



MacArthur Green

**East Anglia THREE**

**Collision Risk Modelling for alternative turbines**

---

Prepared by:	Dr Mark Trinder
Reviewed by:	Rafe Dewar
Date:	28/02/2019
Tel:	0141 342 5404
Web:	<a href="http://www.macarthurgreen.com">www.macarthurgreen.com</a>
Address:	93 South Woodside Road   Glasgow   G20 6NT

---

**Document Quality Record.**

<b>Version</b>	<b>Status</b>	<b>Person Responsible</b>	<b>Date</b>
1	Draft	MT	25/02/2019
2	Reviewed	RD	28/02/2019
3	Updated	MT	01/03/2019
4	Final Client Approval	RC	12/03/2019

## CONTENTS

1	Introduction .....	2
2	Methods.....	2
3	Results.....	3
3.1	172 Turbines .....	3
3.2	172 Consented Turbines / 140 Alternative 1 / 112 Alternative 2	<b>Error! Bookmark not defined.</b>

## 1 INTRODUCTION

This note provides annual collision estimates for the five key seabird species of primary interest during the assessment and examination for the East Anglia THREE Wind Farm: gannet, kittiwake, lesser black-backed gull, herring gull and great black-backed gull.

The estimates have been calculated using the Band (2012<sup>1</sup>) Collision Risk Model (CRM) using parameters for the consented turbines and a proposed alternative turbine to provide an indication of the predicted change to the collision risk predictions which this turbine represents. Only the turbine parameters have been changed, with all the other parameters (seabird density, biometrics, flight heights, avoidance rates, nocturnal activity, etc.) kept the same as those reported in Appendix 13.3 of the East Anglia THREE Environmental Statement (ES) (APEM 2015<sup>2</sup>) and MacArthur Green (2016<sup>3</sup>).

## 2 METHODS

The collision estimates were calculated with the Band (2012) CRM using the seabird and turbine parameters presented below (Tables 1 to 4). The consented East Anglia THREE Wind Farm design comprises 172 turbines, 52 (30%) of which have a lower rotor tip height of 22m from Mean Sea level (MSL) with the remaining 120 (70%) with a lower rotor tip height of 24m. This split height was included in the calculations presented in this note for the consented and alternative turbine, with a minimum of 52 turbines at the lower height.

**Table 1. Wind turbine parameters**

Parameter	Consented turbine	Alternative 1
Turbine model	7MW	-
No. turbines	172	Max. calculated from CRM (see Table 5)
Rotation speed (RPM)	11	7.81
Rotor radius (m)	77	110
Hub height (m) *	99 / 101	132 / 134
Max blade width (m)	5	6.6
Blade pitch (°)	15	15
Tidal offset (m)	0	0
Wind farm width (km)	33.25	33.25
Latitude (°)	52.67	52.67

\* note that in the ES a hub height of 99m was used for all turbines in the consented design. This was superseded during the project examination with a 30:70 split in hub heights which ensure lower rotor tip heights of 22m for a maximum of 52 turbines and 24m for the remainder (120) and this was the basis of the consented design.

The number of alternative turbines was calculated using the Band (2012) CRM as the maximum number which did not exceed the mortality (for any species) predicted for the consented design.

<sup>1</sup> Band, B. (2012). Using a Collision Risk Model to Assess Bird Collision Risks for Offshore Windfarms.

<sup>2</sup> APEM (2015). East Anglia THREE Appendix 13.3 Collision Risk Modelling Methodology and Predictions. Environmental Statement Volume 3 Document Reference - 6.3.13 (3)

<sup>3</sup> MacArthur Green (2016). East Anglia THREE Offshore Ornithology East Anglia THREE Revised CRM for Increase in Draft Height, East Anglia ONE Revised CRM for Final Wind Farm Design & Updated Cumulative CRM Tables Project Update Information for Deadline 5 Document Reference – Deadline 5/ Revised CRM/the Applicant

**Table 2. Wind farm operating percentages.**

Month	Operating time (%)
January	95.23
February	93.65
March	92.30
April	91.04
May	91.78
June	88.86
July	90.00
August	89.60
September	92.20
October	94.29
November	95.40
December	95.03

