleet Sands	0.00	1.00	0.00	0.75	0.0	0.000	0.000	0.00	1.000	0.00	0.00	0.000	0.000
Kentish Flats Extension	0.00	1.00	0.00	0.75	0.0	0.000	0.000	0.00	1.000	0.00	0.00	0.000	0.000
Lincs	1.20	1.04	1.25	0.75	0.9	0.013	0.008	0.90	1.043	0.94	0.82	0.015	0.007
London Array	2.30	0.39	0.90	0.75	0.7	0.009	0.005	1.80	0.391	0.70	0.62	0.011	0.005
Lynn and Inner Dowsing	0.00	1.06	0.00	0.75	0.0	0.000	0.000	0.00	1.055	0.00	0.00	0.000	0.000
Scroby Sands	0.00	1.00	0.00	0.75	0.0	0.000	0.000	0.00	1.000	0.00	0.00	0.000	0.000
Sheringham Shoal	0.00	0.98	0.00	0.75	0.0	0.000	0.000	0.00	0.981	0.00	0.00	0.000	0.000
Teesside	25.00	0.67	16.86	0.75	12.6	0.177	0.101	15.00	0.675	10.12	8.85	0.159	0.071
Thanet	0.40	0.45	0.18	0.75	0.1	0.002	0.001	0.40	0.445	0.18	0.16	0.003	0.001
Humber Gateway	3.20	0.39	1.26	0.75	0.9	0.013	0.008	2.60	0.394	1.02	0.90	0.016	0.007
Westermost Rough	0.20	0.82	0.16	0.75	0.1	0.002	0.001	0.20	0.819	0.16	0.14	0.003	0.001
Beatrice	10.70	0.55	5.89	0.75	4.4	0.062	0.035	39.80	0.550	21.90	19.16	0.345	0.153
Blyth Demonstrator	2.30	1.00	2.30	0.75	1.7	0.024	0.014	1.80	1.000	1.80	1.58	0.028	0.013
Creyke Beck A	58.50	1.00	58.50	0.75	43.9	0.614	0.351	154.00	1.000	154.00	134.75	2.426	1.078
Creyke Beck B	78.20	1.00	78.20	0.75	58.7	0.821	0.469	205.70	1.000	205.70	179.99	3.240	1.440
Dudgeon	0.00	1.00	0.00	0.75	0.0	0.000	0.000	0.00	1.000	0.00	0.00	0.000	0.000
East Anglia ONE	136.90	0.45	61.47	0.75	46.1	0.645	0.369	71.00	0.449	31.88	27.89	0.502	0.223
EOWDC	5.90	0.76	4.50	0.75	3.4	0.047	0.027	1.10	0.763	0.84	0.73	0.013	0.006
Galloper	27.80	0.42	11.65	0.75	8.7	0.122	0.070	31.80	0.419	13.32	11.66	0.210	0.093
Hornsea P1	54.20	0.59	32.22	0.75	24.2	0.338	0.193	24.70	0.594	14.68	12.85	0.231	0.103
Moray Firth	2.10	1.00	2.10	0.75	1.6	0.022	0.013	35.00	1.000	35.00	30.63	0.551	0.245
Race Bank	23.90	0.59	14.12	0.75	10.6	0.148	0.085	5.60	0.591	3.31	2.90	0.052	0.023

Annex 4



Wind farm	Estimated number of collisions during autumn passage ¹							Estimated number of collisions during spring passage ¹							
	Consented design	TCE factor	Built design	Seasonal adjustment	After seasonal adjustment	Fowlsheugh		Consented design	TCE factor	Built design	After seasonal adjustment (0.875)	Fowlsheugh			
						Adult	Sub-adult					Adult	Sub-adult		
Rampion	37.40	0.68	25.61	0.75	19.2	0.269	0.154	29.70	0.685	20.34	17.79	0.320	0.142		
Teesside A	65.10	1.00	65.10	0.75	48.8	0.684	0.391	39.90	1.000	39.90	34.91	0.628	0.279		
Teesside B	100.10	1.00	100.10	0.75	75.1	1.051	0.601	61.40	1.000	61.40	53.73	0.967	0.430		
Triton Knoll	138.90	0.34	47.16	0.75	35.4	0.495	0.283	50.20	0.340	17.04	14.91	0.268	0.119		
Hornsea P2	8.40	1.00	8.40	0.75	6.3	0.088	0.050	19.00	1.000	19.00	16.63	0.299	0.133		
East Anglia THREE	69.00	1.00	69.00	0.75	51.8	0.725	0.414	49.00	1.000	49.00	42.88	0.772	0.343		
TOTAL						6.5	3.7	TOTAL						11.3	5.0

Table 1-12 Calculation of non-breeding proportion of St Abb's Head to Fast Castle SPA kittiwakes in the BDMPS

	St Abb's Head to Fast Castle SPA	SPA population		BDMPS population
		Adults	Sub-adults	All birds
		6,668	5,913	
Autumn: Adults 60% St Abb's Head to Fast Castle SPA population in BDMPS sub-adults 40% ¹	Autumn St Abb's Head to Fast Castle SPA birds in BDMPS	4,001	2,365	
Spring: Adults 60% St Abb's Head to Fast Castle SPA population in BDMPS sub-adults 30% ¹	Spring: St Abb's Head to Fast Castle SPA birds in BDMPS	4,001	1,774	
BDMPS autumn ¹		480,815	349,028	829,843
BDMPS spring ¹		375,815	251,944	627,759
Autumn proportion		0.005	0.003	
Spring proportion		0.006	0.003	

