Seagreen S36C Application

Screening Report

January 2022

Annex 1 - Collision Risk Model for Seagreen Wind Energy Wind farm

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Comparison of different turbine parameters on estimated seabird mortality

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Collision Risk Model for Seagreen Wind Energy Wind farm

Comparison of different turbine parameters on estimated seabird mortality

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Acronyms and Abbreviations

BTO	British Trust for Ornithology
CRM	Collision Risk Model
Gannet	Northern gannet (*Morus bassanus*)
Herring gull	European herring gull (*Larus argentatus*)
Kittiwake	Black-legged kittiwake (*Rissa tridactyla*)
MS-LOT	Marine Scotland - Licensing Operations Team
NatureScot	Scotland's Nature Agency
RPM	Revolutions Per Minute
sCRM	Stochastic Collision Risk Model
WTG	Wind Turbine Generator

1. INTRODUCTION

A Collision Risk Model (CRM) was used to estimate and compare the annual mortality of three species of seabird between different designs of Wind Turbine Generator (WTG) within a proposed Seagreen Wind Farm Array.

The three species of seabird compared were northern gannet (*Morus bassanus*), black-legged kittiwake (*Rissa tridactyla*), and European herring gull (*Larus argentatus*). These species were chosen to keep in line with previously conducted CRMs and were identified through a Marine Scotland Scoping Opinion in 2017.

The estimates have been calculated using the Band (2012) Collision Risk Model (Excel file accessed through the British Trust for Ornithology Strategic Ornithological Support Services website) and also using the McGregor (2018) Stochastic Collision Risk Model (sCRM) (rShiny App accessed through the Scottish Government website).

Three sets of WTGs were compared for this assessment they are categorised as:

- Originally consented WTGs
- Currently constructed WTGs
- Newly proposed WTGs

Two layouts of these WTGs were compared:

- 150 WTGs originally consented
- 114 WTGs currently constructed + 36 WTGs newly proposed

Only turbine parameters were changed within the CRMs to allow for comparison, all other input parameters to the model were kept consistent within each model. Seabird density and biometric data were kept consistent between both CRMs. Site specific flight height distribution was not available from survey data and as such was taken from the Cook *et al* (2011) found within the Band CRM excel and from Johnston *et al* (2014) as is available within the sCRM web app.

2. METHOD

Estimated mortality rates through collision with turbine blades are calculated using Option 2 of the Band CRM and Option 2 and Option 3 of the McGregor sCRM. Whilst Option 1 would be preferable there was not enough site specific survey data that could be used. It is also in keeping as close as possible to the methods and parameters of the original consent application CRM in which Option 2 was chosen.

- Option 2 assumes uniform distribution, based on the proportion of sea birds at collision risk height (between lowest and highest height of the turbine blades) taken from species specific pooled and modelled flight data.
    - Within the Band CRM, this proportion at collision risk height data comes from the Cook *et al* (2011) aggregate dataset. Gannet and kittiwake flight height proportions are present from 0–150m within the Excel CRM. Flight height proportions between 0–150m herring gull were not available. As neither site survey data nor aggregate data of flight heights were available, and the known proportion of birds between 20–150m was 28.4% (Cook *et al* 2011) this proportion was used for herring gull for all WTGs in the Band CRM.
    - Within the McGregor sCRM, the proportion at collision risk height comes from the Johnston *et al* (2014) modelled flight data. For all three species of sea bird, flight height proportions were available within the sCRM rShiny app from 0–300m.

- Option 3 is an extension of Option 2, with the full range of flight distributions between minimum and maximum heights of the turbine blades is incorporated with a calculation of varying risk of collision across the swept area.
  - Within the Band CRM Option 3 was not considered as there was not a full enough range of flight height data from the Cook *et al* (2011) dataset as all turbines had a maximum height above 150m for gannet and kittiwake.
  - Within the McGregor sCRM, this extended modelling is presented as per Nature Scot guidance for only the kittiwake and herring gull.

The parameters used within each model to obtain the collision estimates are presented below (see Table 1 to Table 4).

In both the Band CRM and McGregor sCRM sets of results were obtained for estimated mortality for each of the 3 seabird species, the number of WTGs in each set were:

- 150 WTGs with originally consented parameters;
- 36 WTGs newly proposed parameters; and
- 114 WTGs currently constructed parameters.

