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## Abbreviations and Acronyms

| | |
|---|---|
| COWRIE | Collaborative Offshore Wind Research into the Environment |
| CRM | Collision Risk Model |
| ES | Environmental Statement |
| ESAS | European Seabirds at Sea |
| MSL | Mean Sea Level |
| MS-LOT | Marine Scotland Licencing and Operations Team |
| PCH | Potential Collision Height |
| SD | Standard Deviation |
| SOSS | Strategic Ornithological Support Services |
| SNCB | Statutory Nature Conservation Body |

# 11C Estimation of the Development Alone and Cumulative Collision Risk

## 11C.1 Introduction

1 The Scoping Opinion from Marine Scotland Licencing and Operations Team (MS-LOT) identifies six key seabird species on which potential impacts from the Development should be assessed (*Appendix 11A: Baseline Technical Report*). Of these six species, the Scoping Opinion advises that collision risk should be considered for three – i.e. gannet, kittiwake and herring gull.

2 This report presents the details of the approach and methods used to estimate the potential collision risk to these three seabird species, along with the outputs from the resulting collision risk models (CRMs). This is undertaken both for the different design options being considered for the Development, and for the 2014 and 2017 designs for the other three Forth and Tay wind farms (i.e. Neart na Gaoithe, Seagreen Alpha and Seagreen Bravo).

## 11C.2 Methods

### 11C.2.1 Collision risk modelling

3 CRMs were undertaken using the Strategic Ornithological Support Services (SOSS) offshore CRM (Band 2012). The SOSS offshore CRM can generate collision estimates by two different methods (basic and extended models), each of which have two different options. The basic model assumes a uniform flight height distribution across the rotor swept heights, whilst the extended model uses species-specific modelled flight height distributions to account for variation in the distribution of flights across the rotor swept heights (Band 2012, Johnston *et al.* 2014a, b). Seabird flight height distributions tend to be skewed towards the lower rotor swept heights, where collision risk is lower (Band 2012), so that for most species the extended model will give lower collision estimates than the basic for a given avoidance rate and set of wind farm parameters.

4 Each of the basic and extended models can be run using either site-specific flight height data (i.e. as collected from the development area in question) or generic flight height data, which derive from pre-construction surveys for wind farm developments at 32 sites in the UK and elsewhere in Europe (Johnston *et al.* 2014a, b). This gives rise to options 1 (site-specific flight height data) and 2 (generic flight height data) for the basic model and options 3 (generic flight height data) and 4 (site-specific flight height data) for the extended model (Band 2012).

5 Work undertaken to derive species-specific avoidance rates for use with the SOSS offshore CRM failed to identify suitable values for gannet and kittiwake in relation to the extended model (Cook *et al.* 2014). Therefore, as advised in the Scoping Opinion, the CRMs for the current assessment are undertaken using options 1 and 2 for gannet and kittiwake and options 1, 2 and 3 for herring gull. The avoidance rates applied to the CRMs for each species and model option follow the available Statutory Nature Conservation Bodies (SNCBs) advice (SNCBs 2014), and are as advised in the Scoping Opinion (*Table 11C.1*). Variation about the

estimated collision estimates, as calculated with the recommended avoidance rate, is expressed by applying the mean avoidance rate ±2 standard deviations (SDs).

**Table 11C.1 Avoidance rates (±2 SD) used in the CRMs according to species and model option**

| Species | Model option | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Gannet | 98.9% (± 0.2%) | 98.9% (± 0.2%) | N/A |
| Kittiwake | 98.9% (± 0.2%) | 98.9% (± 0.2%) | N/A |
| Herring gull | 99.5% (± 0.1%) | 99.5% (± 0.1%) | 99.0% (± 0.2%) |

6 Some of the seasonal periods advised for gannet and kittiwake encompassed half months (e.g. for gannet the spring passage and breeding periods were from December to mid-March and mid-March to September, respectively). In these cases, half of the estimated collisions for the 'split' month were allocated to each of the two consecutive seasonal periods encompassing the month (as advised in the Scoping Opinion).

### 11C.2.2 Bird densities and flight heights

7 Collision risk is estimated on the basis of the densities of birds in flight recorded within the Development Area, whilst the flight height estimates are used to determine the percentage of the birds in flight which occur at rotor swept heights. The bird flight density and flight height data used in the current CRMs are as for the CRMs used for the Inch Cape 2013 Environmental Statement (ES) and Marine Scotland 2014 Appropriate Assessment, with these data being treated in the same way as for the earlier CRMs (ICOL 2013, MS-LOT 2014).

8 Thus, the flight densities of each species within the Development Area are calculated using data collected during the baseline surveys, which were carried out by an adapted European Seabirds at Sea (ESAS) method and following guidelines for Collaborative Offshore Wind Research into the Environment (COWRIE) (Camphuysen *et al*. 2004, Maclean *et al*. 2009). These surveys were undertaken at approximately monthly intervals, from September 2010 and September 2012 (inclusive). Details of the methods used to count birds in flight and estimate the monthly densities are provided in *Appendix 11A.*

9 As advised in the Scoping Opinion, the mean flight densities for each month (as calculated from the values from the different survey years) were used as the inputs to the CRMs. There was only one survey for November (there being no 2010 November survey), whilst the estimates for May 2011 derived from the survey undertaken on 3 June 2011 (there being two separate June surveys but no May survey in 2011). The mean monthly flight densities (with the associated SDs) are given in *Table 11C.2*.

**Table 11C.2 Mean monthly flight densities ± 1 SD (birds/km$^2$) for each of the three species for which collision risk is estimated**

| Species | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov[1] | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gannet | 0.150 ±0.072 | 0.556 ±0.235 | 0.578 ±0.184 | 2.174 ±1.720 | 4.328 ±1.286 | 3.776 ±1.068 | 3.628 ±2.479 | 5.134 ±2.388 | 1.512 ±0.646 | 1.035 ±0.250 | 0.193 - | 0.000 ±0.000 |
| Kittiwake | 0.200 ±0.001 | 0.048 ±0.068 | 0.569 ±0.604 | 0.612 ±0.422 | 0.839 ±0.475 | 1.998 ±1.378 | 3.682 ±2.826 | 0.487 ±0.277 | 2.495 ±3.299 | 1.591 ±0.036 | 0.628 - | 0.347 ±0.354 |
| Herring gull | 0.100 ±0.001 | 0.048 ±0.000 | 0.000 ±0.000 | 0.000 ±0.000 | 0.024 ±0.035 | 0.122 ±0.172 | 0.000 ±0.000 | 0.024 ±0.034 | 0.000 ±0.000 | 0.025 ±0.036 | 0.048 - | 0.147 ±0.067 |

[1]No SD can be calculated for November because there was only a single survey in that month.

10 As described above (*Table 11C.2.1*), the CRMs were undertaken using options 1 and 2 for gannet and kittiwake, and options 1, 2 and 3 for herring gull. The option 2 and 3 CRMs used the generic flight height data for each species (Johnston *et al.* 2014a, b). Site-specific flight height data for each species were collected during the ESAS-type baseline surveys, with these data being derived from the entire survey area (encompassing the Development Area and a surrounding four kilometre buffer) to increase sample size. Flight heights were recorded in five metre height bands up to 50 m, above which 10 m bands were used up to 100 m, and subsequently 50 m bands. However, to account for an apparent tendency to bias recording towards the 10 m intervals, the flight height records from the five metre height bands were amalgamated into 10 m bands.

11 For gannet and herring gull (the two larger species), the recorded flight heights were used from all observations, irrespective of whether or not they derived from the 300 x 300m snapshot count areas. However, for kittiwake, flight height records were restricted to those deriving from the snapshot count areas. This was on the basis that there was a greater chance of under-recording low flying birds beyond 300 m from the vessel, given the smaller size of this species. Thus, flight heights were estimated for;

- 12,655, 825 and 911 gannets during the breeding, autumn passage and spring passage periods, respectively;
- 1,417, 755 and 210 kittiwakes during the breeding, autumn passage and spring passage periods, respectively; and
- 80 and 253 herring gulls during the breeding and non-breeding periods, respectively.

12 For the site-specific data, the percentage of flights occurring within the rotor swept heights (or the potential collision height – PCH) was calculated separately for each of the seasonal periods applied to each species (see below). To calculate the percentage of birds at PCH, the number of birds recorded in those height bands encompassed by PCH was summed and expressed as a percentage of the total number of birds. Where there was partial overlap between a height band and PCH, then the number of birds at PCH within the height band was assumed to be proportional to the extent of overlap (e.g. an overlap of two metres equating to 20 per cent of the records from the 10 m height band being assumed to be at PCH).

13 The variability about the percentage of flights estimated at PCH by the site-specific data was calculated for both gannet and kittiwake, and compared with the estimates from the generic data. This was not undertaken for herring gull because of the relatively small number of flights of this species recorded during the 'at-sea' surveys, whilst the difference in the collision estimates between options 1 and 2 of the CRM were less marked for this species than for either gannet or kittiwake – see below).

14 Variability in the site-specific estimates was calculated by making the number of flights recorded at PCH during each survey the dependent variable in a regression with a quasi-binomial error structure and logit link function, and with the total number of birds recorded in flight during the survey made the binomial denominator (Crawley 2007). By fitting the null

model (i.e. with no covariates or factors included), the resulting parameter estimate equates to the logit transformed mean value for the dependent variable divided by the total number of birds in flight. The 95 per cent confidence limits for this mean value were calculated, so that the back transformed values gave the estimated proportion of flights at PCH together with the associated upper and lower 95 per cent confidence limits. This calculation was undertaken separately for each seasonal period for both species. A quasi-binomial error structure was used instead of a binomial error structure to account for over-dispersion in some of the models (i.e. where the residual deviance over the residual degrees of freedom exceeds one). The use of a quasi-binomial error is more conservative in that it estimates greater variation about the mean. These calculations were undertaken in the R statistical software (R Development Core Team, 2012).

15 The generic flight height data are available as estimates of the percentage of flights occurring at one metre intervals from 0 – 1 m to 299 – 300 m, with lower and upper 95 per cent confidence limits for each estimate[1]. For the purposes of comparisons with the site-specific flight estimates, these estimates and their confidence limits were summed across the one metre height intervals encompassed by the rotor swept heights.

### 11C.2.3 Other species-specific parameters

16 In addition to the estimates of density and flight height, the input parameters for the CRM include data on a number of other attributes of the species for which collision risk is being estimated. These are detailed below for the three species on which CRMs were undertaken for the current assessment (*Table 11C.3*).

**Table 11C.3 Details of species-specific parameters used as in the CRMs**

| Species | Parameter | | | | |
|---|---|---|---|---|---|
| | Bird length (m)[1] | Wingspan (m)[1] | Flight speed ($m.s^{-1}$)[2] | Flight type | Nocturnal activity[3] |
| Gannet | 0.94 | 1.73 | 14.9 | flapping | 1 (=0%) |
| Kittiwake | 0.39 | 1.08 | 13.1 | flapping | 2 (=25%) |
| Herring gull | 0.60 | 1.44 | 12.8 | flapping | 2 (=25%) |

[1]From BTO Birdfacts (https://www.bto.org/about-birds/birdfacts) [Accessed 10/05/2018].
[2]From Pennycuik (1997) for gannet and Alerstam *et al.* (2007) for kittiwake and herring gull.
[3]Following the advice of the Scoping Opinion.

