APPENDIX 10

MIGRATORY COLLISION RISK MODELLING REPORT

Sceirde Rocks Offshore Wind Farm Technical Appendix 11.4: Migratory Collision Risk Modelling

Document Authorisations and History

Review	Date	Prepared by	Checked by	Approved by	Comments
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Distribution List

Name	Organisation	Email Address
Kieran O'Malley	Corio	redacted
Orla Murphy	MKO	redacted

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1 Introduction

1.1 Background

1 The Sceirde Rocks Offshore Wind Farm project (hereafter 'Sceirde Rocks' or 'proposed Project') is a proposed offshore wind farm, located along the south coast of County Galway, west Ireland. The Offshore Array Area covers 37.22km^2 and is defined as the location in which the wind turbines and offshore substation will be located.

2 This Technical Appendix has been produced to support Technical Appendix 11.3: Collision Risk Modelling Report (Gittings, 2024) and Chapter 11: Offshore Ornithology and considers the potential impact to migratory bird species within the Offshore Array Area (OAA). Migratory species are not typically recorded during monthly site-specific surveys due to the brief nature of migration timings as well as movement outside of routine survey windows i.e. at night or during poor weather (Woodward *et al.,* 2023). They may still be at risk of collision with turbines and so should be assessed for this risk.

3 Migratory species travel to, from and through western Ireland when moving from high latitude breeding grounds to more southerly wintering areas and vice versa. Some migratory bird species are present within the area year-round and while some groups overwinter in the area, others are present during autumn (post-breeding dispersal) or spring (return) migrations. Many seabirds migrate through western Irish waters while non-seabird species such as waders, waterfowl, passerines and non-passerines also migrate through the area.

1.2 Migratory Collision Risk Modelling

4 Collisions with turbines and/or turbine blades may cause injury or mortality and it is important to assess the risk of collision for new developments. Generally, this risk is quantified by estimating the likelihood of a bird being struck when entering the 'risk area' of operational turbine blades. This paradigm assumes that a strike equates to mortality of the individual. The process of estimating potential collisions is known as Collision Risk Modelling (CRM). Following increased data collection using recent technological advances, including radar and GPS tracking, it is now possible to assess the collision risk of some migratory species.

5 To model the movements of migratory birds for the proposed Project, the Marine Scotland Avian Migration Collision Risk Model Shiny Application (hereafter 'mCRM app') was used (Version 0.41 available at https://github.com/hiDef-Aerial-Surveying/mCRM), with adjustment to deal with the focus of this work being Ireland rather than UK for which the tool was originally designed. This tool is currently only suitable for modelling those species which follow a "point-to-point" migration path rather than those which take an alternate longer route, such as following the coastline, rather than flying directly over land.

2 Methods

2.1 Screening process

6 Between October 2021 and September 2023, a series of 24 monthly Digital Aerial Surveys (DAS) were flown over the Offshore Ornithology Study Area (OAA and a 4km buffer) and the wider area out to a 10km surrounding buffer. While the surveys provide an overview of the bird species present within the Project throughout the year, due to the snap-shot nature of DAS, migratory species moving through the area quickly are often not picked up by the surveys. This is also the case for birds present within the area at night, during poor weather or at high altitudes when surveys are not occurring. Despite this, it is still important to determine the estimated mortality of these species due to collision during the operational phase of the Project. Migratory species, particularly seabirds, which were found in significant numbers within the survey area were already considered within project Collision Risk Modelling (see Technical Appendix 11.3: Collision Risk Modelling Report).

7 For the mCRM assessment those SPAs hosting migratory species not previously considered were determined by level of connectedness of straight-line migration pathways that passed through the proposed OAA. Relevant SPAs were screened in using the percentage of migration pathways which may intersect with the boundary of the OAA of the proposed Project, taking the geometric centre of the SPA as the SPA location. This was undertaken using R code where the country boundaries for Europe (Iceland) and North America (Greenland) obtained from the NPWS website (NPWS, 2024) were combined with the Irish boundary so the migratory paths could be drawn between the sampled points along the coastline of each country. The sampled points were selected approximately 1km apart along the coastlines of both Iceland and Greenland and points that intersected with land were removed to ensure that only valid landfall locations remain.

