Outer Dowsing Offshore Wind

Report to Inform Appropriate Assessment

Annex 2: Ornithology Population Viability Analysis (Habitats Regulations Assessment)

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Acronyms & Terminology

Abbreviations: Acronyms

Abbreviation: Acronym	Description
GT R4 ltd	The Applicant. The special project vehicle created in partnership between Corio Generation (a wholly owned Green Investment Group portfolio company), Gulf Energy Development and TotalEnergies.
PVA	Population Viability Analysis
SPA	Special Protection Area
CPS	Counterfactual of Population Size
CPGR	Counterfactual of Population Growth Rate

Terminology

Term	Definition
The Applicant	GT R4 Ltd. The Applicant making the application for a DCO. The Applicant is GT R4 Limited (a joint venture between Corio Generation, Total Energies and Gulf Energy Development (GULF)), trading as Outer Dowsing Offshore Wind. The Project is being developed by Corio Generation (a wholly owned Green Investment Group portfolio company), TotalEnergies and GULF.
The Project	Outer Dowsing Offshore Wind, an offshore wind generating station together with associated onshore and offshore infrastructure.

Reference Documentation

Document Number	Title
6.1.3	Project Description
7.1	Report to Inform Appropriate Assessment

1 Introduction

1.1 Project background

1. GT R4 Limited (trading as Outer Dowsing Offshore Wind) hereafter referred to as the 'Applicant', is proposing to develop the Project. The Project will be located approximately 54km from the Lincolnshire coastline in the southern North Sea. The Project will include both offshore and onshore infrastructure including an offshore generating station (windfarm), export cables to landfall, Offshore Reactive Compensation Platforms (ORCPs), onshore cables, connection to the electricity transmission network, ancillary and associated development and areas for the delivery of up to two Artificial Nesting Structures (ANS) and the creation of a biogenic reef (if these compensation measures are deemed to be required by the Secretary of State) (see Volume 1, Chapter 3: Project Description (document reference 6.1.3) for full details).
2. This technical appendix provides the methodology and results for any population viability analysis carried out to inform the conclusions of the Offshore and Intertidal Ornithology assessments presented Chapter 7.1 Report to Inform Appropriate Assessment (Document reference: 7.1).

1.2 Population Viability Analysis (PVA)

3. For species that have predicted high number of mortalities due to displacement or collision with turbine blades, it is important to assess the implications of these moralities on SPA populations. To estimate the effect that a development, alone or in-combination, may have on a designated feature, Population Viability Analysis (PVA) can be used. PVA models use demographic parameters to forecast future population levels under different scenarios over a set period, comparing 'impacted' scenarios to a 'baseline' by alteration of demographic parameters (survival and productivity). The baseline conditions consider there to be no impact from the development and therefore the population will follow unaltered growth rates. Whereas the impact scenarios model an impacted population over a defined period.
4. This report provides the modelling methodology and results using SPA populations (as presented in the technical baseline). The species selected for PVA modelling were (see Table 1.1):
   - Common guillemot (*Uria aalge*);
   - Gannet (*Morus bassanus*);
   - Kittiwake (*Rissa tridactyla*);
   - Puffin (*Fratercula arctica*); and
   - Razorbill (*Alca torda*).

Table 1.1. Initial SPA population sizes defined from recent Seabird Monitoring Programme (SMP) counts.

Species	Coquet Island SPA	Farne Islands SPA	Flamborough and Filey Coast SPA
Common guillemot	NA	46,332	149,980
Gannet	NA	NA	30,466
Kittiwake	NA	NA	89,148
Puffin	50,058	NA	NA
Razorbill	NA	NA	61,346

5. PVA was undertaken using the Seabird PVA Tool developed by Natural England (Searle et al. 2019). The Seabird PVA Tool was accessed via the 'Shiny App' interface, which is a user-friendly graphical user interface accessible via a standard web-browser that uses the nepva R package to perform the modelling and analysis. The advantages of using an online platform for modelling and analysis purposes are that users are not required to use any R code, users are not required to install or maintain R, and updates to the model are made directly to the server. The tool can assess any type of impact in terms of change to demographic parameters, or as a cull or harvest of a fixed size per year (Searle *et al.,* 2019).