[1] https://www.bto.org/science/wetland-and-marine/soss/projects [Accessed 10/05/2018]

## 11C.3 Development-alone collision estimates

### 11C.3.1 Design options

17 In relation to collision risk, two design options are considered for the Development (both with a total rotor swept area of 87,000 $m^2$ below 50 m above Mean Sea Level (MSL). These differ in the number of Wind Turbine Generators (WTGs), the WTG hub height and rotor blade diameter, as well as in the maximum rotor blade width and estimated rotor speed (Table 11C.4). For both designs, there are fewer WTGs than for the 2014 design on which the previous Appropriate Assessment was undertaken (MS-LOT 2014), whilst the greater hub heights result in greater clearance above the sea surface (despite the larger rotor diameters associated with these designs).

**Table 11C.4 Wind farm parameters used in the CRMs for the two design options considered (together with the parameters used in the 2014 design presented for comparison)**

| Parameter | 2014 Appropriate Assessment design | 2017 designs | |
|---|---|---|---|
| | | 40 WTG | 72 WTG |
| Number of WTGs | 110 | 40 | 72 |
| Hub height (relative to MSL) (m)[1,2] | 110.97 | 152.6 | 116.1 |
| Rotor diameter (m) | 172 | 250 | 167 |
| Height to upper blade tip (relative to MSL) (m) [1,2] | 196.97 | 277.6 | 199.6 |
| Height to lower blade tip (relative to MSL) (m) [1,2] | 24.97 | 27.6 | 32.6 |
| Maximum blade width (m) | 6.0 | 7.8 | 6.0 |
| Rotor speed (rpm)[3] | 7.39 | 5.72 | 8.72 |
| Pitch (°) | 10 | 10 | 10 |
| Monthly percentage of time operational (%)[3] | 91 | 80 | 80 |

[1]Values are given relative to MSL because the CRM is calculated using MSL. MSL is 2.9m above LAT for the Development Area.
[2]Values represent the average heights above MSL. Heights vary because of changes in water depth across the site. Turbine parameters will not exceed those as detailed in *Chapter 7: Description of Development* and will be such that the CRM estimates do not exceed those calculated for the assessment (on the basis of the data, methods and assumptions used here) .
[3]Values are estimated on a monthly basis with the annual mean for all months presented. The CRM uses the mean values from across the months comprising the relevant seasonal periods (see below). The values used in each CRM can be obtained from *Annex 11C.1*.

### 11C.3.2 Collision estimates

**Differences between designs**

18 Collision estimates for gannet and kittiwake were lower for the 72 WTG design than for the 40 WTG design, (almost) irrespective of seasonal period and model option (*Table 11C.5*). The only exceptions were for the option 2 autumn and spring passage estimates for gannet, which were the same for both designs. This finding may appear counter-intuitive, given that the collision estimates will increase in direct proportion to WTG number (all else being equal). However, the 'air gap' (i.e. distance from sea surface to lower rotor blade height) for the 72 WTG is five metres higher than for the 40 WTG design (*Table 11C.4*) and this more than compensates for the greater number of WTGs in terms of reducing the collision estimates, with a smaller percentage of birds at PCH for the 72 WTG design (*Table 11C.6*). Overall, the differences between the two designs were relatively small for both of these species, which is expected given that the two designs had the same rotor swept area below 50 m MSL.

19 Collision estimates for herring gull were low, with a maximum of one and three collisions estimated for the breeding and non-breeding periods, respectively. These estimates were lower than for either gannet or kittiwake, except for the option 1 breeding season estimates for kittiwake, which were the same as for herring gull. Given the very low number of estimated collisions for herring gull, the differences between the two designs were minor. The 72 WTG design gave lower estimates during the breeding season for option 1 but higher estimates during the non-breeding season for both options 2 and 3, and represented the worst-case for this species overall. However, in all cases the differences between the two designs equated to a single collision (*Table 11C.5*).

**Table 11C.5 Collision estimates according to wind farm design and CRM option**

| Species | Design | Seasonal period | Estimated number of collisions (range with ±2 SD applied to avoidance rate)[1] | | |
|---|---|---|---|---|---|
| | | | Option 1 | Option 2 | Option 3 |
| Gannet | 72 WTG | Breeding (mid-Mar – Sep) | 32 (26 – 38) | 96 (79 – 113) | N/A |
| | | Autumn passage (Oct – Nov) | 0 (0 – 0) | 5 (4 – 6) | N/A |
| | | Spring passage (Dec – mid-Mar) | 0 (0 – 0) | 4 (3 – 5) | N/A |
| | 40 WTG | Breeding (mid-Mar – Sep) | 46 (38 – 54) | 108 (88 – 128) | N/A |

| Species | Design | Seasonal period | Estimated number of collisions (range with ±2 SD applied to avoidance rate)[1] | | |
|---|---|---|---|---|---|
| | | | Option 1 | Option 2 | Option 3 |
| | | Autumn passage (Oct – Nov) | 1 (0.8 – 1.2) | 5 (4 – 6) | N/A |
| | | Spring passage (Dec – mid-Mar) | 1 (0.8 – 1.2) | 4 (3 – 5) | N/A |
| Kittiwake | 72 WTG | Breeding (mid-Apr – Aug) | 0 (0 – 0) | 36 (29 – 43) | N/A |
| | | Autumn passage (Sep – Dec) | 7 (6 – 8) | 23 (19 – 27) | N/A |
| | | Spring passage (Jan – mid-Apr) | 1 (0.8 – 1.2) | 5 (4 – 6) | N/A |
| | 40 WTG | Breeding (mid-Apr – Aug) | 1 (0.8 – 1.2) | 40 (33 – 47) | N/A |
| | | Autumn passage (Sep – Dec) | 19 (16 – 23) | 26 (21 – 31) | N/A |
| | | Spring passage (Jan – mid-Apr) | 3 (2 – 4) | 6 (5 – 7) | N/A |
| Herring gull | 72 WTG | Breeding (Apr – Aug) | 0 (0 – 0) | 1 (0.8 – 1.2) | 1 (0.8 – 1.2) |
| | | Non-breeding (Sep – Mar) | 1 (0.8 – 1.2) | 3 (2 – 4) | 2 (1.6 – 2.4) |
| | 40 WTG | Breeding (Apr – Aug) | 1 (0.8 – 1.2) | 1 (0.8 – 1.2) | 1 (0.8 – 1.2) |
| | | Non-breeding (Sep – Mar) | 1 (0.8 – 1.2) | 2 (1.6 – 2.4) | 1 (0.8 – 1.2) |

[1]Avoidance rates applied to each combination of species and model option are as given in *Table 11C.1*, as are the values for the SD about the estimated avoidance rate.

**Differences between model options**

20 For both gannet and kittiwake, the option 1 collision estimates were considerably lower than the option 2 estimates (*Table 11C.5*). These differences were most marked for kittiwake,

particularly during the breeding period (with the option 1 estimates being zero and one collisions for the 72 and 40 WTG designs, respectively), but were also substantial for gannet (with the option 2 estimates for the breeding period being three and two and half times greater than for option 1 for the 72 and 40 WTG designs, respectively).

21 These differences are due to the lower percentage of flights estimated to occur at PCH by the site-specific flight height data than by the generic flight height data (*Table 11C.6*, *Appendix 11A*). Consideration of the statistical variability associated with these estimates demonstrates that for gannet and kittiwake the estimates for flights at PCH using the generic data exceeds the upper 95 per cent confidence limit for the site-specific estimates in all but two instances (i.e. kittiwake spring passage for the 72 WTG design and kittiwake autumn passage for the 40 WTG design). Also, there is no overlap in the 95 per cent confidence intervals for the respective generic and site-specific estimates in five of the 12 comparisons for gannet and kittiwake (most notably for kittiwake during the breeding period - *Table 11C.6*). Thus, there is relatively strong statistical support for the observed differences in the site-specific and generic flight height estimates.

**Table 11C.6 Percentage of flights estimated to occur at PCH (with 95 per cent confidence limits[1]) on the basis of the site-specific and generic flight height data for the two design options**

| Species | Design | Seasonal period | CRM option | |
|---|---|---|---|---|
| | | | 1 | 2 |
| Gannet | 72 WTG | Breeding | 1.1 (0.5 – 2.3) | 3.3 (1.1 – 7.4) |
| | | Autumn passage | 0.2 (0.1 – 0.4) | 3.3 (1.1 – 7.4) |
| | | Spring passage | 0.0 (0.0 – 0.0) | 3.3 (1.1 – 7.4) |
| | 40 WTG | Breeding | 2.4 (1.1 – 4.5) | 5.6 (2.1 – 11.0) |
| | | Autumn passage | 1.2 (0.5 – 2.3) | 5.6 (2.1 – 11.0) |
| | | Spring passage | 0.6 (0.0 – 1.9) | 5.6 (2.1 – 11.0) |
| Kittiwake | 72 WTG | Breeding | 0.0 (0.0 – 0.0) | 4.3 (3.0 – 5.8) |
| | | Autumn passage | 1.3 (0.2 – 3.8) | 4.3 (3.0 – 5.8) |
| | | Spring passage | 0.8 (0.0 – 5.0) | 4.3 (3.0 – 5.8) |
| | 40 WTG | Breeding | 0.2 (0.0 – 0.37) | 7.1 (5.1 – 9.1) |
| | | Autumn passage | 5.2 (2.6 – 8.2) | 7.1 (5.1 – 9.1) |
| | | Spring passage | 3.0 (0.3 – 5.1) | 7.1 (5.1 – 9.1) |
| Herring gull | 72 WTG | Breeding | 5.0 | 15.1 (10.5 – 25.6) |

| Species | Design | Seasonal period | CRM option | |
|---|---|---|---|---|
| | | | 1 | 2 |
| | | Non-breeding | 3.6 | 15.1 (10.5 – 25.6) |
| | 40 WTG | Breeding | 9.6 | 20.3 (14.8 – 31.7) |
| | | Non-breeding | 9.8 | 20.3 (14.8 – 31.7) |

[1]Confidence limits not calculated for the herring gull site-specific estimates because these are based on relatively small sample of flights (see text).

22 Such differences in the estimated percentage of birds at PCH between the site-specific and generic flight height data are not particularly surprising, given that for both gannet and kittiwake the analyses of the generic flight height data suggest high between-site variability for these two species and a low confidence in the applicability of the estimated flight heights to new sites (Johnston *et al.* 2014a, b). At least some of these differences for kittiwake may be associated with seasonal effects (Johnston and Cook, 2016). Furthermore, a high proportion of the sites which contribute to the generic flight heights are in more southerly locations than the Development Area and relatively far from major breeding colonies of both gannet and kittiwake. Therefore, the generic flight heights for gannet and kittiwake may be biased towards passage or wintering birds (which for kittiwake, at least, fits with the closer match to the autumn and spring passage site-specific flight heights).