8 From this complete range, 10,000 points were randomly selected from both the Ireland (or the SPA polygon for those species linked to an SPA) and Europe/North America polygons and then converted to polyline objects so that they could be the start and end points for the migratory paths. These polylines were saved and used to establish the percentage of intersection to determine which colonies/sites should be included in the mCRM tool. Furthermore, the boundary of the outermost lines was taken and converted to a polygon to represent the migration corridor for each site. In the final modelling scenarios, there was a different migration corridor for each individual SPA and for Ireland as a whole. The migration corridor was the same for each species within the SPAs/Ireland, so there were six different corridors in total (Annex 2: Migration pathways).

9 The proportion of potential migration lines that intersected with the OAA from each SPA was calculated. All SPAs in Ireland were included in initial screening with those that had no lines intersecting with the OAA screened out at this point (Annex 1: Long list of SPAs).

10 An arbitrary 10% threshold for the percentage of migration paths intersecting with the OAA was set as per other recent assessments such as North Irish Sea Array (NISA) Windfarm Ltd (GoBe, 2023); only those SPAs with migratory features with at least 10% of lines intersecting with the OAA carried forward. Where there were fewer than 10% of straight-line migration paths crossing the OAA between origin (or destination) and the SPA centroid, that SPA was screened out as it was expected that only negligible numbers of birds would be passing through the site, and any associated collisions would be minimal. The SPAs meeting this threshold and the associated designated features are presented in Table 1. Only the migratory non-seabird species associated with each SPA are considered in this assessment as seabird species are already included in a separate assessment (refer to Technical Appendix 11.3: Collision Risk Modelling Report). The screening

process showed that the SPAs only intersected with the migration pathways to Iceland, and therefore Greenland was not included in the final models.

Table 1 Long-list of SPAs with more than 10% intersection with the OAA and designated non-seabird migratory species

Designated Site	Distance to Offshore Array Area (km)	Features considered for collision risk
Cliffs of Moher SPA	44	No migratory non-seabird species
Clonakilty Bay SPA	195	Shelduck (*Tadorna tadorna*), dunlin (*Calidris alpina*), black-tailed godwit (*Limosa limosa*), curlew (*Numenius arquata*)
Eirk Bog SPA	145	Greenland white-fronted goose (*Anser albifrons*)
Illaunonearaun SPA	66	Barnacle goose (*Branta leucopsis*)
Inishmore SPA	11	No migratory non-seabird species
Kerry Head SPA	90	No migratory non-seabird species
Killarney National Park SPA	133	Greenland white-fronted goose (*Anser albifrons*), merlin (*Falco columbarius*)
Loop Head SPA	73	No migratory non-seabird species
Mullaghanish to Mushermore Mountaints SPA	150	Hen harrier (*Circus cyaneus*)
Seven Heads SPA	200	Chough (*Pyrrhocorax pyrrhocorax*)
Stacks to Mullaghereik Mountains SPA	98	Hen harrier (*Circus cyaneus*)
The Gearagh SPA	165	Wigeon (*Mareca penelope*), teal (*Anas crecca*), coot (*Fulica atra*), mallard (*Anas platyrhynchos*)

11 SPAs in which no migratory non-seabird species are designated features were screened out as there is no potential pathway for effect on the Conservation Objectives of the SPA. Once the list of SPAs was complete, the designated migratory species for each site were screened in based on where at least 1% of the Irish population is expected to pass through the OAA each year as per other project assessments (e.g. NISA Windfarm Ltd; GoBe, 2023). Species where less than 1% of the Irish population is likely to pass through the area were screened out; these were coot, curlew, hen harrier and chough. In addition, as merlin, chough and hen harrier are terrestrial qualifying interest species during the breeding season for which the potential migratory numbers are low, these species were also screened out.

12 Oystercatcher (*Haematopus ostralegus*) and whimbrel (*Numenius phaeopus)* were not listed as a qualifying interest of any of the selected SPAs however, both species have a substantial Icelandic breeding populations that pass through west Ireland on migration (BirdLife International, 2024a). Autumn migration for whimbrel passes at sea west of Ireland and so only the spring migration is considered (BirdLife International, 2024b).

As birds are not concentrated in SPAs, the assessment undertaken looked at the whole migration path from Ireland to Iceland. All migratory species screened into the assessment are presented in Table 2.

Table 2 Short list of non-seabird migratory species screened into mCRM assessment

Species		
Barnacle goose	Black-tailed godwit	Dunlin
Greenland white-fronted goose	Mallard	Oystercatcher
Shelduck	Teal	Whimbrel
Wigeon		

2.2 Running the tool

13 Potential collision risk of migratory species throughout the OAA was estimated using the mCRM app. This application is a stochastic adaptation of the Band (2012) collision risk spreadsheet used solely for migratory species and was accessed through the 'Shiny App' and run through R statistical software.