2 Methodology

2.1 Guidance and models

6. The user guide for the Seabird PVA Tool provided by Natural England (Searle *et al.,* 2019) has been followed for modelling and assessment of potential impacts. The demographic parameters used for the PVA are presented in section 2.2.

2.2 PVA modelling approach and demographic parameters

2.2.1 Simulation type

7. All PVA models were undertaken using the 'Simulation' run type, which is used to simulate population trajectories based on the specified demographic parameters, initial population sizes and scenarios the user inputs into the model.
8. The Seabird PVA Tool uses a Leslie matrix to construct a PVA model (Caswell, 2000) based on the parameters provided by the user. Users can specify whether they wish the model to include demographic stochasticity, environmental stochasticity, density dependence, density independence or whether they want the model to run deterministically.
9. A deterministic model translates the demographic parameters provided into actual numbers and provides a simplistic model, which can be used to generate average trends. Due to the lack of stochasticity, a deterministic model will produce the same result every time the simulation is run. In situations where little is known about how the population size has varied, or how the scale of impact may vary, running a deterministic model might provide a more candid assessment of the population and how it may be impacted.
10. A stochastic model produces probabilistic outputs to account for the impact of environmental and demographic stochasticity. Environmental stochasticity describes the effects random variation in factors such as weather can have on a population and is modelled by the incorporation of randomly generated values for the probability of survival from one-time step to the next. Demographic stochasticity refers to the effect that random variation has on population structure and demographic rates. It is modelled by generating random numbers of surviving individuals for any given survival probability distribution. Demographic stochasticity can usually be ignored for populations greater than 100 individuals, however including demographic stochasticity will not cause any penalty when simulating larger populations (WWT Consulting, 2012).

11. All PVA modelling in this report was undertaken with environmental and deterministic stochasticity. To ensure robust results, all simulations were set to run 5,000 times. All models were run for a 35-year time span, representing the likely lifespan of the Project. Demographic processes such as growth, survival, productivity, and recruitment are density-dependent, as their rates change in relation to the number of individuals in a population. Density dependence can be described as either compensatory or depensatory (Begon, Townsend & Harper 2005). Compensation is characterised by demographic changes that cause a stabilising effect on a populations long-term average. Depensation acts to further decrease the rate of population growth in declining populations and can delay the rate of recovery. This is typically exhibited in populations that have been significantly depleted in size and is caused by a reduction in the benefits associated with conspecific presence.
12. Density dependence is self-evident in the natural environment, as without density dependence, populations would grow exponentially. For seabird populations, the mechanisms as to how this operates are largely uncertain. If density dependence is mis-specified in an assessment, the modelled predictions may be unreliable. Therefore, it is more typical to use density independent models for seabird assessments, despite the lack of biologically necessary density dependence. As such, density independent models lack any means by which a population can recover once it has been reduced beyond a certain point, they are therefore appropriate for impact assessment purposes on the grounds of precaution (i.e. another source of precaution in the assessment process) (Ridge *et al.,* 2019).
13. Although both the counterfactual of population size (CPS) and counterfactual of population growth rate (CGR) are presented within this report, the Applicant considers that only the counterfactual of population growth rate should be used for interpreting the predicted impacts. This is because the counterfactual of population growth rate can be compared against known population trends for a feature : receptor and is relatively insensitive to the baseline rate of growth and direction (positive or negative). Whereas the counterfactual of population size will predict very large differences in comparison to the baseline population size, especially when density dependent factors allowing for population recovery or preventing exponential growth are not considered within the PVA, as is the case with these assessments.

2.2.2 Demographic parameters

14. The input demographic parameters were primarily taken from Horswill and Robinson (2015), with some parameters provided within the tool. Where the parameters differ from this it has been highlighted (Table 2.1).

Table 2.1 Summary of SPA demographic rates for PVA species.