23 The reliability of seabird flight height estimates derived from subjective 'by eye' estimation during boat-based surveys (as undertaken to collect the current site-specific flight heights and the majority of the generic flight heights also – *Appendix 11A*, Johnston *et al.* 2014a, b) has been questioned (Cleasby et al. 2015, Green et al. 2016). However, although it is likely that there will be error about the estimates that are generated by this method, there appears to be no evidence to suggest any inherent systematic bias in the method (or in the resulting estimates).

24 Considering the site-specific flight estimates for gannet and kittiwake, it is clear that any systematic bias towards underestimating flight height would have to be substantial to account for the observed differences between these and the generic flight heights. This is most readily apparent for kittiwake. Using the data for the breeding period (for which sample size is largest, and the collision estimates from option 2 highest), the site-specific data estimate 10.4 per cent of kittiwake flights to be above 10 m, 0.6 per cent to be above 20 m and no flights above 30 m (*Appendix 11A*). Therefore, the heights of almost 70 per cent of the flights estimated to be above 10 m would have to be underestimated by at least 8 to 18 m to match the 7.1 per cent of flights estimated to be at PCH by the generic flight data for the 40 WTG design (for which the 'air gap' is 28 m, relative to MSL). For the 72 WTG design (for which the 'air gap' is 33 m relative to MSL), the equivalent comparison suggests that over 40 per cent of flight heights estimated to be above 10 m would have to be underestimated by at least 13 to 23 m to match the 4.3 per cent of kittiwakes estimated to be at PCH by the generic flight height data.

**Estimating Development-alone collisions according to population age classes**

25 Age distributions for gannet, kittiwake and herring gull were derived from plumage characteristics of birds recorded during the ESAS-type surveys of the Development Area and four kilometre buffer (*Appendix 11A*). The breakdown of age classes for each species in each seasonal period according to these data is summarised in *Table 11C.7*.

**Table 11C.7 Species age distributions by seasonal period in the Development Area and four kilometre buffer as estimated on the basis of plumage characteristics during the ESAS-type baseline surveys.**

| Species | Seasonal period | Age class | | |
|---|---|---|---|---|
| | | Adults | Immatures | Juveniles |
| Gannet | Breeding | 97% | 2% | 1% |
| | Autumn passage | 94% | 2% | 4% |
| | Spring passage | 98% | 2% | 0% |
| Kittiwake | Breeding | 93% | 3% | 4% |
| | Autumn passage | 59% | <1% | 40% |
| | Spring passage | 83% | 5% | 12% |
| Herring gull | Breeding | 79% | 21% | 0% |
| | Non-breeding | 55% | 28% | 17% |

26 Applying these age distributions to the Development-alone collision estimates for the 40 WTG design for gannet and kittiwake and the 72 WTG design for herring gull (i.e. the worst case for each species), suggests that there would be 105, 37 and 1 collisions to adult gannets, kittiwakes and herring gulls, respectively, during the breeding period based upon the option 2 CRMs for the former two species and the option 3 CRM for the latter. For the option 1 CRMs, the equivalent estimates of breeding period collisions to adult birds are 45, 1 and 0 for gannets, kittiwakes and herring gulls, respectively. However, the Scoping Opinion advised that 10 per cent of adult gannets and adult kittiwakes, and 35 per cent of adult herring gulls should be assumed to be sabbatical birds, so that the estimated collisions to the breeding adults from the regional population are correspondingly lower (*Table 11C.8*). For gannet and kittiwake, no correction was made for assumed sabbatical birds within the passage period collision estimates due to the different approach taken to the apportioning of these estimates to different colony populations (see *Appendix 11B*).

**Table 11C.8 Development-alone collision estimates for the 40 WTG design for gannet and kittiwake and the 72 WTG for herring gull, apportioned to age classes and accounting for the assumed occurrence of sabbatical birds amongst the adult age class[1]**

| Species | Seasonal period | Estimated number of collisions[2] | | | | | |
|---|---|---|---|---|---|---|---|
| | | Option 1 | | | Option 2 or 3[3] | | |
| | | Adults | Immatures | Juveniles | Adults | Immatures | Juveniles |
| Gannet | Breeding | 40.2 | 0.9 | 0.5 | 94.3 | 2.1 | 1.1 |
| | Autumn passage | 0.9 | 0.0 | 0.0 | 4.7 | 0.1 | 0.2 |
| | Spring passage | 1.0 | 0.0 | 0.0 | 3.9 | 0.1 | 0.0 |
| Kittiwake | Breeding | 0.8 | 0.0 | 0.0 | 33.5 | 1.2 | 1.6 |
| | Autumn passage | 11.2 | 0.2 | 7.6 | 15.3 | 0.0 | 10.4 |
| | Spring passage | 2.5 | 0.1 | 0.4 | 5.0 | 0.3 | 0.7 |
| Herring gull | Breeding | 0.0 | 0.0 | 0.0 | 0.5 | 0.2 | 0.0 |
| | Non-breeding | 0.2 | 0.3 | 0.2 | 0.7 | 0.6 | 0.3 |

[1]The collision estimates for the adult age class have been reduced by 10 % for gannet and kittiwake and by 35 % for herring gull to take account of sabbatical birds (with these percentages as advised in the Scoping Opinion), although for gannet and kittiwake this reduction is only applied to the breeding period estimates and not to those for the passage periods due the different apportioning method used.
[2]Collision estimates are presented to 1 decimal place due to the small numbers involved for some CRM options and age classes.
[3]Option 2 estimates are presented for gannet and kittiwake, and option 3 estimates for herring gull.

### 11C.3.3 Effects of variable WTG heights

27 As indicated in *Table 11C.4*, the WTG hub heights available for both the 72 WTG and 40 WTG designs are average values taken from across the Development Area because of the variation in water depth across the site. This could result in underestimating collision risk if the increase in the estimated percentage of birds at PCH that arises from a reduction in hub height is greater than the concomitant decrease resulting from an equivalent increase in hub height. However, ICOL will commit to ensuring that the range of hub heights used within the Wind Farm will be such as to give collision estimates (on the basis of the data, methods and assumptions used here) which do not exceed the worst case presented in *Table 11C.5* for gannet, kittiwake or herring gull.

## 11C.4 Cumulative collision estimates for the Forth and Tay wind farms

### 11C.4.1 Collision estimates for the other Forth and Tay wind farms

28 To estimate the cumulative impacts of collisions from the Wind Farm with the other three Forth and Tay wind farms, CRMs were also undertaken for Neart na Gaoithe and the Seagreen Alpha and Bravo proposed developments. These were undertaken for both the consented 2014 designs as well as for the 2017 designs (to the extent that was possible from the available information on the 2017 designs).

29 The CRM spreadsheets for these proposed developments, as used for the purposes of the 2014 Appropriate Assessment (MS-LOT 2014), were supplied by the respective developers. For the purposes of estimating collisions for the 2014 designs, the input parameters were amended only to reflect the revised seasonal periods (as advised in the Scoping Opinion) and the species-specific nocturnal activity scores advised in the Scoping Opinion (*Table 11C.3*). The information available on the respective 2017 designs for each of the proposed developments was used to amend the relevant CRM input parameters and provide collision estimates for these designs. Information on the site-specific flight height data was not available for all these proposed developments, so that these CRMs used only option 2 (for all three species) and option 3 (for herring gull). The avoidance rates (and associated SDs) were as used in the CRMs for the Wind Farm (*Table 11C.1*). Details of the wind farm parameters used for the 2014 and 2017 designs for Neart na Gaoithe and Seagreen Alpha and Bravo are presented in *Table 11C.9*, with the associated collision estimates presented in *Table 11C.10*.

**Table 11C.9 Wind farm parameters used in the CRMs for the 2014 and 2017 designs for the other Forth and Tay proposed developments**

| Parameter | Neart na Gaoithe | | Seagreen Alpha | | Seagreen Bravo | |
|---|---|---|---|---|---|---|
| | 2014 | 2017 | 2014 | 2017 | 2014 | 2017 |
| Number of WTGs | 75 | 54 | 75 | 60 | 75 | 60 |
| Hub height (relative to MSL) (m)[1] | 104.5 | 118.5 | 111.0 | 136.8 | 111.0 | 136.8 |
| Rotor diameter (m) | 154 | 167 | 167 | 220 | 167 | 220 |
| Height to upper blade tip (relative to MSL) (m) [1] | 181.5 | 202.0 | 194.5 | 246.8 | 194.5 | 246.8 |
| Height to lower blade tip (relative to MSL) (m) [1] | 27.5 | 35.0 | 27.5 | 26.8 | 27.5 | 26.8 |
| Maximum blade width (m) | 5.0 | 5.0 | 5.4 | 5.4 | 5.4 | 5.4 |
| Rotor speed (rpm)[2] | 8.00 | 8.00 | 10.64 | 10.64 | 10.64 | 10.64 |
| Pitch (°) | 15 | 15 | 10 | 10 | 10 | 10 |

| Parameter | Neart na Gaoithe | | Seagreen Alpha | | Seagreen Bravo | |
|---|---|---|---|---|---|---|
| | 2014 | 2017 | 2014 | 2017 | 2014 | 2017 |
| Monthly percentage of time operational (%)[2] | 86 | 86 | 88 | 88 | 88 | 88 |

[1]Values were provided in relation to LAT but are presented relative to MSL because the CRM is calculated using MSL. MSL is taken to be 2.65 m above LAT for Neart na Gaoithe (based on the tidal offset value used in the 2014 CRM sheets for this wind farm), and 2.9 m above LAT for Seagreen (based on the value for Inch Cape).
[2]For Seagreen Alpha and Bravo values are estimated on a monthly basis with the annual mean for all months presented. The CRM uses the mean values from across the months comprising the relevant seasonal periods (see below). The values used in each CRM can be obtained from *Annex 11C.1*.