Parameters used whilst running the Band CRM were the same as or as close as possible to the parameters and methods used in the original Seagreen consent.

The Seagreen site has a latitude of 56.37 degrees and this was kept consistent in all models to inform the number of daylight hours.

The maximum width of the windfarm was assessed to be 30km.

Tidal offset within the Band CRM was 0 m and within the McGregor sCRM was 2.3 m, to provide correction for flight heights measured from mean sea level and turbine parameters measured from highest astronomical tide (tidal data from the National Tidal and Sea Level Facility at Aberdeen port shows mean sea level 2.55 m and highest astronomical tide 4.85 m).

Each WTG design has 3 blades. Monthly proportion of time operational was set at 88% for the WTGs originally consented and 90% for WTGs currently constructed and WTGs newly proposed. Rotation speed of 14 rpm was used as a worst case scenario for the WTGs originally consented, and WTGs newly proposed. Rotation speed of 8.8 rpm was used for the WTGs currently constructed. In the Band CRM to keep in line with a previously conducted CRM in 2012, a second model run was undertaken for WTGs originally consented with a likely monthly average rpm, giving an annual average of 10.6 rpm (see Table 2). Rotor pitch was 10 degrees consistently in each model. Maximum rotor width was set at 5.4 m for the WTGs originally consented, and WTGs currently constructed, and at 7.6 m for the WTGs newly proposed. Rotor radius was 83.5 m for the WTGs originally consented, 82 m for the WTGs currently constructed, and 121 m for the WTGs newly proposed.

Maximum height above the mean sea level was 194.3 m for the WTGs originally consented, 198.5 m for the WTGs currently constructed, and 273.5 m for the WTGs newly proposed. Hub height above the mean sea level was 110.8 m for the WTGs originally consented, 116.5 m for the WTGs currently constructed, and 152.5 m for the WTGs newly proposed. The air gap between the lowest sweep of the rotor and mean sea level was 27.3 m for the WTGs originally consented, 34.5 m for the WTGs currently constructed, and 31.5 m for the WTGs newly proposed.

Seabird morphological and behavioural parameters were kept the same in all models (see Table 4). Bird length and wingspan from BWPi 2004 data, flight speed from Alerstam *et al* 2007, flight type set to flapping for all species, and nocturnal activity proportions were taken from data previously agreed within a scoping opinion from MS-LOT and found within Seagreen (2018) EIAR Appendix 8B. Seabird monthly flight density is derived from site survey data as used in the Seagreen (2018) EIAR Appendix 8B (see Table 3).

Avoidance rates used within the Band CRM for Option 2 are the same as in Seagreen (2018) EIAR Appendix 8B and these are:

- Gannet – 98.9% (±0.2%)
- Kittiwake – 98.9% (±0.2%)
- Herring gull – 99.5% (±0.1%)

Avoidance rates used within the McGregor sCRM are taken from Bowgen & Cook (2018) as recommended in Nature Scot guidance. The avoidance rates are:

- Gannet:
  - Option 2 – 99.7% (±0.2%)
  - Option 3 – N/A (Option 3 not considered for gannet)
- Kittiwake:
  - Option 2 – 99.2% (±0.2%)
  - Option 3 – 96.7% (±2.7%)
- Herring gull:
  - Option 2 – 99.7% (±0.2%)
  - Option 3 – 99.2% (±0.2%)

Table 1: WTG Parameters and data

Parameter	Consented WTG	Constructed WTG	Newly Proposed WTG
Array latitude (degrees)	56.37	56.37	56.37
Number of WTGs in Array	150 (36*)	114	36
Width of Array (km)	30	30	10
Number of blades	3	3	3
Rotation speed (rpm)	14 (10.6*)	8.8	14
Rotor radius (m)	83.5	82	121
Maximum blade width (m)	5.4	5.4	7.6
Rotor blade pitch (degrees)	10	10	10
Airgap above mean sea level (m)	27.3	34.5	31.5
Total height of WTG above mean sea level (m)	194.3	198.5	273.5
Hub height above mean sea level (m)	110.8	116.5	152.5
Monthly proportion of time operational (%)	88	90	90

