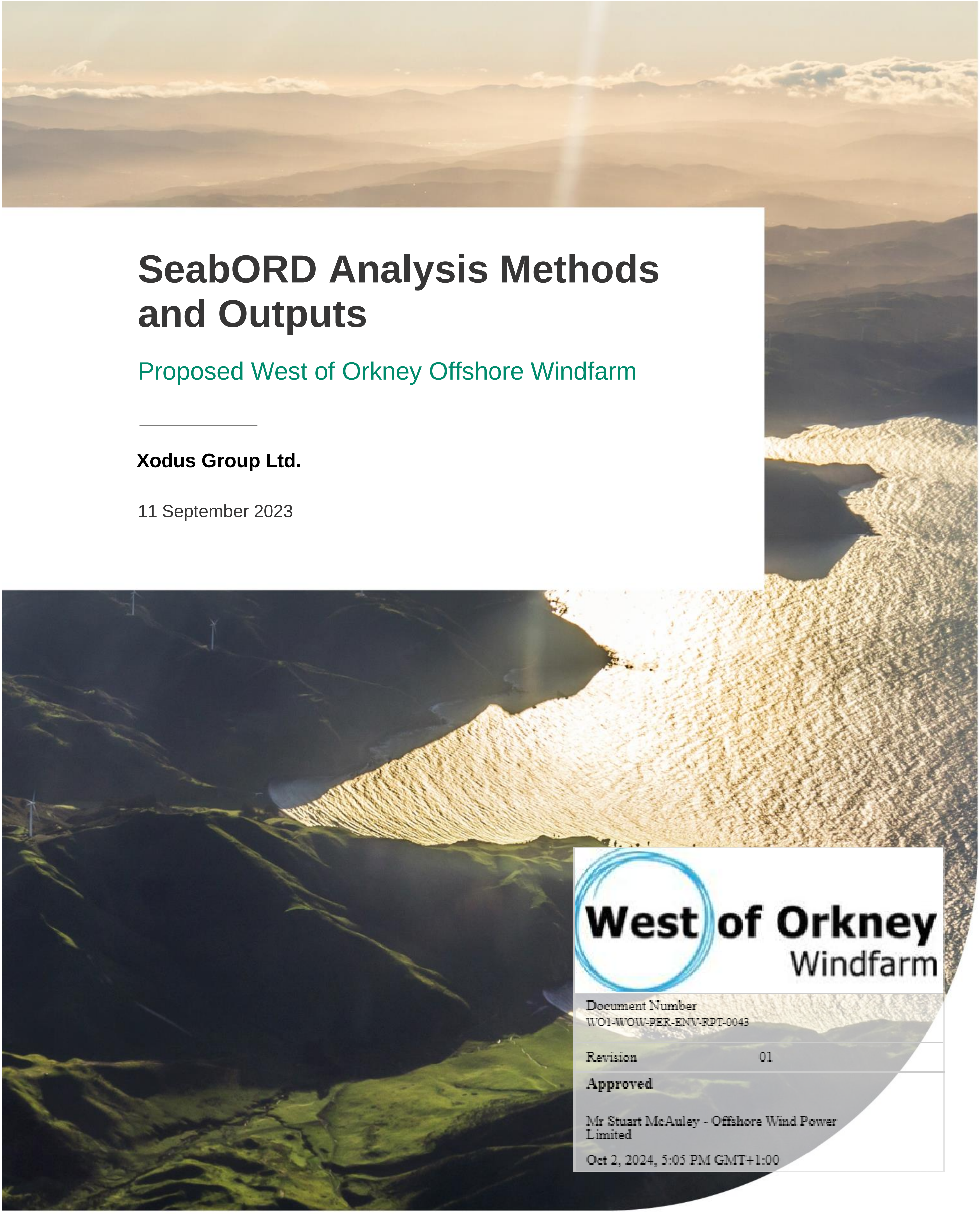

SeabORD Analysis Methods and Outputs

Proposed West of Orkney Offshore Windfarm

Xodus Group Ltd.

11 September 2023

West of Orkney Windfarm

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Approved

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Contents

1. Introduction

The applicant, Offshore Wind Power Limited (OWPL) is proposing the development of the West of Orkney Windfarm (‘the Project’), an Offshore Wind Farm (OWF), located approximately 23 kilometres (km) from the north coast of Scotland and 28 km from the west coast of Hoy, Orkney. The total area of the Option Agreement Area (OAA) is 657 km^2.

The location of the offshore Project area defines the ‘Red Line Boundary’ for the Section 36 Consent and Marine Licence applications and includes the OAA and the associated offshore Export Cable Corridor (ECC).

The development has the potential to have direct impacts upon seabirds in three main ways:

1. Mortality through collision with rotating turbine blades
2. Loss of foraging habitat as a result of displacement from the vicinity of the development; and,
3. Increased travel times to foraging locations due to avoiding (being barriered by) the development

There may also be indirect effects such as changes in levels of competition, which may decrease if collision impacts are high, or increase due to birds displaced from the windfarm increasing bird density at foraging locations elsewhere.

The SeabORD tool has been developed to predict direct and indirect impacts of displacement and barrier effects arising from offshore windfarms on seabirds (Searle *et al.*, 2018).