**Table 11C.10 Collision estimates for the other Forth and Tay proposed developments according to the 2014 and 2017 designs. (Seasonal periods are as defined in *Table 11C.5*).**

| Development | Species | Seasonal period | Estimated number of collisions (range with ±2 SD applied to avoidance rate)[1] | | | |
|---|---|---|---|---|---|---|
| | | | 2014 | | 2017 | |
| | | | Option 2 | Option 3 | Option 2 | Option 3 |
| Neart na Gaoithe | Gannet | Breeding | 196 (160 – 232) | N/A | 69 (56 – 82) | N/A |
| | | Autumn passage | 14 (11 – 17) | N/A | 5 (4 – 6) | N/A |
| | | Spring passage | 14 (11 – 17) | N/A | 5 (4 – 6) | N/A |
| | Kittiwake | Breeding | 18 (15 – 21) | N/A | 7 (6 – 8) | N/A |
| | | Autumn passage | 33 (27 – 39) | N/A | 12 (10 – 14) | N/A |
| | | Spring passage | 3 (2 – 4) | N/A | 1 (0.8 – 1.2) | N/A |
| | Herring gull | Breeding | 3 (2 – 4) | 3 (2 – 4) | 2 (1.6 – 2.4) | 1 (0.8 – 1.2) |
| | | Non-breeding | 6 (5 – 7) | 5 (4 – 6) | 3 (2 – 4) | 2 (1.6 – 2.4) |
| Seagreen Alpha | Gannet | Breeding | 279 (228 – 330) | N/A | 278 (227 – 329) | N/A |
| | | Autumn passage | 11 (9 – 13) | N/A | 11 (9 – 13) | N/A |

| Development | Species | Seasonal period | Estimated number of collisions (range with ±2 SD applied to avoidance rate)[1] | | | |
|---|---|---|---|---|---|---|
| | | | 2014 | | 2017 | |
| | | | Option 2 | Option 3 | Option 2 | Option 3 |
| | | Spring passage | 12 (10 – 14) | N/A | 12 (10 – 14) | N/A |
| | Kittiwake | Breeding | 78 (64 – 92) | N/A | 74 (61 – 87) | N/A |
| | | Autumn passage | 116 (95 – 137) | N/A | 112 (92 – 132) | N/A |
| | | Spring passage | 43 (35 – 51) | N/A | 42 (34 – 50) | N/A |
| | Herring gull | Breeding | 4 (3 – 5) | 3 (2 – 4) | 4 (3 – 5) | 3 (2 – 4) |
| | | Non-breeding | 7 (6 – 8) | 5 (4 – 6) | 6 (5 – 7) | 5 (4 – 6) |
| Seagreen Bravo | Gannet | Breeding | 176 (144 – 208) | N/A | 175 (143 – 207) | N/A |
| | | Autumn passage | 13 (11 – 15) | N/A | 13 (11 – 15) | N/A |
| | | Spring passage | 13 (11 – 15) | N/A | 13 (11 – 15) | N/A |
| | Kittiwake | Breeding | 84 (69 – 99) | N/A | 80 (65 – 95) | N/A |
| | | Autumn passage | 64 (52 – 76) | N/A | 62 (51 – 73) | N/A |
| | | Spring passage | 56 (46 – 66) | N/A | 54 (44 – 64) | N/A |
| | Herring gull | Breeding | 3 (2 – 4) | 2 (1.6 – 2.4) | 3 (2 – 4) | 2 (1.6 – 2.4) |
| | | Non-breeding | 5 (4 – 6) | 4 (3 – 5) | 5 (4 – 6) | 4 (3 – 5) |

[1]Avoidance rates applied to each combination of species and model option are as given in *Table 11C.1*, as are the values for the SD about the estimated avoidance rate.

### 11C.4.2 Estimating cumulative collisions for the Forth and Tay wind farms according to population age classes

30 Age distributions for gannet, kittiwake and herring gull, as based on boat-based survey data from the respective proposed wind farms, were available for Neart na Gaoithe and Seagreen Alpha and Bravo. These age distributions were supplied by the respective developer for Neart na Gaoithe and extracted from the Seagreen ES (Seagreen 2012), and were available only as adults and sub-adults[2], with immatures and juveniles not distinguished (*Table 11C.11*).

**Table 11C.11 Percentage of adults by seasonal period in the counts of each species on the proposed development areas for Neart na Gaoithe, Seagreen Alpha and Seagreen Bravo (as determined from plumage characteristics)**

| Proposed development | Species | Seasonal period | Percentage of adults (%) |
|---|---|---|---|
| Neart na Gaoithe | Gannet | Breeding | 97 |
| | | Autumn passage | 94 |
| | | Spring passage | 98 |
| | Kittiwake | Breeding | 93 |
| | | Autumn passage | 57 |
| | | Spring passage | 79 |
| | Herring gull | Breeding | 77 |
| | | Non-breeding | 69 |
| Seagreen Alpha | Gannet | Breeding | 97 |
| | | Autumn passage | 89 |
| | | Spring passage | 98 |
| | Kittiwake | Breeding | 93 |
| | | Autumn passage | 67 |
| | | Spring passage | 87 |
| | Herring gull | Breeding | 64 |
| | | Non-breeding | 48 |
| Seagreen Bravo | Gannet | Breeding | 98 |

[2] The term sub-adult is used where no distinction is made between immatures and juveniles.

| Proposed development | Species | Seasonal period | Percentage of adults (%) |
|---|---|---|---|
| | | Autumn passage | 97 |
| | | Spring passage | 99 |
| | Kittiwake | Breeding | 95 |
| | | Autumn passage | 72 |
| | | Spring passage | 83 |
| | Herring gull | Breeding | 78 |
| | | Non-breeding | 50 |

31 The age distributions in *Table 11C.11* were applied to the collision estimates for the 2014 and 2017 designs of the respective proposed developments (*Table 11C.10*) to provide the breakdown of collisions by population age class. As for the Development-alone, the collision estimates for adults were amended to account for assumed sabbatical birds (using the percentages advised in the Scoping Opinion, but noting that this was not applied to the passage period collision estimates for gannet or kittiwake – see above). The cumulative collision estimates for the breeding adult and sub-adult age classes for the Development together with the other three Forth and Tay developments were then calculated using the CRM option 2 estimates for gannet and kittiwake, and the option 3 estimates for herring gull (again as derived for the 40 WTG design for the Development). These cumulative collision estimates are presented in *Table 11C.12* below.

**Table 11C.12 Cumulative collision estimates for the Wind Farm together with the other Forth and Tay proposed wind farms apportioned to age classes, and accounting for the assumed occurrence of sabbatical birds amongst the adult age class[1]. Estimates are based upon the 40 WTG design for the Wind Farm.**

| Species | Seasonal period | Estimated number of collisions by option 2 (gannet and kittiwake) and option 3 (herring gull) | | | |
|---|---|---|---|---|---|
| | | 2014 design for other developments | | 2017 design for other developments | |
| | | Adults | Sub-adults | Adults | Sub-adults |
| Gannet | Breeding | 664 | 21 | 552 | 17 |
| | Autumn passage | 40 | 3 | 32 | 2 |
| | Spring passage | 42 | 1 | 33 | 1 |
| Kittiwake | Breeding | 186 | 14 | 170 | 12 |

| Species | Seasonal period | Estimated number of collisions by option 2 (gannet and kittiwake) and option 3 (herring gull) | | | |
|---|---|---|---|---|---|
| | | 2014 design for other developments | | 2017 design for other developments | |
| | | Adults | Sub-adults | Adults | Sub-adults |
| | Autumn passage | 158 | 81 | 142 | 70 |
| | Spring passage | 91 | 17 | 87 | 16 |
| Herring gull | Breeding | 4 | 2 | 3 | 2 |
| | Non-breeding | 6 | 7 | 4 | 6 |

[1]The collision estimates for the adult age class have been reduced by 10 % for gannet and kittiwake and by 35 % for herring gull to take account of sabbatical birds (with these percentages as advised in the Scoping Opinion) although for gannet and kittiwake this reduction is only applied to the breeding period estimates and not to those for the passage periods due to the different apportioning method used.

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# ANNEX 11C.1: Excel worksheets showing the input parameters used for the different collision risk models

## Development CRMs – 72 WTG design

### Gannet

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | | | used in overall collision risk sheet | | | | | | | used in available hours sheet | | | | |
| **Sheet 1 - Input data** | | | used in migrant collision risk sheet | | | | | | | used in large array correction sheet | | | | |
| | | | used in single transit collision risk sheet or extended model | | | | | | | not used in calculation but stated for reference | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **Gannet** | | | | | | | | | | | | |
| Bird length | m | 0.94 | | | | | | | | | | | | |
| Wingspan | m | 1.73 | | | | | | | | | | | | |
| Flight speed | m/sec | 14.9 | | | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | 1 | | | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | 0.1505 | 0.556 | 0.5785 | 2.1745 | 4.328 | 3.7765 | 3.6285 | 5.134 | 1.512 | 1.0355 | 0.193 | 0 |
| Proportion at rotor height | % | 1.1% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2000 | 4000 | 0 | 0 |
| Width of migration corridor | km | | | | | | | | | | | | | |
| Proportion at rotor height | % | | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **IC - Large** | | | | | | | | | | | | |
| Latitude | degrees | 56.49 | | | | | | | | | | | | |
| Number of turbines | | 72 | | | | | | | | | | | | |
| Width of windfarm | km | 6.774 | | | | | | | | | | | | |
| Tidal offset | m | | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | | | | | | | | | | | | | |
| No of blades | | 3 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Rotation speed | rpm | 7.89 | 10.26 | 9.67 | 9.68 | 8.38 | 7.66 | 7.15 | 6.72 | 7.19 | 8.45 | 9.41 | 9.96 | 10.12 |
| Rotor radius | m | 83.5 | | | | | | | | | | | | |
| Hub height | m | 116.1 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 89% | 85% | 86% | 77% | 74% | 71% | 69% | 72% | 78% | 86% | 87% | 88% |
| Max blade width | m | 6.000 | | | | | | | | | | | | |
| Pitch | degrees | 10 | | | | | | | | | | | | |

**Murray Grant:**
For 2017 advised seasonal periods, values should be:
Breeding season - 1.1%
Aut pass - 0.2%
Spr pass - 0.0%

**Murray Grant:**
Rotation speeds are unique for each seasonal period as follows:
Breeding - 7.89
Aut pass - 9.68
Spring pass - 9.93

## Kittiwake

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | | | used in overall collision risk sheet | | | | | | | | used in available hours sheet | | | |
| **Sheet 1 - Input data** | | | used in migrant collision risk sheet | | | | | | | | used in large array correction sheet | | | |
| | | | used in single transit collision risk sheet or extended model | | | | | | | | not used in calculation but stated for reference | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **Ki** | | | | | | | | | | | | |
| Bird length | m | 0.39 | | | | | | | | | | | | |
| Wingspan | m | 1.08 | | | | | | | | | | | | |
| Flight speed | m/sec | 13.1 | | | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | 2 | | | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | 0.2 | 0.048 | 0.569 | 0.612 | 0.839 | 1.998 | 3.682 | 0.487 | 2.495 | 1.591 | 0.628 | 0.347 |
| Proportion at rotor height | % | 0.80% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 0 | 4000 | 2000 | 0 | 0 | 0 | 2000 | 4000 | 0 | 0 |
| Width of migration corridor | km | 8 | | | | | | | | | | | | |
| Proportion at rotor height | % | 75% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **Inch Cape** | | | | | | | | | | | | |
| Latitude | degrees | 56.49 | | | | | | | | | | | | |
| Number of turbines | | 72 | | | | | | | | | | | | |
| Width of windfarm | km | 6.774 | | | | | | | | | | | | |
| Tidal offset | m | 0 | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | **Large turbine** | | | | | | | | | | | | |
| No of blades | | 3 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Rotation speed | rpm | 7.42 | 10.26 | 9.67 | 9.68 | 8.38 | 7.66 | 7.15 | 6.72 | 7.19 | 8.45 | 9.41 | 9.96 | 10.12 |
| Rotor radius | m | 83.5 | | | | | | | | | | | | |
| Hub height | m | 116.1 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 89% | 85% | 86% | 77% | 74% | 71% | 69% | 72% | 78% | 86% | 87% | 88% |
| Max blade width | m | 6.000 | | | | | | | | | | | | |
| Pitch | degrees | 10 | | | | | | | | | | | | |