14 Since the tool was designed for UK migratory species, it had to be adapted so that it was compatible for use with Irish sites. In the code, the default migration corridors were changed to include birds with migration pathways that overlapped with the OAA and Iceland. The populations used in the tool were also revised to either the Ireland or SPA-specific populations where applicable.

15 The tool provides two options:

- Creates population estimates within developments by sampling migratory pathways through straight lines drawn between Ireland and non-UK countries; and
- Runs a stochastic version of the migratory collision risk model based on the population estimates and input parameters.

2.3 mCRM inputs

2.3.1 Turbine parameters

The turbine parameters used in the mCRM are presented in Table 3 and are based on the same scenario as described in Chapter 11: Offshore Ornithology. The mean wind speed was calculated using historical data from the Irish National Meteorological Service (Met Éireann, 2024) using the area closest to the proposed Project while the predicted mean wind availability and relationship between rotation speed and blade pitch with windspeed are presented in

Table 4 and

16 Table 5, respectively.

17 Project-specific downtime is not available; therefore, as in Appendix 11.3: Collision Risk Modelling Report, the default values from the Avian Stochastic CRM were used as advised by Corio.

Table 3 Project turbine parameter values for the tested scenarios

Turbine parameter	Value
Latitude	53.26
Windfarm width (km)	8.7
Tidal offset (m)	-2.185
No. turbines	30
No. blades	3
Hub height (m)	178.9
Rotor radius (m)	146
Max. blade width (m)	7.5
Rotation speed (RPM)	Refer to Table 5
Pitch (degrees)	Refer to Table 5
Airgap (m)	32.9
Downtime (mean)	6.30%
Downtime (SD)	2.00%
Wind speed (mean)	7.43 m/sec
Wind speed (SD)	3.32 m/sec

Table 4 Predicted mean wind availability

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wind av. (%)	95.5	96.0	97.7	98.3	98.4	97.5	97.6	97.5	98.2	97.9	96.8	92.0

Table 5 Relationships of rotation speed and blade pitch with windspeed

Wind speed (m/sec)	Rotor speed (rpm)	Pitch (degrees)
0	0	90
1	0	90
2	0	90
3	0	90
4	4.51	5
5	4.53	5
6	4.76	5
7	5.45	5
8	6.22	5
9	6.96	5
10	7.53	5
11	7.74	5
12	7.78	7
13	7.8	7
14	7.79	10
15	7.78	12
16	7.8	14
17	7.8	14
18	7.81	15
19	7.81	17
20	7.81	17
21	7.81	18
22	7.81	20
23	7.81	22
24	7.81	24
25	7.81	25
26	7.81	28
27	7.81	29
28	7.81	32

Wind speed (m/sec)	Rotor speed (rpm)	Pitch (degrees)
29	7.81	33
30	7.81	35
31	7.81	37
32	7.81	39

2.3.2 Bird parameters

18 The default population estimates and proportion of birds at risk of collision provided within the mCRM tool are UK-based and therefore are not representative of bird populations in Ireland. To ensure the assessment is relevant to Irish populations, the defined populations within the tool were altered to reflect the actual migratory pathways within the area of interest. For each SPA, the most recent available population estimates were used and are presented in Table 6. Oystercatcher and whimbrel are included in terms of the whole of Ireland population, also presented in Table 6.

The defined pre-breeding and post-breeding migration seasons used within the assessment for each species are presented in

19 Table 7 and are default values within the mCRM tool (Caneco *et al*., 2022).

Table 6 **Population estimates of screened-in species passing through the OAA and the proportion of birds at risk of collision for each assessed species. The year of the estimate is included in parenthesis**

Species	Population estimate	Proportion at risk of collision
Clonakilty Bay SPA		
Black-tailed godwit	1,080 (2016)[a]	0.202
Dunlin	651 (2016)[a]	0.204
Shelduck	163 (1997)[b]	0.216
Eirk Bog SPA		
Greenland white-fronted goose	<20 (2014)[a]	0.267
Illaunonearaun SPA		
Barnacle goose	<20 (2014)[b]	0.226
Killarney National Park SPA		
Greenland white-fronted goose	106(2001)[c]	0.150
The Gearagh SPA		
Mallard	478 (1996)[c]	0.239
Teal	150 (2005)[d]	0.242
Wigeon	200 (2005)[d]	0.244
Ireland		
Oystercatcher	820,000 (2019)[e]	0.021
Whimbrel	1,800,000 (2023)[e]	0.019

[a]Lewis et al. (2019), [b]Crowe (2005), [c]National Parks and Wildlife Service (2012), [d]Cronin et al. (2009) & [e]BirdLife International (2024).