**Table 3. Seabird densities.**

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Gannet	0.000	0.000	0.082	0.100	0.000	0.054	0.043	0.020	0.117	0.039	1.493	0.415
Kittiwake	0.597	0.597	0.158	0.198	0.079	0.133	0.000	0.000	0.000	0.061	0.855	1.965
Lesser black-backed gull	0.020	0.000	0.000	0.021	0.023	0.018	0.000	0.086	0.048	0.000	0.029	0.000
Herring gull	0.099	0.123	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.086	0.283
Great black-backed gull	0.178	0.240	0.000	0.049	0.000	0.000	0.034	0.000	0.000	0.035	0.062	0.193

**Table 4. Seabird biometrics.**

Species	Body length (m)	Wingspan (m)	Flight speed (ms <sup>-1</sup> )	Proportion at collision height		Flight type	Nocturnal activity score	Band model option
				Lower tip 22m above MSL	Lower tip 24m above MSL			
Gannet	0.94	1.72	14.9	0.0677	0.0558	gliding	2	1
Kittiwake	0.39	1.08	13.1	0.1009	0.0673	flapping	3	1
Lesser black-backed gull	0.58	1.42	13.1	0.2391	0.2105	flapping	3	2
Herring gull	0.6	1.44	12.8	0.2773	0.2476	flapping	3	2
Great black-backed gull	0.71	1.58	13.7	0.2997	0.2693	flapping	3	2

### 3 RESULTS

#### 3.1 Consented and Alternative Design

The maximum number of the alternative turbine which could be installed while not exceeding the collision mortality for the consented wind farm design was calculated as follows:

1. The sum of the mortality for 52 (alternative) turbines with a minimum draught height of 22m (column 5, Table 5) was subtracted from the total consented mortality (column 4, Table 5), with the remainder equivalent to the permissible mortality for turbines with a draught height of 24m.

2. The maximum number of turbines with a 24m draught height that did not exceed the remainder (from step 1) was found by incrementing the turbine number for each species.
3. The total number of alternative turbines was calculated as 52 (from step 1) plus the minimum number identified at step 2 (i.e. when compared across the five species).

Due to the greater rotor swept area, the per turbine collision risk was slightly higher for the alternative turbine, and the species which reached the consented mortality total with the smallest number of alternative turbines was kittiwake (i.e. the per turbine collision risk was highest for this species).

The results of these calculations are provided in Table 5. The total number which did not exceed the consented estimate for kittiwake was 134 turbines (52 at 22m and 82 at 24m).

**Table 5. Comparison of annual collision risk estimates for East Anglia THREE with 172 turbines calculated for the consented design ( as presented in the ES, column 1) and the maximum number of Alternative turbines (columns 5-8) which did not exceed the consented mortality for any species.**

Species	Consented turbine – 172 turbines				Alternative turbine – 134 turbines			
	1	2	3	4	5	6	7	8
	Annual collisions (from ES)	52 turbines at 22m above MSL	120 turbines at 24m above MSL	<b>Annual collisions (consented project, 30%+70%)</b>	52 turbines at 22m above MSL	82 turbines at 24m above MSL	<b>Annual collisions (consented project, 52 @ 22m &amp; 82 @ 24m)</b>	Ratio of consented annual to alt 2 annual (col. 4 / col. 7)
Gannet	56	16.9	32.1	<b>49.0</b>	19.9	25.9	<b>45.8</b>	0.93
Kittiwake	146	44.2	68.0	<b>112.2</b>	54.41	57.2	<b>111.6</b>	0.99
Lesser black-backed gull	10	3.14	6.37	<b>9.51</b>	3.77	5.24	<b>9.01</b>	0.95
Herring gull	26	7.84	16.15	<b>23.99</b>	9.41	13.25	<b>22.7</b>	0.94
Great black-backed gull	42	12.65	26.2	<b>38.85</b>	15.06	21.34	<b>36.4</b>	0.94