**murray.grant:**
For 2017 advised seasonal periods, values should be:
Breeding season - 0.0%
Aut pass - 1.32%
Spr pass - 0.8%

**murray.grant:**
To fit with 2017 advice on seasons:
Breeding season =7.42
Aut pass = 9.48
Spr pass = 9.50

## Herring gull

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | | | used in overall collision risk sheet | | | | | | | | used in available hours sheet | | | |
| **Sheet 1 - Input data** | | | used in migrant collision risk sheet | | | | | | | | used in large array correction sheet | | | |
| | | | used in single transit collision risk sheet or extended model | | | | | | | | not used in calculation but stated for reference | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **Herring gull** | | | | | | | | | | | | |
| Bird length | m | 0.60 | | | | | | | | | | | | |
| Wingspan | m | 1.44 | | | | | | | | | | | | |
| Flight speed | m/sec | 12.8 | | | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | 2 | | | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | 0.1001021 | 0.0484165 | 0 | 0 | 0.0244738 | 0.1218324 | 0 | 0.0242601 | 0 | 0.0252525 | 0.0483092 | 0.1472915 |
| Proportion at rotor height | % | 5.0% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2000 | 4000 | 0 | 0 |
| Width of migration corridor | km | | | | | | | | | | | | | |
| Proportion at rotor height | % | | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **IC - Large** | | | | | | | | | | | | |
| Latitude | degrees | 56.49 | | | | | | | | | | | | |
| Number of turbines | | 72 | | | | | | | | | | | | |
| Width of windfarm | km | 6.774 | | | | | | | | | | | | |
| Tidal offset | m | | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | | | | | | | | | | | | | |
| No of blades | | 3 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Rotation speed | rpm | 7.42 | 10.26 | 9.67 | 9.68 | 8.38 | 7.66 | 7.15 | 6.72 | 7.19 | 8.45 | 9.41 | 9.96 | 10.12 |
| Rotor radius | m | 83.5 | | | | | | | | | | | | |
| Hub height | m | 116.1 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 89% | 85% | 86% | 77% | 74% | 71% | 69% | 72% | 78% | 86% | 87% | 88% |
| Max blade width | m | 6.000 | | | | | | | | | | | | |
| Pitch | degrees | 10 | | | | | | | | | | | | |

**Murray Grant:**
% at PCH:
Breeding - 5.0%
Non-breed - 3.6%

**Murray Grant:**
For herring gull 2017 advised seasons, rotor speeds as follows:
Breeding - 7.42
Non-breed - 9.65

# Development CRMs – 40 WTG design

## Gannet

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | | | used in overall collision risk sheet | | | | | | | | used in available hours sheet | | | |
| **Sheet 1 - Input data** | | | used in migrant collision risk sheet | | | | | | | | used in large array correction sheet | | | |
| | | | used in single transit collision risk sheet or extended model | | | | | | | | not used in calculation but stated for reference | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **Gannet** | | | | | | | | | | | | |
| Bird length | m | 0.94 | | | | | | | | | | | | |
| Wingspan | m | 1.73 | | | | | | | | | | | | |
| Flight speed | m/sec | 14.9 | | | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | 1 | | | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | 0.1505 | 0.556 | 0.5785 | 2.1745 | 4.328 | 3.7765 | 3.6285 | 5.134 | 1.512 | 1.0355 | 0.193 | 0 |
| Proportion at rotor height | % | 2.4% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2000 | 4000 | 0 | 0 |
| Width of migration corridor | km | | | | | | | | | | | | | |
| Proportion at rotor height | % | | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **IC - Large** | | | | | | | | | | | | |
| Latitude | degrees | 56.49 | | | | | | | | | | | | |
| Number of turbines | | 40 | | | | | | | | | | | | |
| Width of windfarm | km | 6.774 | | | | | | | | | | | | |
| Tidal offset | m | | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | | | | | | | | | | | | | |
| No of blades | | 3 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Rotation speed | rpm | 5.18 | 6.73 | 6.34 | 6.35 | 5.50 | 5.03 | 4.69 | 4.41 | 4.71 | 5.54 | 6.17 | 6.53 | 6.64 |
| Rotor radius | m | 125 | | | | | | | | | | | | |
| Hub height | m | 152.6 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 89% | 85% | 86% | 77% | 74% | 71% | 69% | 72% | 78% | 86% | 87% | 88% |
| Max blade width | m | 7.800 | | | | | | | | | | | | |
| Pitch | degrees | 10 | | | | | | | | | | | | |

**Murray Grant:**
For 2017 advised seasonal periods, values should be:
Breeding season - 2.4%
Aut pass - 1.2%
Spr pass - 0.6%

**Murray Grant:**
Rotation speeds are unique for each seasonal period as follows:
Breeding - 5.18
Aut pass - 6.35
Spring pass - 6.51

## Kittiwake

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | | | used in overall collision risk sheet | | | | | | | used in available hours sheet | | | | |
| **Sheet 1 - Input data** | | | used in migrant collision risk sheet | | | | | | | used in large array correction sheet | | | | |
| | | | used in single transit collision risk sheet or extended model | | | | | | | not used in calculation but stated for reference | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **Ki** | | | | | | | | | | | | |
| Bird length | m | 0.39 | | | | | | | | | | | | |
| Wingspan | m | 1.08 | | | | | | | | | | | | |
| Flight speed | m/sec | 13.1 | | | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | 2 | | | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | 0.2 | 0.048 | 0.569 | 0.612 | 0.839 | 1.998 | 3.682 | 0.487 | 2.495 | 1.591 | 0.628 | 0.347 |
| Proportion at rotor height | % | 0.20% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 0 | 4000 | 2000 | 0 | 0 | 0 | 2000 | 4000 | 0 | 0 |
| Width of migration corridor | km | 8 | | | | | | | | | | | | |
| Proportion at rotor height | % | 75% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **Inch Cape** | | | | | | | | | | | | |
| Latitude | degrees | 56.49 | | | | | | | | | | | | |
| Number of turbines | | 40 | | | | | | | | | | | | |
| Width of windfarm | km | 6.774 | | | | | | | | | | | | |
| Tidal offset | m | 0 | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | **Large turbine** | | | | | | | | | | | | |
| No of blades | | 3 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Rotation speed | rpm | 4.87 | 6.73 | 6.34 | 6.35 | 5.50 | 5.03 | 4.69 | 4.41 | 4.71 | 5.54 | 6.17 | 6.53 | 6.64 |
| Rotor radius | m | 125 | | | | | | | | | | | | |
| Hub height | m | 152.6 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 89% | 85% | 86% | 77% | 74% | 71% | 69% | 72% | 78% | 86% | 87% | 88% |
| Max blade width | m | 7.800 | | | | | | | | | | | | |
| Pitch | degrees | 10 | | | | | | | | | | | | |

**murray.grant:**
For 2017 advised seasonal periods, values should be:
Breeding season - 0.2%
Aut pass - 5.24%
Spr pass - 3.0%

**murray.grant:**
To fit with 2017 advice on seasons:
Breeding season =4.87
Aut pass = 6.21
Spr pass = 6.23

## Herring gull

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | | | used in overall collision risk sheet | | | | | | | used in available hours sheet | | | | |
| **Sheet 1 - Input data** | | | used in migrant collision risk sheet | | | | | | | used in large array correction sheet | | | | |
| | | | used in single transit collision risk sheet or extended model | | | | | | | not used in calculation but stated for reference | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **Herring gull** | | | | | | | | | | | | |
| Bird length | m | 0.60 | | | | | | | | | | | | |
| Wingspan | m | 1.44 | | | | | | | | | | | | |
| Flight speed | m/sec | 12.8 | | | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | 2 | | | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | 0.1001021 | 0.0484165 | 0 | 0 | 0.0244738 | 0.1218324 | 0 | 0.0242601 | 0 | 0.0252525 | 0.0483092 | 0.1472915 |
| Proportion at rotor height | % | 9.6% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2000 | 4000 | 0 | 0 |
| Width of migration corridor | km | | | | | | | | | | | | | |
| Proportion at rotor height | % | | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **IC - Large** | | | | | | | | | | | | |
| Latitude | degrees | 56.49 | | | | | | | | | | | | |
| Number of turbines | | 40 | | | | | | | | | | | | |
| Width of windfarm | km | 6.774 | | | | | | | | | | | | |
| Tidal offset | m | | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | | | | | | | | | | | | | |
| No of blades | | 3 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Rotation speed | rpm | 4.87 | 6.73 | 6.34 | 6.35 | 5.50 | 5.03 | 4.69 | 4.41 | 4.71 | 5.54 | 6.17 | 6.53 | 6.64 |
| Rotor radius | m | 125 | | | | | | | | | | | | |
| Hub height | m | 152.6 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 89% | 85% | 86% | 77% | 74% | 71% | 69% | 72% | 78% | 86% | 87% | 88% |
| Max blade width | m | 7.800 | | | | | | | | | | | | |
| Pitch | degrees | 10 | | | | | | | | | | | | |

**Murray Grant:**
% at PCH:
Breeding - 9.6%
Non-breed - 9.8%

**Murray Grant:**
For herring gull 2017 advised seasons, rotor speeds as follows:
Breeding - 4.87
Non-breed - 6.33

## Neart na Gaoithe – 2014 design

### Gannet

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | | | used in overall collision risk sheet | | | | | | | | used in available hours sheet | | | |
| **Sheet 1 - Input data** | | | used in migrant collision risk sheet | | | | | | | | used in large array correction sheet | | | |
| | | | used in single transit collision risk sheet or extended model | | | | | | | | not used in calculation but stated for reference | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **Gannet** | | | | | | | | | | | | |
| Bird length | m | 0.94 | | | | | | | | | | | | |
| Wingspan | m | 1.73 | | | | | | | | | | | | |
| Flight speed | m/sec | 14.9 | | | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | 1 | | | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | 0.084 | 1.328 | 2.358 | 1.24 | 4.412 | 3.419 | 5.12 | 4.175 | 4.742 | 2.272 | 0.287 | 0.031 |
| Proportion at rotor height | % | 7.3% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2000 | 4000 | 0 | 0 |
| Width of migration corridor | km | | | | | | | | | | | | | |
| Proportion at rotor height | % | | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **NNG - 12** | | | | | | | | | | | 0.063 | |
| Latitude | degrees | 56.27 | | | | | | | | | | | | |
| Number of turbines | | 75 | | | | | | | | | | | | |
| Width of windfarm | km | 8.22 | | | | | | | | | | | | |
| Tidal offset | m | 2.65 | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | **6MW turbine** | | | | | | | | | | | | |
| No of blades | | 3 | | | | | | | | | | | | |
| Rotation speed | rpm | 8 | | | | | | | | | | | | |
| Rotor radius | m | 77 | | | | | | | | | | | | |
| Hub height | m | 101.85 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 89% | 86% | 87% | 85% | 86% | 85% | 84% | 82% | 86% | 87% | 89% | 86% |
| Max blade width | m | 5.000 | | | | | | | | | | | | |
| Pitch | degrees | 15 | | | | | | | | | | | | |