Demographic Parameter	Common Guillemot (Flamborough and Filey Coast SPA)	Common Guillemot (Farne Islands SPA)	Gannet (Flamborough and Filey Coast SPA)	Kittiwake (Flamborough and Filey Coast SPA)	Puffin (Coquet Island SPA)	Razorbill (Flamborough and Filey Coast SPA)
Adult Survival	0.940 (0.025)	0.940 (0.025)	0.919 (0.042)	0.854 (0.077)	0.907 (0.083)	0.895 (0.067)
Productivity (SD) (per pair)	0.724 (0.118)	0.787 (0.140)	0.798 (0.066)	0.873 (0.332)	0.576 (0.331)	0.619 (0.075)
Age of recruitment	6	6	5	4	5	5
Brood size (per pair)	1	1	1	2	1	1
Survival 0-1	0.560 (0.058)	0.560 (0.058)	0.424 (0.045)	0.790 (0.077)	0.709 (0.108)	0.630 (0.067)
Survival 1-2	0.792 (0.152)	0.792 (0.152)	0.829 (0.026)	0.854 (0.077)	0.709 (0.108)	0.630 (0.067)
Survival 2-3	0.917 (0.098)	0.917 (0.098)	0.891 (0.019)	0.854 (0.077)	0.709 (0.108)	0.895 (0.067)
Survival 3-4	0.938 (0.107)	0.938 (0.107)	0.895 (0.019)	0.854 (0.077)	0.760 (0.093)	0.895 (0.067)
Survival 4-5	0.940 (0.025)	0.940 (0.025)	0.919 (0.042)	-	0.805 (0.083)	0.895 (0.067)
Survival 5-6	0.940 (0.025)	0.940 (0.025)	-	-	-	-

2.2.3 PVA species-specific outputs

15. The outputs from the PVA tool are the CGR and CPS (Searle *et al.,* 2019). These provide the ratio of impacted to unimpacted scenarios and allows for interpretation of the predicted impact upon the population (Cook and Robinson, 2016). CPS is the median of the ratio of end-point population size of the impacted to un-impacted (baseline) scenarios. CGR is the median of the ratio of the annual growth rate of the impacted to un-impacted population. Both are expressed as a proportion.

3 Impact scenarios

3.1 Magnitude of impact

16. Each impact scenario has an additional population-level mortality due to the presence of turbines, and therefore imposed risk of collision and of displacement effects. This additional mortality impacts the survival rate and therefore predicts the magnitude of impact on an SPA population for different scenarios. The model used relative harvest (i.e. impact on adult survival rate) which was calculated using the predicted mortalities apportioned to the site divided by the initial population size (Table 1.1). Table 3.1 to Table 3.5 present the scenarios carried out, the estimated mortality for that scenario and the impact that mortality has on the survival rate for the relevant species. It is this reduction in survival rate which is input into the PVA model.

Table 3.1 Common guillemot displacement magnitude of impact.

SPA	Impact scenario	Displacement : Mortality rate (%)	Mortalities	Impact on adult survival rate
Farne Islands SPA	Project alone	30 : 1	1.3	0.000
		50 : 1	2.1	0.000
		70 : 2	5.9	0.000
		70 : 10	29.3	0.001
	In-combination	30 : 1	44.1	0.001
		50 : 1	73.5	0.002
		70 : 2	205.8	0.004
		70 : 10	1029.1	0.022
Flamborough and Filey Coast SPA	Project alone	30 : 1	15.5	0.000
		50 : 1	25.9	0.000
		70 : 2	72.5	0.000
		70 : 10	362.7	0.002
	In-combination	30 : 1	254.5	0.002
		50 : 1	424.1	0.003
		70 : 2	1187.6	0.008
		70 : 10	5937.7	0.040
	NE method Project alone	30 : 1	50.8	0.000
		50 : 1	84.7	0.001
		70 : 2	237.2	0.002
		70 : 10	1185.8	0.008
	NE method In-combination	30 : 1	289.7	0.002
		50 : 1	482.9	0.003
		70 : 2	1352.2	0.009
		70 : 10	6760.8	0.045

Table 3.2 Gannet combined collision and displacement magnitude of impact.