SeabORD is a spatially explicit individual-based model that simulates the energetic consequences of displacement and barrier effects, predicting impacts on foraging and reproductive success through the chick-rearing period (Searle et al., 2014; 2018). A baseline simulation is run in which simulated birds forage and provision themselves and their young based on a series of rules underlying the model, and baseline adult and chick survival rates are predicted. The former is extrapolated over the winter period based on adult weight at the end of the chick rearing period whilst the latter refers only to the chick-rearing period. The simulation is then re-run assuming that a certain user-defined proportion of the population is displaced from and/or barriered by one or more windfarm footprints. In this “impact” model, adult and chick survival varies from the baseline model as a result of:

1. The energetic consequences of barriered birds having to travel further to reach their chosen foraging locations; and
2. Displaced birds from the windfarm footprint travelling to different foraging locations which may be closer or further away from their colonies and where they may encounter different levels of competition.

SeabORD modelling has been conducted for the offshore Project in line with NatureScot guidance (NatureScot, 2023b), to provide context to displacement assessments carried out using the industry standard matrix approach (SNCBs, 2022). This report details the methods used and the resulting outputs.

2. Methods

Models were run using SeabORD version 1.3, available from https://www.webarchive.org.uk/wayback/archive/20181002061834/https://www.gov.scot/Topics/marine/marineenergy/mre/current/SeabORD. This is currently the most up-to-date publicly available version of the model, though it is noted that this will soon be superseded by the version implemented within Marine Scotland’s Cumulative Effects Framework (CEF) tool (NatureScot, 2023a). The model was run on a Project-only basis, meaning that cumulative impacts including other developments in the area were not assessed. This was because:

- NatureScot did not request the cumulative effects of multiple projects to be included;

- The tool regularly crashed and was extremely slow to run in this region with only the Project included, so adding further projects would have resulted in excessive time needed to complete the runs; and
- The addition of the Pentland Floating Offshore Windfarm would have resulted in different results to those found by the seabORD model completed for that application due to different approaches taken (e.g. assumption of populations in the North Caithness Cliff's SPA being from only the Dunnet Head colony – see Section 2.1).

2.1. Species and colonies assessed

The species modelled and focal Special Protection Areas (SPAs) for which analysis should be run were selected in consultation with NatureScot, based on advice provided in their response to letter WO1-WOW-HSE-EV-LT-0020 (email response from Kim McEwan, dated 31 May 2023). The species for which NatureScot requested SeabORD modelling were guillemot and puffin.

For guillemot, seven SPAs were assessed for barrier and displacement effects using SeabORD. These were:

- North Caithness Cliffs
- Sule Skerry and Sule Stack
- Hoy
- Marwick Head
- Rousay
- Cape Wrath
- West Westray

For puffin, four SPAs were assessed for displacement effects using SeabORD. These were:

- North Caithness Cliffs
- Sule Skerry and Sule Stack
- Hoy
- Cape Wrath

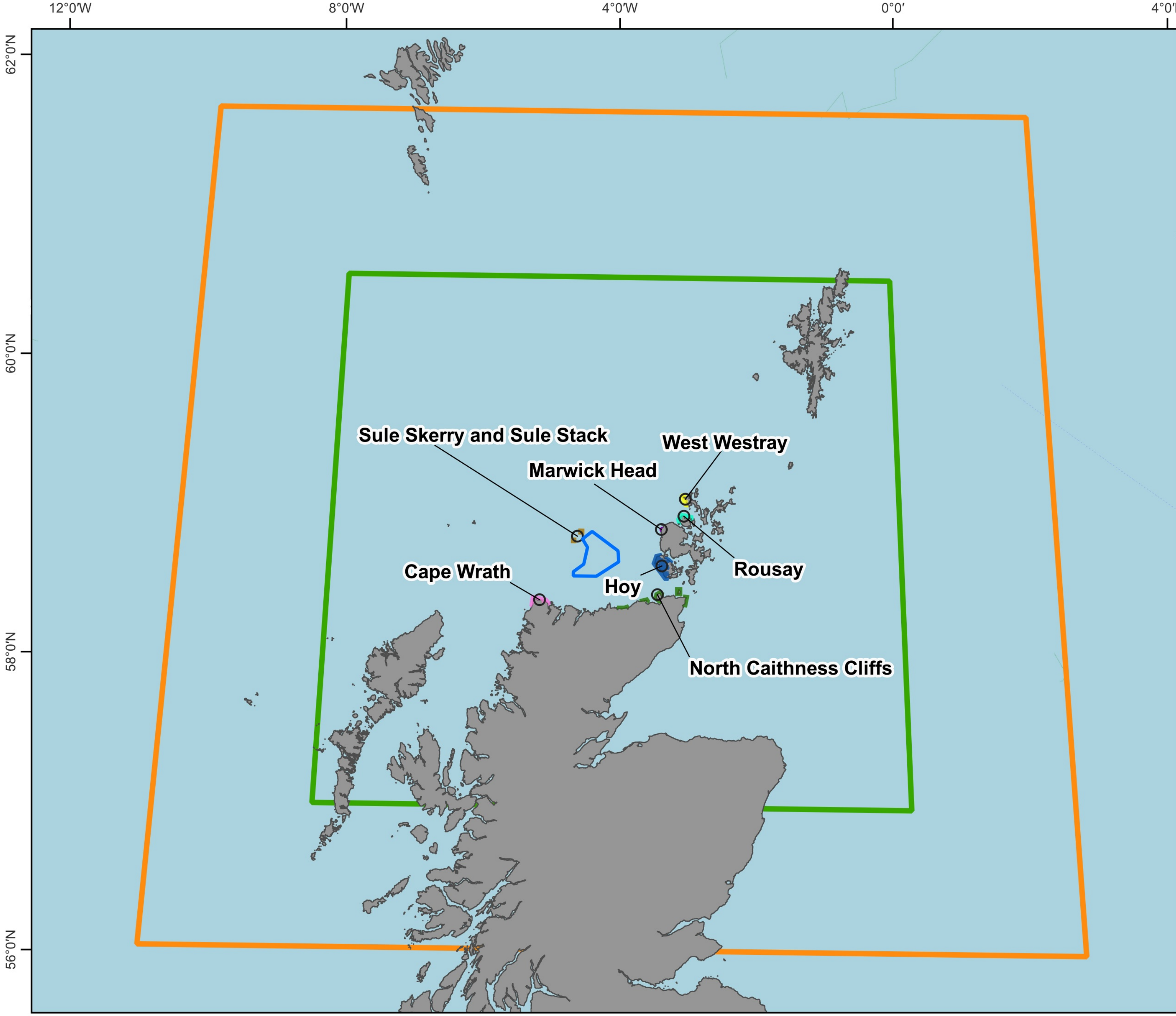
The SeabORD tool can incorporate data for up to six colonies to simulate competition effects at different foraging locations. Due to the need for calibration of the model for each individual colony (to ensure that the baseline model reflects expected chick survival and adult mass loss in a moderate year for each, see Section 2.7 for details), separate models must be run for each colony, with other colonies included only to ensure that the effect of competition with individuals from these colonies are incorporated in the simulations.