## Kittiwake

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | | | used in overall collision risk sheet | | | | | | | | used in available hours sheet | | | |
| **Sheet 1 - Input data** | | | used in migrant collision risk sheet | | | | | | | | used in large array correction sheet | | | |
| | | | used in single transit collision risk sheet or extended model | | | | | | | | not used in calculation but stated for reference | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **Kittiwake** | | | | | | | | | | | | |
| Bird length | m | 0.39 | | | | | | | | | | | | |
| Wingspan | m | 1.08 | | | | | | | | | | | | |
| Flight speed | m/sec | 13.1 | | | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | 2 | | | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | 0.147 | 0.044 | 0.189 | 0.214 | 0.616 | 0.234 | 0.943 | 0.171 | 0.653 | 0.803 | 0.764 | 3.364 |
| Proportion at rotor height | % | 6.5% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2000 | 4000 | 0 | 0 |
| Width of migration corridor | km | | | | | | | | | | | | | |
| Proportion at rotor height | % | | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **NNG - 12** | | | | | | | | | | | 0.063 | |
| Latitude | degrees | 56.27 | | | | | | | | | | | | |
| Number of turbines | | 75 | | | | | | | | | | | | |
| Width of windfarm | km | 8.22 | | | | | | | | | | | | |
| Tidal offset | m | 2.65 | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | **6MW turbine** | | | | | | | | | | | | |
| No of blades | | 3 | | | | | | | | | | | | |
| Rotation speed | rpm | 8 | | | | | | | | | | | | |
| Rotor radius | m | 77 | | | | | | | | | | | | |
| Hub height | m | 101.85 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 89% | 86% | 87% | 85% | 86% | 85% | 84% | 82% | 86% | 87% | 89% | 86% |
| Max blade width | m | 5.000 | | | | | | | | | | | | |
| Pitch | degrees | 15 | | | | | | | | | | | | |

## Herring gull

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | | | used in overall collision risk sheet | | | | | | | | used in available hours sheet | | | |
| **Sheet 1 - Input data** | | | used in migrant collision risk sheet | | | | | | | | used in large array correction sheet | | | |
| | | | used in single transit collision risk sheet or extended model | | | | | | | | not used in calculation but stated for reference | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **Herring gull** | | | | | | | | | | | | |
| Bird length | m | 0.61 | | | | | | | | | | | | |
| Wingspan | m | 1.44 | | | | | | | | | | | | |
| Flight speed | m/sec | 12.8 | | | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | 2 | | | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | 0.231 | 0.065 | 0.118 | 0.043 | 0.085 | 0.086 | 0.042 | 0 | 0 | 0 | 0.096 | 0.159 |
| Proportion at rotor height | % | 35.6% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2000 | 4000 | 0 | 0 |
| Width of migration corridor | km | | | | | | | | | | | | | |
| Proportion at rotor height | % | | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **NNG - 12** | | | | | | | | | | | 0.063 | |
| Latitude | degrees | 56.27 | | | | | | | | | | | | |
| Number of turbines | | 75 | | | | | | | | | | | | |
| Width of windfarm | km | 8.22 | | | | | | | | | | | | |
| Tidal offset | m | 2.65 | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | **6MW turbine** | | | | | | | | | | | | |
| No of blades | | 3 | | | | | | | | | | | | |
| Rotation speed | rpm | 8 | | | | | | | | | | | | |
| Rotor radius | m | 77 | | | | | | | | | | | | |
| Hub height | m | 101.85 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 89% | 86% | 87% | 85% | 86% | 85% | 84% | 82% | 86% | 87% | 89% | 86% |
| Max blade width | m | 5.000 | | | | | | | | | | | | |
| Pitch | degrees | 15 | | | | | | | | | | | | |

## Seagreen Alpha – 2014 design

### Gannet

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | | | used in overall collision risk sheet | | | | | | | | used in available hours sheet | | | |
| **Sheet 1 - Input data** | | | used in migrant collision risk sheet | | | | | | | | used in large array correction sheet | | | |
| | | | used in single transit collision risk sheet or extended model | | | | | | | | not used in calculation but stated for reference | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **Gannet** | | | | | | | | | | | | |
| Bird length | m | 0.94 | | | | | | | | | | | | |
| Wingspan | m | 1.73 | | | | | | | | | | | | |
| Flight speed | m/sec | 14.9 | | | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | 1 | | | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | 0.2882982 | 0.4169353 | 1.9670819 | 1.153 | 7.6638359 | 8.8192925 | 1.3649668 | 4.7025728 | 2.4171735 | 1.1937633 | 0.4451997 | 0.081898 |
| Proportion at rotor height | % | 5.1% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2000 | 4000 | 0 | 0 |
| Width of migration corridor | km | | | | | | | | | | | | | |
| Proportion at rotor height | % | | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **SG - A** | | | | | | | | | | | | |
| Latitude | degrees | 56.37 | | | | | | | | | | | | |
| Number of turbines | | 75 | | | | | | | | | | | | |
| Width of windfarm | km | | | | | | | | | | | | | |
| Tidal offset | m | | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | **7MW** | | | | | | | | | | | | |
| No of blades | | 3 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Rotation speed | rpm | 10.37 | 11.2 | 10.9 | 10.8 | 10.5 | 10.2 | 10.3 | 10.1 | 10 | 10.7 | 11 | 11.1 | 10.9 |
| Rotor radius | m | 83.5 | | | | | | | | | | | | |
| Hub height | m | 111 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% |
| Max blade width | m | 5.400 | | | | | | | | | | | | |
| Pitch | degrees | 10 | | | | | | | | | | | | |

**Murray Grant:**
Rotation speeds are unique for each seasonal period as follows:
Breeding - 10.37
Aut pass - 11.05
Spring pass - 10.95

## Kittiwake

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | | | used in overall collision risk sheet | | | | | | | | used in available hours sheet | | | |
| **Sheet 1 - Input data** | | | used in migrant collision risk sheet | | | | | | | | used in large array correction sheet | | | |
| | | | used in single transit collision risk sheet or extended model | | | | | | | | not used in calculation but stated for reference | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **Kittiwake** | | | | | | | | | | | | |
| Bird length | m | 0.39 | | | | | | | | | | | | |
| Wingspan | m | 1.08 | | | | | | | | | | | | |
| Flight speed | m/sec | 13.1 | | | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | 2 | | | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | 1.3135025 | 0.5555556 | 2.5343344 | 2.056 | 1.1255333 | 3.125244 | 1.8746994 | 0.5195335 | 3.3860351 | 2.3191904 | 9.6160419 | 0.5796056 |
| Proportion at rotor height | % | 10.3% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2000 | 4000 | 0 | 0 |
| Width of migration corridor | km | | | | | | | | | | | | | |
| Proportion at rotor height | % | | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **SG - A** | | | | | | | | | | | | |
| Latitude | degrees | 56.37 | | | | | | | | | | | | |
| Number of turbines | | 75 | | | | | | | | | | | | |
| Width of windfarm | km | | | | | | | | | | | | | |
| Tidal offset | m | | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | **7MW** | | | | | | | | | | | | |
| No of blades | | 3 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Rotation speed | rpm | 10.22 | 11.2 | 10.9 | 10.8 | 10.5 | 10.2 | 10.3 | 10.1 | 10 | 10.7 | 11 | 11.1 | 10.9 |
| Rotor radius | m | 83.5 | | | | | | | | | | | | |
| Hub height | m | 111 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% |
| Max blade width | m | 5.400 | | | | | | | | | | | | |
| Pitch | degrees | 10 | | | | | | | | | | | | |

**Murray Grant:**
To fit with 2017 advice on seasons:
Breeding: 10.22
Aut passage: 10.92
Spr passage:10.85

## Herring gull

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | | | used in overall collision risk sheet | | | | | | | | used in available hours sheet | | | |
| **Sheet 1 - Input data** | | | used in migrant collision risk sheet | | | | | | | | used in large array correction sheet | | | |
| | | | used in single transit collision risk sheet or extended model | | | | | | | | not used in calculation but stated for reference | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **Herring gull** | | | | | | | | | | | | |
| Bird length | m | 0.61 | | | | | | | | | | | | |
| Wingspan | m | 1.44 | | | | | | | | | | | | |
| Flight speed | m/sec | 12.8 | | | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | 2 | | | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | 0.1019258 | 0.1031593 | 0.1586145 | 0.0350926 | 0.1062241 | 0.085966 | 0.0360239 | 0 | 0.0178701 | 0.0730842 | 0.0338732 | 0.1252648 |
| Proportion at rotor height | % | 22.7% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2000 | 4000 | 0 | 0 |
| Width of migration corridor | km | | | | | | | | | | | | | |
| Proportion at rotor height | % | | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **SG - A** | | | | | | | | | | | | |
| Latitude | degrees | 56.37 | | | | | | | | | | | | |
| Number of turbines | | 75 | | | | | | | | | | | | |
| Width of windfarm | km | | | | | | | | | | | | | |
| Tidal offset | m | | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | **7MW** | | | | | | | | | | | | |
| No of blades | | 3 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Rotation speed | rpm | 10.22 | 11.2 | 10.9 | 10.8 | 10.5 | 10.2 | 10.3 | 10.1 | 10 | 10.7 | 11 | 11.1 | 10.9 |
| Rotor radius | m | 83.5 | | | | | | | | | | | | |
| Hub height | m | 111 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% |
| Max blade width | m | 5.400 | | | | | | | | | | | | |
| Pitch | degrees | 10 | | | | | | | | | | | | |

**Murray Grant:**
breeding period = 10.22
non-breeding period = 10.94

## Seagreen Bravo – 2014 design

### Gannet

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | | | used in overall collision risk sheet | | | | | | | | used in available hours sheet | | | |
| **Sheet 1 - Input data** | | | used in migrant collision risk sheet | | | | | | | | used in large array correction sheet | | | |
| | | | used in single transit collision risk sheet or extended model | | | | | | | | not used in calculation but stated for reference | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **Gannet** | | | | | | | | | | | | |
| Bird length | m | 0.94 | | | | | | | | | | | | |
| Wingspan | m | 1.73 | | | | | | | | | | | | |
| Flight speed | m/sec | 14.9 | | | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | 1 | | | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | 0.3153314 | 0.7838746 | 1.7348523 | 1.096 | 3.0958486 | 3.8067404 | 2.7147059 | 3.9040197 | 1.859025 | 1.4086777 | 0.5946467 | 0.0808181 |
| Proportion at rotor height | % | 5.1% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2000 | 4000 | 0 | 0 |
| Width of migration corridor | km | | | | | | | | | | | | | |
| Proportion at rotor height | % | | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **SG - A** | | | | | | | | | | | | |
| Latitude | degrees | 56.37 | | | | | | | | | | | | |
| Number of turbines | | 75 | | | | | | | | | | | | |
| Width of windfarm | km | | | | | | | | | | | | | |
| Tidal offset | m | | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | **7MW** | | | | | | | | | | | | |
| No of blades | | 3 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Rotation speed | rpm | 10.37 | 11.2 | 10.9 | 10.8 | 10.5 | 10.2 | 10.3 | 10.1 | 10 | 10.7 | 11 | 11.1 | 10.9 |
| Rotor radius | m | 83.5 | | | | | | | | | | | | |
| Hub height | m | 111 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% |
| Max blade width | m | 5.400 | | | | | | | | | | | | |
| Pitch | degrees | 10 | | | | | | | | | | | | |