**Consented worst case 14 rpm but expected 10.6 rpm annually (see Table 2)*

Table 2: Monthly Predicted RPM of Consented Turbines from Seagreen Vortex Hindcast modelling (Used in Band CRM)*

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Avg
11.2	10.9	10.8	10.5	10.2	10.3	10.1	10.0	10.7	11.0	11.1	10.9	10.6

**As used in Addendum to the Seagreen (2018) EIAR – Appendix 8B*

Table 3: Mean Monthly Densities (km^{-2}) of flying birds, with standard deviations. Breeding season in grey, precautionary breeding season in blue.

Species	Value	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Gannet	Mean	0.309	0.613	1.900	1.154	4.986	7.612	2.116	3.403	2.197	1.333	0.532	0.083
	SD	0.126	-	0.752	0.704	0.932	2.809	1.454	2.653	1.078	1.372	0.485	0.118
Kittiwake	Mean	1.911	1.355	2.629	1.804	2.947	2.409	3.414	1.167	2.017	1.999	8.610	0.666
	SD	0.072	-	2.618	0.121	1.604	1.563	3.053	1.225	2.737	1.201	11.332	0.748
Herring gull	Mean	0.120	0.108	0.190	0.028	0.078	0.128	0.019	0.000	0.028	0.072	0.027	0.235
	SD	0.130	-	0.229	0.001	0.053	0.171	0.033	0.000	0.040	0.022	0.038	0.255

Table 4: Seabird morphological and behaviour parameters

Bird	Length (m)	Wingspan (m)	Flight speed (m sec^{-1})	Nocturnal Activity	Flight Type
Gannet	0.94	1.72	14.9	1 (0%)*	Flapping
Kittiwake	0.39	1.08	13.1	2 (50%)*	Flapping
Herring gull	0.61	1.44	12.8	2 (50%)*	Flapping

**Integer for use in Band CRM, percentage for use in McGregor sCRM*

3. RESULTS

The results are presented as annual collision estimates for each species and each Seagreen WTG option, with relevant avoidance rates detailed in the methods applied. The results are based on all flying seabirds regardless of age or breeding status. Due to the model expressing estimated mortality as decimal numbers and excel rounding to the nearest whole number some additions may not sum as displayed.

Table 5 shows estimated annual mortality using the Band CRM Option 2. For the 150 WTGs comparison, there is a decrease in estimated mortality for gannet and kittiwake from the consented WTGs to the combination of newly proposed and constructed WTGs. This is possibly due to the slightly smaller swept area of the 114 constructed WTGs and the larger air gap in both the constructed and newly proposed WTGs. Herring gull sees a slight increase in estimated mortality in the 150 WTGs comparison, likely because the minimum blade tip height is not factored into the herring gull modelling due to data limitations, the higher predicted collisions for herring gull reflects the larger swept area of the newly proposed WTGs.

McGregor sCRM annual estimated mortality as seen in Table 6 and Table 7 shows a large decrease in mortality for all species from the 150 consented to the combination of constructed and newly proposed. Using Option 3 for kittiwake and herring gull there is a decrease in both comparisons from consented to newly proposed (and constructed) WTGs.

Table 5: Band 2012 CRM Estimated Annual Mortality - Option 2

Species	150 WTGs Consented 10.6rpm	150 WTGs Consented 14rpm	114 WTGs Constructed + 36 WTGs Newly proposed
Northern gannet	372	431	166
Black-legged kittiwake	381	424	222
European herring gull*	34*	39*	40*

**Flight height data were not available for herring gull and as such 28.4% proportion at collision risk height was used for all WTG options.*

Table 6: McGregor 2018 sCRM Estimated Annual Mortality - Option 2

Species	150 WTGs Consented	114 WTGs Constructed + 36 WTGs Newly proposed
Northern gannet	173	101
Black-legged kittiwake	587	350
European herring gull	26	19

Table 7: McGregor 2018 sCRM Estimated Annual Mortality - Option 3

Species	150 WTGs Consented	114 WTGs Constructed + 36 WTGs Newly proposed
Black-legged kittiwake	636	301
European herring gull	32	19

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