Table 7 Defined migration seasons of screened-in species used within the mCRM tool

Species	Pre-breeding	Post-breeding	Other
Barnacle goose	Apr - May	Oct-Oct	-
Black-tailed godwit	Apr - May	Aug - Oct	-
Dunlin	Mar - May	Jun-Oct	-
Greenland white-fronted goose	Mar - Apr	Sep - Nov	-
Mallard	Apr - Jun	Sep - Oct	Jan - Mar
Oystercatcher	Jan - Mar	Jul - Nov	-
Shelduck	Jan - Feb	Jun – Jul	Aug - Dec
Teal	Feb - May	Jul - Dec	-
Whimbrel	Apr - Jun	-	-
Wigeon	Mar - Apr	Aug - Nov	-

2.3.3 Avoidance rates and species biometrics

20 Generally, birds exhibit avoidance behaviour to the presence of a windfarm which reduces the chance of mortality from collision (Pavat *et al.,* 2023). Avoidance can occur at three levels; micro-avoidance (avoidance of individual turbine blades), meso-avoidance (avoidance of entire turbines and not solely the rotor swept area) and macro-avoidance (avoidance of the entire windfarm area).

21 The species-specific avoidance rates used in the assessment are presented in Table 8 and are those set as default within the mCRM tool. The species-specific biometrics used within the mCRM are presented in Table 8. All parameters are default within the tool and are determined by the British Trust for Ornithology (BTO).

Table 8 Species-specific inputs into the mCRM tool. Standard deviation is included in parenthesis

Species	Body length (m)	Wingspan (m)	Flight speed (ms^{-1})	Avoidance rate
Barnacle goose	0.64 (0.04)	1.38 (0.04)	17.40 (1.08)	0.9990 (0.0001)
Black-tailed godwit	0.42 (0.02)	0.76 (0.02)	18.10 (6.00)	0.9990 (0.00000)
Dunlin	0.18 (0.01)	0.40 (0.01)	15.30 (1.90)	0.9990 (0.00000)
Greenland white-fronted goose	0.72 (0.06)	1.48 (0.06)	18.75 (7.19)	0.9990 (0.00010)
Mallard	0.58 (0.02)	0.90 (0.02)	15.86 (2.00)	0.9850 (0.00080)
Oystercatcher	0.42 (0.02)	0.83 (0.02)	13.00 (2.50)	0.9990 (0.00000)
Shelduck	0.62 (0.02)	1.12 (0.02)	18.20 (4.30)	0.9850 (0.00080)
Teal	0.36 (0.02)	0.61 (0.02)	17.40 (1.60)	0.9850 (0.00080)
Whimbrel	0.41 (0.02)	0.82 (0.02)	13.80 (0.40)	0.9990 (0.00000)
Wigeon	0.48 (0.02)	0.80 (0.02)	18.50 (2.00)	0.9850 (0.00080)

3 Results

22 The results of the mCRM for each screened in migratory non-seabird species are presented in Table 9.

Table 9 Summary of seasonal and annual collision estimates per SPA of screened in migratory non-seabird species within the OAA

Species	Pre-breeding	Post-breeding	Other	Total
Clonakilty Bay SPA				
Black-tailed godwit	0.007 ± 0.001	0.007 ± 0.001	0.000 ± 0.000	0.014 ± 0.001
Dunlin	0.004 ± 0.000	0.004 ± 0.000	0.000 ± 0.000	0.008 ± 0.000
Shelduck	0.009 ± 0.001	0.009 ± 0.001	0.009 ± 0.001	0.027 ± 0.002
Eirk Bog SPA				
Greenland white-fronted goose	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000
Illaunonearaun SPA				
Barnacle goose	0.001 ± 0.000	0.001 ± 0.000	0.000 ± 0.000	0.002 ± 0.000
Killarney National Park SPA				
Greenland white-fronted goose	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000
The Gearagh SPA				
Mallard	0.057 ± 0.004	0.057 ± 0.004	0.056 ± 0.004	0.170 ± 0.007
Teal	0.016 ± 0.001	0.016 ± 0.001	0.000 ± 0.000	0.032 ± 0.001
Wigeon	0.022 ± 0.002	0.022 ± 0.002	0.000 ± 0.000	0.044 ± 0.003
Ireland				
Oystercatcher	0.039 ± 0.006	0.040 ± 0.006	0.000 ± 0.000	0.079 ± 0.008
Whimbrel	0.030 ± 0.005	0.000 ± 0.000	0.000 ± 0.000	0.030 ± 0.005

4 Conclusions

23 The analysis of migration collisions for these SPA qualifying species show that in all cases, considerably less than a single collision is expected annually. The proportion of these species using Ireland as a staging post or wintering area that are at risk of collision with Sceirde Rocks Offshore Wind Farm is extremely small.