**Murray Grant:**
Rotation speeds are unique for each seasonal period as follows:
Breeding - 10.37
Aut pass - 11.05
Spring pass - 10.95

As calculated in CRM sheet for SG A

## Kittiwake

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | | | used in overall collision risk sheet | | | | | | | used in available hours sheet | | | | |
| **Sheet 1 - Input data** | | | used in migrant collision risk sheet | | | | | | | used in large array correction sheet | | | | |
| | | | used in single transit collision risk sheet or extended model | | | | | | | not used in calculation but stated for reference | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **Kittiwake** | | | | | | | | | | | | |
| Bird length | m | 0.39 | | | | | | | | | | | | |
| Wingspan | m | 1.08 | | | | | | | | | | | | |
| Flight speed | m/sec | 13.1 | | | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | 2 | | | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | 2.3364019 | 2.0476724 | 2.4573382 | 1.3560429 | 2.707487 | 3.159349 | 1.3376954 | 0.3514693 | 0.3860366 | 1.4617893 | 6.6827721 | 0.6867475 |
| Proportion at rotor height | % | 10.3% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2000 | 4000 | 0 | 0 |
| Width of migration corridor | km | | | | | | | | | | | | | |
| Proportion at rotor height | % | | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **SG - B** | | | | | | | | | | | | |
| Latitude | degrees | 56.37 | | | | | | | | | | | | |
| Number of turbines | | 75 | | | | | | | | | | | | |
| Width of windfarm | km | | | | | | | | | | | | | |
| Tidal offset | m | | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | **7MW** | | | | | | | | | | | | |
| No of blades | | 3 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Rotation speed | rpm | 10.22 | 11.2 | 10.9 | 10.8 | 10.5 | 10.2 | 10.3 | 10.1 | 10 | 10.7 | 11 | 11.1 | 10.9 |
| Rotor radius | m | 83.5 | | | | | | | | | | | | |
| Hub height | m | 111 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% |
| Max blade width | m | 5.400 | | | | | | | | | | | | |
| Pitch | degrees | 10 | | | | | | | | | | | | |

**Murray Grant:**
To fit with 2017 advice on seasons:
Breeding season =10.22
Aut pass = 10.92
Spr pass = 10.85

## Herring gull

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | | | used in overall collision risk sheet | | | | | | | | used in available hours sheet | | | |
| **Sheet 1 - Input data** | | | used in migrant collision risk sheet | | | | | | | | used in large array correction sheet | | | |
| | | | used in single transit collision risk sheet or extended model | | | | | | | | not used in calculation but stated for reference | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **Herring gull** | | | | | | | | | | | | |
| Bird length | m | 0.61 | | | | | | | | | | | | |
| Wingspan | m | 1.44 | | | | | | | | | | | | |
| Flight speed | m/sec | 12.8 | | | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | 2 | | | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | 0.0628627 | 0.0415933 | 0.1024429 | 0 | 0.04095 | 0.1466796 | 0 | 0 | 0.0226718 | 0.021952 | 0 | 0.2145828 |
| Proportion at rotor height | % | 22.7% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2000 | 4000 | 0 | 0 |
| Width of migration corridor | km | | | | | | | | | | | | | |
| Proportion at rotor height | % | | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **SG - B** | | | | | | | | | | | | |
| Latitude | degrees | 56.37 | | | | | | | | | | | | |
| Number of turbines | | 75 | | | | | | | | | | | | |
| Width of windfarm | km | | | | | | | | | | | | | |
| Tidal offset | m | | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | **7MW** | | | | | | | | | | | | |
| No of blades | | 3 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Rotation speed | rpm | 10.22 | 11.2 | 10.9 | 10.8 | 10.5 | 10.2 | 10.3 | 10.1 | 10 | 10.7 | 11 | 11.1 | 10.9 |
| Rotor radius | m | 83.5 | | | | | | | | | | | | |
| Hub height | m | 111 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% |
| Max blade width | m | 5.400 | | | | | | | | | | | | |
| Pitch | degrees | 10 | | | | | | | | | | | | |

**Murray Grant:**
breeding period = 10.22
Non-breeding period
=10.94

## Neart na Gaoithe – 2017 design

### Gannet

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | | | used in overall collision risk sheet | | | | | | | | used in available hours sheet | | | |
| **Sheet 1 - Input data** | | | used in migrant collision risk sheet | | | | | | | | used in large array correction sheet | | | |
| | | | used in single transit collision risk sheet or extended model | | | | | | | | not used in calculation but stated for reference | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **Gannet** | | | | | | | | | | | | |
| Bird length | m | 0.94 | | | | | | | | | | | | |
| Wingspan | m | 1.73 | | | | | | | | | | | | |
| Flight speed | m/sec | 14.9 | | | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | 1 | | | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | 0.084 | 1.328 | 2.358 | 1.24 | 4.412 | 3.419 | 5.12 | 4.175 | 4.742 | 2.272 | 0.287 | 0.031 |
| Proportion at rotor height | % | 7.3% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2000 | 4000 | 0 | 0 |
| Width of migration corridor | km | | | | | | | | | | | | | |
| Proportion at rotor height | % | | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **NNG - 12** | | | | | | | | | | | | |
| Latitude | degrees | 56.27 | | | | | | | | | | | | |
| Number of turbines | | 54 | | | | | | | | | | | | |
| Width of windfarm | km | 8.22 | | | | | | | | | | | | |
| Tidal offset | m | 2.65 | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | **6MW turbine** | | | | | | | | | | | | |
| No of blades | | 3 | | | | | | | | | | | | |
| Rotation speed | rpm | 8 | | | | | | | | | | | | |
| Rotor radius | m | 83.5 | | | | | | | | | | | | |
| Hub height | m | 115.5 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 89% | 86% | 87% | 85% | 86% | 85% | 84% | 82% | 86% | 87% | 89% | 86% |
| Max blade width | m | 5.000 | | | | | | | | | | | | |
| Pitch | degrees | 15 | | | | | | | | | | | | |

## Kittiwake

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | | | used in overall collision risk sheet | | | | | | | | used in available hours sheet | | | |
| **Sheet 1 - Input data** | | | used in migrant collision risk sheet | | | | | | | | used in large array correction sheet | | | |
| | | | used in single transit collision risk sheet or extended model | | | | | | | | not used in calculation but stated for reference | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **Kittiwake** | | | | | | | | | | | | |
| Bird length | m | 0.39 | | | | | | | | | | | | |
| Wingspan | m | 1.08 | | | | | | | | | | | | |
| Flight speed | m/sec | 13.1 | | | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | 2 | | | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | 0.147 | 0.044 | 0.189 | 0.214 | 0.616 | 0.234 | 0.943 | 0.171 | 0.653 | 0.803 | 0.764 | 3.364 |
| Proportion at rotor height | % | 6.5% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2000 | 4000 | 0 | 0 |
| Width of migration corridor | km | | | | | | | | | | | | | |
| Proportion at rotor height | % | | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **NNG - 12** | | | | | | | | | | | | |
| Latitude | degrees | 56.27 | | | | | | | | | | | | |
| Number of turbines | | 54 | | | | | | | | | | | | |
| Width of windfarm | km | 8.22 | | | | | | | | | | | | |
| Tidal offset | m | 2.65 | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | **6MW turbine** | | | | | | | | | | | | |
| No of blades | | 3 | | | | | | | | | | | | |
| Rotation speed | rpm | 8 | | | | | | | | | | | | |
| Rotor radius | m | 83.5 | | | | | | | | | | | | |
| Hub height | m | 115.5 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 89% | 86% | 87% | 85% | 86% | 85% | 84% | 82% | 86% | 87% | 89% | 86% |
| Max blade width | m | 5.000 | | | | | | | | | | | | |
| Pitch | degrees | 15 | | | | | | | | | | | | |

## Herring gull

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | | | used in overall collision risk sheet | | | | | | | | used in available hours sheet | | | |
| **Sheet 1 - Input data** | | | used in migrant collision risk sheet | | | | | | | | used in large array correction sheet | | | |
| | | | used in single transit collision risk sheet or extended model | | | | | | | | not used in calculation but stated for reference | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **Herring gull** | | | | | | | | | | | | |
| Bird length | m | 0.61 | | | | | | | | | | | | |
| Wingspan | m | 1.44 | | | | | | | | | | | | |
| Flight speed | m/sec | 12.8 | | | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | 2 | | | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | 0.231 | 0.065 | 0.118 | 0.043 | 0.085 | 0.086 | 0.042 | 0 | 0 | 0 | 0.096 | 0.159 |
| Proportion at rotor height | % | 35.6% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2000 | 4000 | 0 | 0 |
| Width of migration corridor | km | | | | | | | | | | | | | |
| Proportion at rotor height | % | | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **NNG - 12** | | | | | | | | | | | | |
| Latitude | degrees | 56.27 | | | | | | | | | | | | |
| Number of turbines | | 54 | | | | | | | | | | | | |
| Width of windfarm | km | 8.22 | | | | | | | | | | | | |
| Tidal offset | m | 2.65 | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | **6MW turbine** | | | | | | | | | | | | |
| No of blades | | 3 | | | | | | | | | | | | |
| Rotation speed | rpm | 8 | | | | | | | | | | | | |
| Rotor radius | m | 83.5 | | | | | | | | | | | | |
| Hub height | m | 115.5 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 89% | 86% | 87% | 85% | 86% | 85% | 84% | 82% | 86% | 87% | 89% | 86% |
| Max blade width | m | 5.000 | | | | | | | | | | | | |
| Pitch | degrees | 15 | | | | | | | | | | | | |