North Caithness Cliffs was originally identified as consisting of five separate colonies: Duncansby Head; Dunnet Head; Holburn Head; Melvich; and Stroma. However, given the limitation of SeabORD 1.3 to a maximum of six colonies per run, these were combined and all birds were assumed to forage from Dunnet Head, since this is the most central colony within the SPA. For the Sule Skerry and Sule Stack SPA, birds were assumed to forage from the mid-point of the two islands. The need for such an approach was acknowledged by NatureScot in their response to letter WO1-WOW-HSE-EV-LT-0020, and the approach taken was determined following the advice provided within the response that it would be appropriate in this case to model populations from different colonies constituting the same SPA from a subset of locations. The final locations used for each colony are presented in Figure 2.1 and Table 2.1.

The limitation to six colonies per run also meant that competition effects from all seven SPAs assessed for guillemot could not be simulated within a single model. SPAs were therefore ranked according to the impacts predicted by the matrix-based displacement assessment carried out for the Project (see Offshore RIAA, Appendix C) and the lowest ranked colony (West Westray SPA) was not included for competition effects for other colonies. The second lowest ranked SPA was Cape Wrath, and this was excluded for competition effects from the West Westray SPA model run. The final colonies included for competition effects in each model are presented in Table 2.1. The population size (in pairs) from each SPA colony was based on the most recent full SPA count available from the SMP database.

2.2. Fraction of the population modelled

SeabORD allows for a user-specified fraction of the population to be modelled to allow quicker 'test' runs to be carried out and also because the model is incredibly computationally intensive and can take an extremely long time to run for an entire population. SeabORD outputs are relatively insensitive to the fraction of the population that is modelled (Mobbs *et al.*, 2018), though it is recommended that final SeabORD runs should be carried out for as high a proportion of the population as is feasible to allow the quantification of uncertainty to be as precise as possible (Mobbs *et al.*, 2018). In this case, due to the large number of individuals being modelled and large amount of sea area within the foraging ranges of the species being studied, prohibitively long run times and several occasions during which the tool crashed meant that it was only possible to carry out the analysis for 20% of the guillemot population and 10% of the puffin population (Table 2.1). Run-times for the different stages of the modelling carried out are provided in Appendix A and exceeded 18 hours for the final runs alone, excluding tens of calibration runs as well as re-starts due to crashes. It was also noted that run time did not increase linearly with proportion of the population simulated, rather that run times got disproportionately slower with increasing percentage of the population modelled rendering it unfeasible to further increase this proportion.



Project:

West of Orkney

Title:

Figure 2.1: West of Orkney Option Agreement Area and Colonies and Regions used for SeabORD Analysis

Key

Option Agreement Area

Special Protection Area (SPA)

- Cape Wrath
- Hoy
- Marwick Head
- North Caithness Cliffs
- Rousay
- Sule Skerry and Sule Stack
- West Westray
- Locations used for SPAs included in the analysis

Region used for analysis

- Guillemot
- Puffin

Coordinate System: WGS 84 / UTM Zone 30N
Graticules: WGS 84

0 50 100 150 200 km

N

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Table 2.1: SPA colonies modelled using SeabORD modelling

Species	SPA	Colony	Number of pairs	Proportion of the population modelled	Latitude	Longitude	Colonies included for competition
Guillemot	North Caithness Cliffs	Duncansby Head, Dunnet Head, Holburn Head, Melvich, Stroma	25284	20%	58.66399155	-3.399308833	Sule Skerry and Sule Stack, Hoy, Marwick Head, Rousay, Cape Wrath
	Sule Skerry and Sule Stack	Sule Skerry and Sule Stack	6544	20%	59.05296628	-4.457915190	North Caithness Cliffs, Hoy, Marwick Head, Rousay, Cape Wrath
	Hoy	Hoy	7929	20%	58.85870173	-3.343172794	North Caithness Cliffs, Sule Skerry and Sule Stack, Marwick Head, Rousay, Cape Wrath
	Marwick Head	Marwick Head	7790	20%	59.10605961	-3.352462886	North Caithness Cliffs, Sule Skerry and Sule Stack, Hoy, Rousay, Cape Wrath
	Rousay	Rousay	3842	20%	59.19636641	-3.054905794	North Caithness Cliffs, Sule Skerry and Sule Stack, Hoy, Marwick Head, Cape Wrath
	Cape Wrath	Cape Wrath	24771	20%	58.61596854	-4.932545096	North Caithness Cliffs, Sule Skerry and Sule Stack, Hoy, Marwick Head, Rousay
	West Westray	West Westray	18653	20%	59.31174484	-3.035852305	North Caithness Cliffs, Sule Skerry and Sule Stack, Hoy, Marwick Head, Rousay