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Annex 1: Long list of SPAs

Table 10 Long list of SPAs and proportion of migration lines intersecting per SPA

SPA	Proportion of intersecting migration lines
All Saints Bog SPA	0.0000
Ballyallia Lough SPA	0.0000
Ballycotton Bay SPA	0.0000
Ballymacoda Bay SPA	0.0000
Ballyteigue Burrow SPA	0.0000
Bannow Bay SPA	0.0000
Beara Peninsula SPA	0.0000
Blackwater Callows SPA	0.0000
Blackwater Estuary SPA	0.0000
Blasket Islands SPA	0.0000
Cahore Marshes SPA	0.0000
Castlemaine Harbour SPA	0.0000
Cliffs of Moher SPA	0.0000
Clonakilty Bay SPA	0.1482
Connemara Bog Complex SPA	0.0000
Coole-Garryland SPA	0.0000
Cork Harbour SPA	0.0000
Corofin Wetlands SPA	0.0000
Courtmacsherry Bay SPA	0.0789
Cregganna Marsh SPA	0.0000
Dalkey Islands SPA	0.0000
Deenish Island and Scariff Island SPA	0.0000
Dingle Peninsula SPA	0.0000
Dovegrove Callows SPA	0.0000
Dungarvan Harbour SPA	0.0000
Eirk Bog SPA	0.1463

SPA	Proportion of intersecting migration lines
Galley Head to Duneen Point SPA	0.0839
Helvick Head to Ballyquin SPA	0.0000
Illaunonearaun SPA	0.3386
Inishmore SPA	0.0000
Inner Galway Bay SPA	0.0000
Iveragh Peninsula SPA	0.0000
Keeragh Islands SPA	0.0000
Kerry Head SPA	0.0439
Kilcolman Bog SPA	0.0000
Killarney National Park SPA	0.1776
Lady's Island Lake SPA	0.0000
Loop Head SPA	0.0000
Lough Cutra SPA	0.0000
Lough Derg (Shannon) SPA	0.0000
Lough Rea SPA	0.0000
Magharee Islands SPA	0.0000
Mid-Clare Coast SPA	0.0000
Middle Shannon Callows SPA	0.0000
Mid-Waterford Coast SPA	0.0000
Mullaghanish to Musheramore Mountains SPA	0.1859
Old Head of Kinsale SPA	0.0000
Poulaphouca Reservoir SPA	0.0000
Puffin Island SPA	0.0000
Rahasane Turlough SPA	0.0000
River Little Brosna Callows SPA	0.0000
River Nore SPA	0.0000
River Shannon and River Fergus Estuaries SPA	0.0000
River Suck Callows SPA	0.0000
Saltee Islands SPA	0.0000

SPA	Proportion of intersecting migration lines
Seas off Wexford SPA	0.0000
Seven Heads SPA	0.1056
Sheep's Head to Toe Head SPA	0.0585
Skelligs SPA	0.0000
Slieve Aughty Mountains SPA	0.0000
Slieve Bloom Mountains SPA	0.0000
Slievefelim to Silvermines Mountains SPA	0.0000
Slyne Head To Ardmore Point Islands SPA	0.0000
Sovereign Islands SPA	0.0000
Stack's to Mullaghareirk Mountains, West Limerick Hills and Mount Eagle SPA	0.2132
Tacumshin Lake SPA	0.0000
The Bull And The Cow Rocks SPA	0.0000
The Gearagh SPA	0.1798
The Murrough SPA	0.0000
The Raven SPA	0.0000
Tralee Bay Complex SPA	0.0000
Tramore Back Strand SPA	0.0000
Wexford Harbour and Slobs SPA	0.0000
Wicklow Head SPA	0.0000
Wicklow Mountains SPA	0.0000

Annex 2: Migration pathways

Figure 1 Migration pathways for each screened in SPA and Ireland