## Seagreen Alpha – 2017 design

### Gannet

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | | | used in overall collision risk sheet | | | | | | | used in available hours sheet | | | | |
| **Sheet 1 - Input data** | | | used in migrant collision risk sheet | | | | | | | used in large array correction sheet | | | | |
| | | | used in single transit collision risk sheet or extended model | | | | | | | not used in calculation but stated for reference | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **Gannet** | | | | | | | | | | | | |
| Bird length | m | 0.94 | | | | | | | | | | | | |
| Wingspan | m | 1.73 | | | | | | | | | | | | |
| Flight speed | m/sec | 14.9 | | | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | 1 | | | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | 0.2882982 | 0.4169353 | 1.9670819 | 1.153 | 7.6638359 | 8.8192925 | 1.3649668 | 4.7025728 | 2.4171735 | 1.1937633 | 0.4451997 | 0.081898 |
| Proportion at rotor height | % | 5.1% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2000 | 4000 | 0 | 0 |
| Width of migration corridor | km | | | | | | | | | | | | | |
| Proportion at rotor height | % | | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **SG - A** | | | | | | | | | | | | |
| Latitude | degrees | 56.37 | | | | | | | | | | | | |
| Number of turbines | | 60 | | | | | | | | | | | | |
| Width of windfarm | km | | | | | | | | | | | | | |
| Tidal offset | m | | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | **7MW** | | | | | | | | | | | | |
| No of blades | | 3 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Rotation speed | rpm | 10.37 | 11.2 | 10.9 | 10.8 | 10.5 | 10.2 | 10.3 | 10.1 | 10 | 10.7 | 11 | 11.1 | 10.9 |
| Rotor radius | m | 110 | | | | | | | | | | | | |
| Hub height | m | 136.8 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% |
| Max blade width | m | 5.400 | | | | | | | | | | | | |
| Pitch | degrees | 10 | | | | | | | | | | | | |

**Murray Grant:**
Rotation speeds are unique for each seasonal period as follows:
Breeding - 10.37
Aut pass - 11.05
Spring pass - 10.95

## Kittiwake

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | | | used in overall collision risk sheet | | | | | | | | used in available hours sheet | | | |
| **Sheet 1 - Input data** | | | used in migrant collision risk sheet | | | | | | | | used in large array correction sheet | | | |
| | | | used in single transit collision risk sheet or extended model | | | | | | | | not used in calculation but stated for reference | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **Kittiwake** | | | | | | | | | | | | |
| Bird length | m | 0.39 | | | | | | | | | | | | |
| Wingspan | m | 1.08 | | | | | | | | | | | | |
| Flight speed | m/sec | 13.1 | | | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | 2 | | | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | 1.3135025 | 0.5555556 | 2.5343344 | 2.056 | 1.1255333 | 3.125244 | 1.8746994 | 0.5195335 | 3.3860351 | 2.3191904 | 9.6160419 | 0.5796056 |
| Proportion at rotor height | % | 10.3% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2000 | 4000 | 0 | 0 |
| Width of migration corridor | km | | | | | | | | | | | | | |
| Proportion at rotor height | % | | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **SG - A** | | | | | | | | | | | | |
| Latitude | degrees | 56.37 | | | | | | | | | | | | |
| Number of turbines | | 60 | | | | | | | | | | | | |
| Width of windfarm | km | | | | | | | | | | | | | |
| Tidal offset | m | | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | **7MW** | | | | | | | | | | | | |
| No of blades | | 3 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Rotation speed | rpm | 10.85 | 11.2 | 10.9 | 10.8 | 10.5 | 10.2 | 10.3 | 10.1 | 10 | 10.7 | 11 | 11.1 | 10.9 |
| Rotor radius | m | 110 | | | | | | | | | | | | |
| Hub height | m | 136.8 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% |
| Max blade width | m | 5.400 | | | | | | | | | | | | |
| Pitch | degrees | 10 | | | | | | | | | | | | |

**Murray Grant:**
To fit with 2017 advice on seasons:
Breeding: 10.22
Aut passage: 10.92
Spr passage:10.85

## Herring gull

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | | | used in overall collision risk sheet | | | | | | | | used in available hours sheet | | | |
| **Sheet 1 - Input data** | | | used in migrant collision risk sheet | | | | | | | | used in large array correction sheet | | | |
| | | | used in single transit collision risk sheet or extended model | | | | | | | | not used in calculation but stated for reference | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **Herring gull** | | | | | | | | | | | | |
| Bird length | m | 0.61 | | | | | | | | | | | | |
| Wingspan | m | 1.44 | | | | | | | | | | | | |
| Flight speed | m/sec | 12.8 | | | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | 2 | | | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | 0.1019258 | 0.1031593 | 0.1586145 | 0.0350926 | 0.1062241 | 0.085966 | 0.0360239 | 0 | 0.0178701 | 0.0730842 | 0.0338732 | 0.1252648 |
| Proportion at rotor height | % | 22.7% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2000 | 4000 | 0 | 0 |
| Width of migration corridor | km | | | | | | | | | | | | | |
| Proportion at rotor height | % | | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **SG - A** | | | | | | | | | | | | |
| Latitude | degrees | 56.37 | | | | | | | | | | | | |
| Number of turbines | | 60 | | | | | | | | | | | | |
| Width of windfarm | km | | | | | | | | | | | | | |
| Tidal offset | m | | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | **7MW** | | | | | | | | | | | | |
| No of blades | | 3 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Rotation speed | rpm | 10.94 | 11.2 | 10.9 | 10.8 | 10.5 | 10.2 | 10.3 | 10.1 | 10 | 10.7 | 11 | 11.1 | 10.9 |
| Rotor radius | m | 110 | | | | | | | | | | | | |
| Hub height | m | 136.8 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% |
| Max blade width | m | 5.400 | | | | | | | | | | | | |
| Pitch | degrees | 10 | | | | | | | | | | | | |

**Murray Grant:**
10.22 for breeding season
10.94 for non-breeding season

## Seagreen Bravo – 2017 design

### Gannet

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | | | used in overall collision risk sheet | | | | | | | | used in available hours sheet | | | |
| **Sheet 1 - Input data** | | | used in migrant collision risk sheet | | | | | | | | used in large array correction sheet | | | |
| | | | used in single transit collision risk sheet or extended model | | | | | | | | not used in calculation but stated for reference | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **Gannet** | | | | | | | | | | | | |
| Bird length | m | 0.94 | | | | | | | | | | | | |
| Wingspan | m | 1.73 | | | | | | | | | | | | |
| Flight speed | m/sec | 14.9 | | | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | 1 | | | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | 0.3153314 | 0.7838746 | 1.7348523 | 1.096 | 3.0958486 | 3.8067404 | 2.7147059 | 3.9040197 | 1.859025 | 1.4086777 | 0.5946467 | 0.0808181 |
| Proportion at rotor height | % | 5.1% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2000 | 4000 | 0 | 0 |
| Width of migration corridor | km | | | | | | | | | | | | | |
| Proportion at rotor height | % | | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **SG - A** | | | | | | | | | | | 0.063 | |
| Latitude | degrees | 56.37 | | | | | | | | | | | | |
| Number of turbines | | 60 | | | | | | | | | | | | |
| Width of windfarm | km | | | | | | | | | | | | | |
| Tidal offset | m | | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | **7MW** | | | | | | | | | | | | |
| No of blades | | 3 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Rotation speed | rpm | 10.37 | 11.2 | 10.9 | 10.8 | 10.5 | 10.2 | 10.3 | 10.1 | 10 | 10.7 | 11 | 11.1 | 10.9 |
| Rotor radius | m | 110 | | | | | | | | | | | | |
| Hub height | m | 136.8 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% |
| Max blade width | m | 5.400 | | | | | | | | | | | | |
| Pitch | degrees | 10 | | | | | | | | | | | | |

**Murray Grant:**
Rotation speeds are unique for each seasonal period as follows:
Breeding - 10.37
Aut pass - 11.05
Spring pass - 10.95

As calculated in CRM sheet for SG A

## Kittiwake

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | | | used in overall collision risk sheet | | | | | | | used in available hours sheet | | | | |
| **Sheet 1 - Input data** | | | used in migrant collision risk sheet | | | | | | | used in large array correction sheet | | | | |
| | | | used in single transit collision risk sheet or extended model | | | | | | | not used in calculation but stated for reference | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **Kittiwake** | | | | | | | | | | | | |
| Bird length | m | 0.39 | | | | | | | | | | | | |
| Wingspan | m | 1.08 | | | | | | | | | | | | |
| Flight speed | m/sec | 13.1 | | | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | 2 | | | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | 2.3364019 | 2.0476724 | 2.4573382 | 1.3560429 | 2.707487 | 3.159349 | 1.3376954 | 0.3514693 | 0.3860366 | 1.4617893 | 6.6827721 | 0.6867475 |
| Proportion at rotor height | % | 10.3% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2000 | 4000 | 0 | 0 |
| Width of migration corridor | km | | | | | | | | | | | | | |
| Proportion at rotor height | % | | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **SG - B** | | | | | | | | | | | | |
| Latitude | degrees | 56.37 | | | | | | | | | | | | |
| Number of turbines | | 60 | | | | | | | | | | | | |
| Width of windfarm | km | | | | | | | | | | | | | |
| Tidal offset | m | | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | **7MW** | | | | | | | | | | | | |
| No of blades | | 3 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Rotation speed | rpm | 10.85 | 11.2 | 10.9 | 10.8 | 10.5 | 10.2 | 10.3 | 10.1 | 10 | 10.7 | 11 | 11.1 | 10.9 |
| Rotor radius | m | 110 | | | | | | | | | | | | |
| Hub height | m | 136.8 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% |
| Max blade width | m | 5.400 | | | | | | | | | | | | |
| Pitch | degrees | 10 | | | | | | | | | | | | |

**Murray Grant:**
To fit with 2017 advice on seasons:
Breeding season =10.22
Aut pass = 10.92
Spr pass = 10.85

## Herring gull

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | | | used in overall collision risk sheet | | | | | | | | used in available hours sheet | | | |
| **Sheet 1 - Input data** | | | used in migrant collision risk sheet | | | | | | | | used in large array correction sheet | | | |
| | | | used in single transit collision risk sheet or extended model | | | | | | | | not used in calculation but stated for reference | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **Herring gull** | | | | | | | | | | | | |
| Bird length | m | 0.61 | | | | | | | | | | | | |
| Wingspan | m | 1.44 | | | | | | | | | | | | |
| Flight speed | m/sec | 12.8 | | | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | 2 | | | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | 0.0628627 | 0.0415933 | 0.1024429 | 0 | 0.04095 | 0.1466796 | 0 | 0 | 0.0226718 | 0.021952 | 0 | 0.2145828 |
| Proportion at rotor height | % | 22.7% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2000 | 4000 | 0 | 0 |
| Width of migration corridor | km | | | | | | | | | | | | | |
| Proportion at rotor height | % | | | | | | | | | | | | | |
| Proportion of flights upwind | % | 50.0% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **SG - B** | | | | | | | | | | | 0.063 | |
| Latitude | degrees | 56.37 | | | | | | | | | | | | |
| Number of turbines | | 60 | | | | | | | | | | | | |
| Width of windfarm | km | | | | | | | | | | | | | |
| Tidal offset | m | | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | **7MW** | | | | | | | | | | | | |
| No of blades | | 3 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Rotation speed | rpm | 10.94 | 11.2 | 10.9 | 10.8 | 10.5 | 10.2 | 10.3 | 10.1 | 10 | 10.7 | 11 | 11.1 | 10.9 |
| Rotor radius | m | 110 | | | | | | | | | | | | |
| Hub height | m | 136.8 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% | 88% |
| Max blade width | m | 5.400 | | | | | | | | | | | | |
| Pitch | degrees | 10 | | | | | | | | | | | | |

**Murray Grant:**
10.22 for breeding season
10.94 for non-breeding season