Species	SPA	Colony	Number of pairs	Proportion of the population modelled	Latitude	Longitude	Colonies included for competition
Puffin	North Caithness Cliffs	Duncansby Head, Dunnet Head, Holburn Head, Melvich, Stroma	1527	10%	58.66399155	-3.399308833	Sule Skerry and Sule Stack, Hoy, Cape Wrath
	Sule Skerry and Sule Stack	Sule Skerry and Sule Stack	47742	10%	59.05296628	-4.457915190	North Caithness Cliffs, Hoy, Cape Wrath
	Hoy	Hoy	1500	10%	58.85870173	-3.343172794	North Caithness Cliffs, Sule Skerry and Sule Stack, Cape Wrath
	Cape Wrath	Cape Wrath	1122	10%	58.61596854	-4.932545096	North Caithness Cliffs, Sule Skerry and Sule Stack, Hoy

2.3. Model region

The model region inputs are coordinates which define the spatial extent over which the model is to be run. For both species, colonies to be included were buffered by the species-specific foraging range (mean maximum plus one standard deviation as defined in Woodward *et al*, 2019) plus 5%. The additional 5% was included to avoid restricting the locations where modelled birds could forage, given that the function used to determine distribution of foraging locations assumes that a proportion of birds forage beyond the maximum foraging range (see Section 2.4). Model regions for each species were then determined as the minimum rectangular area that contained all of the buffers (Figure 2.1). Coordinates used are presented in Table 2.2.

Table 2.2: Region definitions used for SeabORD modelling

Species	Buffer size (km)*	North limit (degrees)	South limit (degrees)	East limit (degrees)	West limit (degrees)
Guillemot	161.4	60.760855165	57.167166687	-0.203095170	-7.703329455
Puffin	278.7	61.813783830	56.114015111	1.848829508	-9.705724096

*Source: *Mean maximum foraging range plus 1 standard deviation from Woodward et al. 2019, plus 5%.*

2.4. Determination of foraging locations

SeabORD can simulate the distribution of seabird foraging locations either using colony-specific foraging probability density maps, or under the assumption that the probability of a bird foraging in a given location declines with distance from the colony according to a distance decay function (Searle *et al.*, 2018). Since data were not available to generate a robust input map of foraging distributions of birds from the input colonies, distance decay functions were used. The function used by SeabORD 1.3 to generate the distance decay curve is parameterised with a user-defined species-specific foraging range and a proportion of animals expected to forage within that range. Foraging ranges used for the modelling represented the mean maximum foraging range plus one standard deviation from Woodward *et al*., 2019. Assuming a normal distribution, the inclusion of the standard deviation should mean that ~84% of mean maximum foraging ranges fall within this range. However, since this is a maximum, the majority of foraging trips would be likely to be shorter than this. Therefore, the default value of 95% was used as the input for the percentage of birds within the foraging range. Values used are presented in Table 2.3.

The resulting distance decay functions and normalised bird density maps for each species and colony combination are presented in Appendix B.

Table 2.3: Method used to describe foraging distributions within the SeabORD modelling

Species	Method	Foraging range (km)*	Percentage in foraging range
Guillemot	Distance decay	153.7	95%
Puffin	Distance decay	265.4	95%

*Source: *Woodward et al. 2019*

2.5. Prey distribution

Prey distribution can also be modelled based on input prey distribution maps, or assuming a uniform distribution of prey across the modelled extent. Since suitable prey distribution data were not available for the area, a uniform prey density was assumed.

2.6. Behavioural assumptions and barrier navigation method

It was assumed that 60% of birds would be displaced and 100% of those would also be barriered in line with current guidance (NatureScot, 2023b). It was assumed that displacement occurred within the OAA plus a 2 km buffer and that displaced birds (i.e. those selecting foraging locations within the windfarm footprint plus 2 km buffer and being susceptible to displacement) would select new foraging locations within a 5 km buffer around the displacement zone (Table 2.4). It should be noted that this will likely overestimate displacement as the array area will be smaller than the OAA.

The SeabORD tool allows the incorporation of two navigation methods to describe the movement of barriered birds avoiding the windfarm footprint. These are the perimeter method and the A* pathfinding method. If the perimeter method is used, a barrier-susceptible simulated bird selecting a foraging location beyond the displacement zone (the site plus a buffer determined by the 'border' input parameter) will travel up to the edge of the displacement zone and then travel around the displacement zone perimeter until it reaches the point where their original trajectory would have passed out of the other side of the displacement zone, at which point it continues along its previous flight path. The A* pathfinding method instead uses an algorithm to identify the most efficient path to the foraging location whilst avoiding the displacement zone. Since the A* pathfinding method substantially increases computational time and assumes that birds are immediately able to find the most efficient path around the windfarm footprint, a precautionary approach was taken in which the perimeter method was used.