¹From Furness (2015) Tables 47 and 49

Annex 4



Table 1-13 Calculation of non-breeding season collision effects on kittiwake at St Abb's Head to Fast Castle SPA from wind farms in the UK North Sea (after Macarthur Green 2015b)

Wind farm	Estimated number of collisions during autumn passage ₁						Estimated number of collisions during spring passage ₁					
	Consented design	TCE factor	Built design	After seasonal adjustment (0.75)	St Abbs Head to Fast Castle		Consented design	TCE factor	Built design	After seasonal adjustment (0.875)	St Abbs Head to Fast Castle	
					Adult	Sub-adult					Adult	Sub-adult
Greater Gabbard	15.00	1.064	15.96	11.97	0.060	0.036	11.400	1.064	12.13	10.62	0.064	0.032
Gunfleet Sands	0.00	0.890	0.00	0.00	0.000	0.000	0.000	0.890	0.00	0.00	0.000	0.000
Kentish Flats Extension	0.00	1.000	0.00	0.00	0.000	0.000	0.000	1.000	0.00	0.00	0.000	0.000
Lincs	1.20	1.043	1.25	0.94	0.005	0.003	0.900	1.043	0.94	0.82	0.005	0.002
London Array	2.30	0.391	0.90	0.67	0.003	0.002	1.800	0.391	0.70	0.62	0.004	0.002
Lynn and Inner Dowsing	0.00	1.055	0.00	0.00	0.000	0.000	0.000	1.000	0.00	0.00	0.000	0.000
Scroby Sands	0.00	1.000	0.00	0.00	0.000	0.000	0.000	1.000	0.00	0.00	0.000	0.000
Sheringham Shoal	0.00	0.981	0.00	0.00	0.000	0.000	0.000	1.000	0.00	0.00	0.000	0.000
Teesside	25.00	0.675	16.86	12.65	0.063	0.038	15.000	0.675	10.12	8.85	0.053	0.027
Thanet	0.40	0.445	0.18	0.13	0.001	0.000	0.400	0.445	0.18	0.16	0.001	0.000
Humber Gateway	3.20	0.394	1.26	0.95	0.005	0.003	2.600	0.394	1.02	0.90	0.005	0.003
Westermost Rough	0.20	0.819	0.16	0.12	0.001	0.000	0.200	0.819	0.16	0.14	0.001	0.000
Beatrice	10.70	0.550	5.89	4.42	0.022	0.013	39.800	0.550	21.90	19.16	0.115	0.057
Blyth Demonstrator	2.30	1.000	2.30	1.73	0.009	0.005	1.800	1.000	1.80	1.58	0.009	0.005
Creyke Beck A	58.50	1.000	58.50	43.88	0.219	0.132	154.000	1.000	154.00	134.75	0.809	0.404
Creyke Beck B	78.20	1.000	78.20	58.65	0.293	0.176	205.700	1.000	205.70	179.99	1.080	0.540
Dudgeon	0.00	0.515	0.00	0.00	0.000	0.000	0.000	1.000	0.00	0.00	0.000	0.000
East Anglia ONE	136.90	0.449	61.47	46.10	0.231	0.138	71.000	0.449	31.88	27.89	0.167	0.084
EOWDC	5.90	0.763	4.50	3.38	0.017	0.010	1.100	0.763	0.84	0.73	0.004	0.002
Galloper	27.80	0.419	11.65	8.73	0.044	0.026	31.800	0.419	13.32	11.66	0.070	0.035
Hornsea P1	54.20	0.594	32.22	24.16	0.121	0.072	24.700	0.594	14.68	12.85	0.077	0.039
Moray Firth	2.10	1.000	2.10	1.58	0.008	0.005	35.000	1.000	35.00	30.63	0.184	0.092
Race Bank	23.90	0.591	14.12	10.59	0.053	0.032	5.600	0.591	3.31	2.90	0.017	0.009
Rampion	37.40	0.685	25.61	19.21	0.096	0.058	29.700	0.685	20.34	17.79	0.107	0.053

Annex 4



Wind farm	Estimated number of collisions during autumn passage ¹						Estimated number of collisions during spring passage ¹					
	Consented design	TCE factor	Built design	After seasonal adjustment (0.75)	St Abbs Head to Fast Castle		Consented design	TCE factor	Built design	After seasonal adjustment (0.875)	St Abbs Head to Fast Castle	
					Adult	Sub-adult					Adult	Sub-adult
Teesside A	65.10	1.000	65.10	48.83	0.244	0.146	39.900	1.000	39.90	34.91	0.209	0.105
Teesside B	100.10	1.000	100.10	75.08	0.375	0.225	61.400	1.000	61.40	53.73	0.322	0.161
Triton Knoll	138.90	0.340	47.16	35.37	0.177	0.106	50.200	0.340	17.04	14.91	0.089	0.045
Hornsea P2	8.40	1.000	8.40	6.30	0.032	0.019	19.000	1.000	19.00	16.63	0.100	0.050
East Anglia THREE	69.00	1.000	69.00	51.75	0.259	0.155	49.000	1.000	49.00	42.88	0.257	0.129
				TOTAL	2.3	1.4				TOTAL	3.8	1.9