Scenario	Impact scenario	Displacement : Mortality rate (%)	Mortalities	Impact on adult survival rate
Flamborough and Filey Coast SPA (combined)	Project alone	60 : 1	4.700	0.000
		70 : 1	5.400	0.000
		80 : 1	5.900	0.000
	In-combination	60 : 1	135.457	0.004
		70 : 1	145.832	0.005
		80 : 1	156.206	0.005

Table 3.3 Kittiwake collisions magnitude of impact

Scenario	Impact scenario	Mortalities	Impact on adult survival rate
Flamborough and Filey Coast SPA	Project alone	14.500	0.000
	In-combination (without compensated projects)	383.000	0.004
	In-combination (with compensated projects)	531.900	0.006

Table 3.4 Puffin displacement magnitude of impact

Scenario	Impact scenario	Displacement : Mortality rate (%)	Mortalities	Impact on adult survival rate
Coquet Island SPA	Project alone	30 : 1	1.084	0.000
		50 : 1	1.806	0.000
		70 : 2	5.915	0.000
		70 : 10	25.285	0.001
	In-combination	30 : 1	9.213	0.000
		50 : 1	15.355	0.000
		70 : 2	42.994	0.001
		70 : 10	214.972	0.004

Table 3.5 Razorbill displacement magnitude of impact

Scenario	Impact scenario	Displacement : Mortality rate (%)	Mortalities	Impact on adult survival rate
Flamborough and Filey Coast SPA	Project alone	30 : 1	6.149	0.000
		50 : 1	10.249	0.000
		70 : 2	28.697	0.000
		70 : 10	143.487	0.002
	In-combination	30 : 1	49.724	0.001
		50 : 1	82.874	0.001

Scenario	Impact scenario	Displacement : Mortality rate (%)	Mortalities	Impact on adult survival rate
		70 : 2	232.047	0.004
		70 : 10	1160.236	0.019
	NE Method Project alone	30 : 1	10.789	0.000
		50 : 1	17.981	0.000
		70 : 2	50.346	0.001
		70 : 10	251.732	0.004
	NE Method In-combination	30 : 1	54.364	0.001
		50 : 1	90.606	0.001
		70 : 2	253.697	0.004
		70 : 10	1268.484	0.021

4 PVA results

4.1 Introduction

17. The outputs of the Seabird PVA Tool are set out in Table 4.1 to Table 4.6 below for all five species. The metrics used to summarise the PVA results are based on the CGR and CPS expressed as a percentage decrease.

4.2 Common Guillemot

4.2.1 Farne Islands SPA

Table 4.1 Metrics and counterfactuals for 5000 simulations, over 35 years, of guillemot PVA at Farne Islands SPA.

Scenario	Displacement : Mortality rate (%)	CGR	CPS	Difference in GR (%)	Difference in PS (%)
Project alone	30 : 1	1.000	0.999	0.003	0.095
	50 : 1	1.000	0.998	0.005	0.177
	70 : 2	1.000	0.995	0.014	0.500
	70 : 10	0.999	0.975	0.071	2.525
In-combination	30 : 1	0.999	0.962	0.107	3.760
	50 : 1	0.998	0.938	0.178	6.211
	70 : 2	0.995	0.835	0.498	16.464
	70 : 10	0.975	0.403	2.492	59.683

4.2.2 Flamborough and Filey Coast SPA

Table 4.2 Metrics and counterfactuals for 5000 simulations, over 35 years, of guillemot PVA at Flamborough and Filey Coast SPA.