Table 2.4: Input parameters controlling behaviour used for the SeabORD modelling

Species	Proportion displaced	Proportion of displaced also barriered	Windfarm border (displacement buffer)	Windfarm buffer (area into which birds are displaced)	Barrier navigation method
Guillemot	60%	100%	2 km	5 km	Perimeter
Puffin	60%	100%	2 km	5 km	Perimeter

Source: Natural Power

2.7. Prey Calibration

Prior to running a full SeabORD analysis, calibration must be carried out to determine appropriate values for the upper and lower prey level input parameters determining the amount of prey resource available to the birds for each combination of species and focal SPA. Trial runs were conducted for each species and SPA combination in which 10% of the population was simulated. A single run was carried out per prey value for a range of single prey input values until the maximum and minimum values that give rise to "moderate" conditions in the baseline were identified. Moderate conditions are defined as the prey values within which the baseline model returns an adult body mass loss within lower and upper thresholds and a chick survival rate above a specified lower threshold expected in a moderate year, as specified in Mobbs *et al.*, 2018 (Table 2.5). Final prey values used are presented in Table 2.6.

Table 2.5: Definition of a "moderate" year, used to calibrate prey levels for SeabORD modelling

Species	Adult mass loss expected during a moderate chick rearing season		Target chick survival for a moderate year
	Lower	Upper	
Guillemot	3.5%	10.5%	> 49%
Puffin	3.5%	10.5%	> 50%

Source: Mobbs et al., 2018

Table 2.6: Final lower and upper prey values used within the SeabORD modelling

Species	Colony	Range of adult mass loss (%)	Range of chick survival (%)	Lower prey value	Upper prey value
Guillemot	North Caithness Cliffs	9.19 – 3.52	49.6 – 93.8	476	595
	Sule Skerry and Sule Stack	8.94 – 3.53	49.2 – 93.9	432	549
	Hoy	9.19 – 3.52	49.6 – 93.6	479	591
	Marwick Head	9.25 – 3.52	49.2 – 93.8	467	580
	Rousay	9.31 – 3.51	50.0 – 93.8	471	581
	Cape Wrath	9.17 – 3.52	49.5 – 93.8	463	580
	West Westray	9.14 – 3.51	49.7 – 94.1	475	583
Puffin	North Caithness Cliffs	10.43 – 3.51	71.9 – 90.2	319	403
	Sule Skerry and Sule Stack	10.41 – 3.52	75.1 – 94.0	301	376
	Hoy	10.41 – 3.53	74.7 – 92.0	319	400
	Cape Wrath	10.47 – 3.53	77.7 – 96.4	319	405

Source: Natural Power

2.8. Run parameters

For the final runs, ten matched-pair simulations were carried out. This represents ten runs utilising different prey values from within the range specified as determined through calibration, selected by SeabORD using stratified random sampling in order to capture the uncertainty associated with prey levels (Searle *et al.*, 2018). Each simulation was run for a baseline and an impact scenario providing matched pairs of outputs from which output metrics were calculated. The starting seed was set to 52 for guillemot runs and 1 for puffin runs.

2.9. Output metrics

A range of output metrics are provided by SeabORD and these also allow calculation of additional metrics. Since models were not run for 100% of the population, predicted absolute numbers of mortalities relate only to the proportion of the population modelled. These numbers can be scaled by multiplying the inverse of the proportion modelled to generate a predicted number of mortalities for the full population. Metrics presented in this report for each species and colony include:

- Scaled mortality rates indicating the mean number of mortalities predicted by SeabORD for each colony, assuming that mortality scales directly with proportion of the colony simulated;
- Survival rates for baseline and impact scenarios, calculated from mean mortality rates (adults only);
- Percentage point reduction in survival rate from the baseline to the impact scenario (which is the same value as the percent additional mortality metric provided by the SeabORD tool) (adults); and
- Percent additional mortality (chicks).

These output metrics relate to adults across the whole year and chicks during the chick-rearing season (since SeabORD does not provide an estimate of chick over-winter survival). Additional metrics that may be useful for comparing with other SeabORD analyses or to understand the mechanisms underlying the impacts that are being predicted are presented in Appendix C.

3. Results

3.1. Guillemot

Results of the SeabORD analysis carried out for guillemot are presented in Table 3.1 and Table 3.2, with supplementary outputs provided in Appendix C.

For guillemot, model outputs suggested that the biggest impact of displacement and barrier effects from the West Orkney Windfarm would be to the Sule Skerry and Sule Stack SPA (0.302% increase in adult annual mortality rate from the baseline scenario in a moderate year), with North Caithness Cliffs, Hoy, Cape Wrath and Marwick Head SPAs also having an increase in adult annual mortality rate in a moderate year of greater than 0.1% (0.184%, 0.170%, 0.128% and 0.106% respectively) (Table 3.1). Rousay and West Westray SPAs had predicted reductions of less than 0.1% in a moderate year (0.072% and 0.034% respectively) (Table 3.1). This pattern is consistent with the distance of each colony away from the windfarm, with Sule Skerry and Sule Stack SPA being closest to the proposed windfarm footprint, and Rousay and West Westray SPAs being furthest away (Figure 2.1). Despite SeabORD only quantifying a very small portion of the total uncertainty inherent within the model (see Section 4), it is notable that the 95% confidence intervals around the reduction in survival rates (or additional mortality rates) include 0, with the exception of Sule Skerry and Sule Stack SPA (Table 3.1).

Similarly for chicks, by far the greatest impact was predicted for Sule Skerry and Sule Stack SPA (Table 3.2) at which a 2.3% increase in mortality during the chick rearing season was predicted. The predicted increase in mortality for the remaining colonies were all below 1% and followed the same pattern as for adults with the exception that higher impacts were predicted for Rousay than Marwick Head SPAs (Table 3.2). This is interesting since the Marwick Head SPA is closer to the proposed development than the Rousay SPA (Figure 2.1).

Table 3.1: Mean predicted guillemot adult annual mortalities (scaled to represent the whole population) and survival rates with and without displacement and barrier effects from the offshore Project

Colony	Population size (birds)	Year type	Scaled Baseline mortality (birds)	Scaled Impact mortality (birds)	Scaled additional mortalities (birds)	Baseline survival rate (%)	Impact survival rate (%)	Percentage point reduction in survival rate (95% confidence intervals)
Sule Skerry and Sule Stack	13088	Poor	2504	2580	77	80.87	80.29	0.584 (0.153 – 1.106)
		Moderate	**1190**	**1230**	**40**	**90.91**	**90.61**	**0.302 (0.011 – 0.593)**
		Good	1066	1084	18	91.87	91.72	0.134 (-0.187 – 0.454)
North Caithness Cliffs	50568	Poor	12221	12358	137	75.83	75.56	0.271 (0.038 – 0.504)
		Moderate	**5952**	**6045**	**93**	**88.23**	**88.05**	**0.184 (-0.054 – 0.421)**
		Good	4862	4945	84	90.39	90.22	0.165 (0.078 – 0.252)
Hoy	15858	Poor	3711	3755	45	76.60	76.32	0.281 (-0.047 – 0.608)
		Moderate	**1758**	**1785**	**27**	**88.92**	**88.75**	**0.170 (-0.036 – 0.376)**
		Good	1511	1531	20	90.47	90.35	0.123 (-0.072 – 0.318)
Marwick Head	15580	Poor	3502	3520	18	77.54	77.41	0.116 (-0.046 – 0.277)
		Moderate	**1770**	**1786**	**17**	**88.64**	**88.54**	**0.106 (-0.046 – 0.277)**
		Good	1337	1349	13	91.42	91.34	0.080 (-0.114 – 0.274)
Rousay	7684	Poor	1692	1709	17	78.00	77.70	0.221 (-0.229 – 0.671)
		Moderate	**947**	**952**	**6**	**87.70**	**87.60**	**0.072 (-0.175 – 0.318)**
		Good	672	676	4	91.30	91.20	0.046 (-0.148 – 0.239)
Cape Wrath	49542	Poor	11062	11121	59	77.67	77.55	0.119 (-0.026 – 0.264)
		Moderate	**5356**	**5420**	**64**	**89.19**	**89.06**	**0.128 (-0.049 – 0.305)**
		Good	4218	4276	58	91.49	91.37	0.117 (-0.055 – 0.289)

Colony	Population size (birds)	Year type	Scaled Baseline mortality (birds)	Scaled Impact mortality (birds)	Scaled additional mortalities (birds)	Baseline survival rate (%)	Impact survival rate (%)	Percentage point reduction in survival rate (95% confidence intervals)
West Westray	37306	Poor	8283	8331	48	78.32	78.20	0.129 (-0.024 – 0.281)
		Moderate	**4017**	**4029**	**13**	**89.49**	**89.46**	**0.034 (-0.063 – 0.130)**
		Good	3234	3241	7	91.54	91.52	0.019 (-0.093 – 0.130)

Table 3.2: Mean predicted guillemot chick mortalities (scaled to represent the whole population) and survival rates during the chick-rearing season with and without displacement and barrier effects from the offshore Project

Colony	Number of chicks*	Scaled baseline mortality (chicks)	Scaled impact mortality (chicks)	Scaled additional mortalities (chicks)	Percent additional mortality (95% confidence intervals)
Sule Skerry and Sule Stack	6544	1276	1425	149	2.277 (-1.258 – 5.811)
North Caithness Cliffs	25284	4782	5003	221	0.872 (-0.298 – 2.042)
Hoy	7929	1591	1654	63	0.794 (0.021 – 1.568)
Marwick Head	7790	1524	1555	31	0.398 (-0.535 – 1.331)
Rousay	3842	790	807	17	0.430 (-0.382 – 1.241)
Cape Wrath	24771	4517	4682	165	0.666 (-0.082 – 1.414)
West Westray	18653	3495	3561	66	0.354 (-0.045 – 0.752)

*Source: Natural Power, *SeabORD assumes one chick per pair of adults simulated*

3.2. Puffin

Results of the SeabORD analyses carried out for puffin are presented in Table 3.3 and Table 3.4, with supplementary outputs provided in Appendix C.

For puffin, model outputs suggested that the biggest impact of displacement and barrier effects from the West Orkney Windfarm would be to the Sule Skerry and Sule Stack SPA for which a 0.495% percentage point reduction in the survival rate was predicted for the impact scenario versus the baseline in a moderate year (Table 3.3). This makes sense since Sule Skerry and Sule Stack SPA is the closest population to the proposed windfarm site (Figure 2.1). Hoy SPA had the second largest predicted impact, with a percentage point reduction in survival of 0.4% and North Caithness Cliffs SPA the third, with a percentage point reduction in survival of 0.26% (Table 3.3). For Cape Wrath SPA, the model predicted an increase in survival rate in the impact scenario under moderate conditions of 0.18% (Table 3.3). The prediction of positive impacts of displacement and barrier effects on adult survival within SeabORD can occur as a result of several different factors within the model including 1) individuals displaced from the windfarm selecting alternative foraging locations closer to the colony, thereby reducing the distance they are required to travel and thus energetic costs associated with foraging, 2) displaced individuals selecting alternative foraging locations with lower competition, and 3) adult birds abandoning their breeding attempt therefore being able to better provision themselves over the chick-rearing season (Searle *et al.*, 2018). As for guillemot, the 95% confidence intervals around the reduction in survival rates (or additional mortality rates) for a moderate year include 0, with the exception of Sule Skerry and Sule Stack SPA (Table 3.3).