Scenario	Approach	Displacement : Mortality rate (%)	CGR	CPS	Difference in GR (%)	Difference in PS (%)
Project alone	Project	30 : 1	1.000	0.996	0.011	0.413
		50 : 1	1.000	0.993	0.019	0.698
		70 : 2	0.999	0.981	0.054	1.926
		70 : 10	0.997	0.907	0.271	9.292
	NE	30 : 1	1.000	0.986	0.038	1.355
		50 : 1	0.999	0.977	0.063	2.258
		70 : 2	0.998	0.938	0.177	6.180
		70 : 10	0.991	0.726	0.885	27.396
In-combination	Project	30 : 1	0.998	0.934	0.190	6.622
		50 : 1	0.997	0.892	0.317	10.796
		70 : 2	0.991	0.726	0.886	27.427
		70 : 10	0.956	0.195	4.433	80.455
	NE	30 : 1	0.998	0.925	0.216	7.493

Scenario	Approach	Displacement : Mortality rate (%)	CGR	CPS	Difference in GR (%)	Difference in PS (%)
		50 : 1	0.996	0.878	0.360	12.195
		70 : 2	0.990	0.694	1.009	30.596
		70 : 10	0.950	0.155	5.048	84.504

4.3 Gannet

4.3.1 Flamborough and Filey Coast SPA

Table 4.3 Metrics and counterfactuals for 5000 simulations, over 35 years, of gannet PVA at Flamborough and Filey Coast SPA.

Scenario	Displacement : Mortality rate (%)	CGR	CPS	Difference in GR (%)	Difference in PS (%)
Project alone	60 : 1	1.000	0.993	0.019	0.672
	70 : 1	1.000	0.993	0.021	0.744
	80 : 1	1.000	0.992	0.023	0.798
In-combination	60 : 1	0.995	0.827	0.524	17.257
	70 : 1	0.994	0.815	0.565	18.458
	80 : 1	0.994	0.804	0.605	19.609

4.4 Kittiwake

4.4.1 Flamborough and Filey Coast SPA

Table 4.4 Metrics and counterfactuals for 5000 simulations, over 35 years, of kittiwake PVA at Flamborough and Filey Coast SPA.

Scenario		CGR	CPS	Difference in GR (%)	Difference in PS (%)
Project alone		1.000	0.993	0.001	0.700
In-combination	Without compensated projects	0.995	0.832	0.512	16.800
	With compensated projects	0.993	0.775	0.700	22.500

4.5 Puffin

4.5.1 Coquet Island SPA

Table 4.5 Metrics and counterfactuals for 5000 simulations, over 35 years, of puffin PVA at Coquet Island SPA.

Scenario	Displacement : Mortality rate (%)	CGR	CPS	Difference in GR (%)	Difference in PS (%)
Project alone	30 : 1	1.000	0.999	0.003	0.119
	50 : 1	1.000	0.999	0.003	0.141
	70 : 2	1.000	0.996	0.013	0.425
	70 : 10	0.999	0.979	0.060	2.097
In-combination	30 : 1	1.000	0.992	0.021	0.787
	50 : 1	1.000	0.988	0.035	1.249
	70 : 2	0.999	0.964	0.101	3.582
	70 : 10	0.995	0.834	0.503	16.617

4.6 Razorbill

4.6.1 Flamborough and Filey Coast SPA

Table 4.6 Metrics and counterfactuals for 5000 simulations, over 35 years, of razorbill PVA at Flamborough and Filey Coast SPA.

Scenario	Approach	Displacement : Mortality rate (%)	CGR	CPS	Difference in GR (%)	Difference in PS (%)
Project alone	Project	30 : 1	1.000	0.996	0.012	0.430
		50 : 1	1.000	0.993	0.019	0.690
		70 : 2	0.999	0.980	0.056	1.956
		70 : 10	0.997	0.905	0.276	9.450
	NE	30 : 1	1.000	0.986	0.038	1.355
		50 : 1	0.999	0.977	0.063	2.258
		70 : 2	0.998	0.938	0.177	6.180
		70 : 10	0.991	0.726	0.885	27.396
In-combination	Project	30 : 1	0.999	0.966	0.096	3.401
		50 : 1	0.998	0.944	0.160	5.595
		70 : 2	0.996	0.851	0.446	14.862
		70 : 10	0.978	0.444	2.230	55.609
	NE	30 : 1	0.998	0.925	0.216	7.493
		50 : 1	0.996	0.878	0.360	12.195
		70 : 2	0.990	0.694	1.009	30.596
		70 : 10	0.950	0.155	5.048	84.504

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