Similarly for chicks, predicted impacts were greatest at Sule Skerry and Sule Stack SPA, followed by Hoy, North Caithness Cliffs and finally Cape Wrath SPAs, with percentage point reduction in survival rate of 0.74%, 0.27%, 0.20% and 0.18% respectively (Table 3.4). All of the 95% confidence intervals around the reduction in survival rates (or additional mortality rates) for include 0 (Table 3.4).

Table 3.3: Mean predicted puffin adult annual mortalities (scaled to represent the while population) and survival rates with and without displacement and barrier effects from the offshore Project

Colony	Population size (birds)	Year type	Scaled baseline mortality (birds)	Scaled impact mortality (birds)	Scaled additional mortalities (birds)	Baseline survival rate (%) (mean)	Impact survival rate (%) (mean)	Percentage point reduction in survival rate (95% confidence intervals)
Sule Skerry and Sule Stack	95484	Poor	17,892	18,265	373	81.26	80.87	0.391 (-0.084 – 0.865)
		Moderate	**12,511**	**12,984**	**473**	**86.90**	**86.40**	**0.495 (0.277 – 0.713)**
		Good	7,319	7,630	311	92.33	92.01	0.326 (0.130 – 0.522)
North Caithness Cliffs	3054	Poor	661	671	10	78.40	78.07	0.327 (-0.707 – 1.361)
		Moderate	**412**	**420**	**8**	**86.54**	**86.27**	**0.261 (-0.350 – 0.873)**
		Good	326	331	5	89.35	89.18	0.163 (-0.948 – 1.275)
Hoy	3000	Poor	651	662	11	78.30	77.93	0.367 (-0.580 – 1.313)
		Moderate	**530**	**542**	**12**	**82.33**	**81.93**	**0.400 (-0.881 – 1.681)**
		Good	340	341	1	88.67	88.63	0.033 (-0.550 – 0.617)
Cape Wrath	2244	Poor	498	509	11	77.77	77.28	0.491 (-0.675 – 1.657)
		Moderate	**360**	**356**	**-4**	**83.93**	**84.11**	**-0.179 (-1.202 – 0.845)**
		Good	148	155	7	93.39	93.08	0.313 (-0.402 – 1.027)

Table 3.4: Mean predicted puffin chick mortalities (scaled to represent the whole population) and survival rates during the chick-rearing season with and without displacement and barrier effects from the offshore Project

Colony	Number of chicks*	Scaled baseline mortality (chicks)	Scaled impact mortality (chicks)	Scaled additional mortalities (chicks)	Percent additional mortality (95% confidence intervals)
Sule Skerry and Sule Stack	47742	5024	5378	354	0.742 (-0.768 – 2.251)
North Caithness Cliffs	1527	208	211	3	0.196 (-0.553 – 0.945)
Hoy	1500	170	174	4	0.267 (-0.550 – 1.083)
Cape Wrath	1122	78	80	2	0.179 (-1.161 – 1.518)

*Source: Natural Power, *SeabORD assumes one chick per pair of adults simulated*

4. Discussion and caveats

As requested by NatureScot, SeabORD models were run to provide additional context to displacement assessment carried out for guillemot and puffin for the proposed offshore Project.

As noted previously, the boundary used in the modelling to determine the area from which displacement and barrier effects would occur represented the OAA rather than the array area itself, since the final wind farm layout is yet to be agreed. The use of this larger area would be expected to give rise to higher predicted displacement and barrier impacts than the use of the final array area. This is because the larger area of the polygon will mean that a greater number of birds simulated during the modelling will be directly impacted by the wind farm, either as a result of selecting a foraging location within the polygon or for which the flight paths to their chosen foraging location will pass through the polygon.

The seabORD modelling framework is more nuanced than the displacement matrix as it seeks to replicate the underlying biological processes determining displacement and barrier effects on sea birds and provides outputs regarding a number of different potential impacts of an offshore windfarm development relating to the survival and reproductive rates of key seabird populations. However, there are a number of caveats which mean that results presented here should not be interpreted as accurate estimates of mortality rates associated with displacement and barrier effects, but rather as supplementary information to indicate how different colonies may be affected relative to one another. These caveats are listed below:

- The model was originally developed to look in detail at scenarios in the Forth and Tay region and was parameterised and calibrated accordingly, therefore using it outside of this region without reviewing and updating the data underlying the model may result in poor model performance. Whilst a handful of the inputs can be customised by the user, the model incorporates upwards of 80 underlying assumptions and parameters (Vallejo *et al.*, 2022), most of which cannot be altered by the user.
- Many of the input parameters and underlying model assumptions are associated with a high degree of uncertainty (Vallejo *et al.*, 2022), the majority of which is not captured within the model outputs (Searle *et al.*, 2018; 2022). For this reason, absolute mortality estimates are likely to be inaccurate and uncertainty measures provided should not be considered to capture the true uncertainty inherent within the model, which will be substantially higher.
- The model was originally devised to use tracking data to represent seabird foraging locations as accurately as possible across the modelled region. Since no appropriate data are available for the north of Scotland, it was necessary to use the distance decay function option within the SeabORD framework. The distance-decay relationship cannot account for the effect of prey abundance which will generally cause hotspots of bird density beyond those where they would be expected to be when only considering distance to the colony (Searle et al. 2018). Instead, the majority of birds will be simulated to forage close to the colony (see distance decay curves and maps in Appendix B) potentially resulting in very different conclusions being drawn (Vallejo *et al.*, 2022).
- The model was developed to be used with a prey map describing the distribution of prey within the study region which is used by the model to simulate food availability. Since suitable prey distribution data were also unavailable, a uniform prey distribution was assumed. This assumption does not reflect the patchy prey distributions known to be encountered by seabirds at sea and has previously been found to give rise to very different outputs than a model using prey distribution data (Vallejo *et al.*, 2022).
- The model was run using the most recent publicly available version of SeabORD, released in 2018, but a new release will shortly be available through the Cumulative Effects Framework (CEF) which may yield different outputs if applied with the same inputs. Therefore, these results should not be directly compared to future outputs generated using the CEF.

- The length of time taken to run SeabORD meant that it was not possible within a reasonable timeframe available to simulate 100% of the individuals in the populations being studied. Whilst model developers state that the model is largely insensitive to the fraction of the population simulated (Mobbs *et al.*, 2018), the assumption that impacts scale with proportion simulated has not been well tested. Additionally, measures of uncertainty may be less accurate than if the entire population had been simulated.
- Due to limitations of the publicly available tool, the five discrete and spatially differentiated colonies making up the North Caithness Cliffs SPA had to be modelled as a single colony foraging from the location of the middle colony. However, in reality, birds located within the different colonies would be expected to experience different levels of impacts from the proposed windfarm based on their spatial locations.
- Similarly, all colonies of interest could not be run in the same model for guillemot. This means that competition effects for all seven models excluded competition with individuals from one of the colonies, and also that the West Westray SPA model outputs may be less comparable with other guillemot runs than the other colony runs are to each other.
- The region definition (the spatial extent over which the model runs) is user-definable and needs to be updated to allow the model to be run outside of the Forth and Tay. However, no guidance is available regarding how to set the region nor how sensitive the model is to this input. It seems intuitive that since few birds are expected to forage beyond the mean maximum foraging range plus one standard deviation, region definitions beyond this should not significantly change simulated bird distributions and thus model outputs. However, this has not previously been shown and given the large amount of time taken to run models, has not been investigated as part of this work.
- More generally, there is currently very little guidance on running SeabORD in a standardised way and what input parameters should be used. Therefore, the implementation of the model is likely to differ by user, limiting comparability among assessments.
- There have been some concerns raised regarding SeabORD predictions which have not yet been adequately resolved. For example, previous work for the consented Inch Cape offshore windfarm found that SeabORD often predicts much higher rates of mortality (by an order of magnitude) than is expected from expert judgement informing the matrix-based approach (ICOL, 2018; Searle *et al*. 2020), and different versions of the model (2014 and 2018) were found to generate very different predictions, despite being based, with a few exceptions, on a very similar set of parameters and assumptions, and the same principles (ICOL, 2018). Inch Cape also identified unintuitive patterns in their SeabORD outputs, for example, very different effects of displacement mortality upon colonies at similar distances to a development and stronger cumulative effects on populations that are on average farther away from the developments being considered than closer populations (ICOL, 2018). Additionally, the authors of SeabORD have highlighted several possible modifications to the model that could be made to increase the representativeness and true quantification of uncertainty within the modelling process (Daunt *et al.*, 2018; Searle *et al.*, 2022), which would likely yield different outputs than the existing model.

SeabORD provides a mechanistic solution to understanding the potential impacts of displacement and barrier effects occurring during the chick-rearing season and has been run for West Orkney to provide further insight into these potential effects. However, given the number of caveats and uncertainty around this approach, as well as the conservatism in the way in which the model has been run, these results have been provided for context only with the industry standard displacement tool being used for the main assessment.

5. References

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A. SeabORD run-times

Run times for SeabORD modelling carried out for offshore Project are presented in Table A.1. Total run time for the work was roughly 475 hours.

Table A.1: Flight paths are calculated during the initial run and are then re-used for subsequent runs.

Species	Run type	Number of runs	Percent population simulated	Duration (hh:mm)
Guillemot	Flight paths (all except West Westray)	1	10	7:07
	Flight paths (West Westray)	1	10	20:37
	Calibration runs (median)	21*	10	0:25
	Full run (Sule Skerry and Sule Stack)	10	20	30:45
	Full run (North Caithness Cliffs)	10	20	30:19
	Full run (Hoy)	10	20	20:58
	Full run (Marwick Head)	10	20	18:38
	Full run (Rousay)	10	20	29:51
	Full run (Cape Wrath)	10	20	29:39
	Full run (West Westray)	10	20	25:49
Puffin	Flight paths	1	10	176:20
	Calibration runs (median)	24*	10	1:24
	Full run (Sule Skerry and Sule Stack)	10	10	14:14
	Full run (North Caithness Cliffs)	10	10	11:06
	Full run (Hoy)	10	10	9:16
	Full run (Cape Wrath)	10	10	11:33

*Source: Natural Power, *individual runs with different fixed prey values.*

B. Distance decay plots and normalised bird densities

The distance decay curves constructed by SeabORD for guillemot and puffin respectively are presented in Figure B.1 and B.2. The normalised bird density surfaces calculated within SeabORD using these as output by SeabORD are presented in Figure B.3 – B.13.

Source: Natural Power

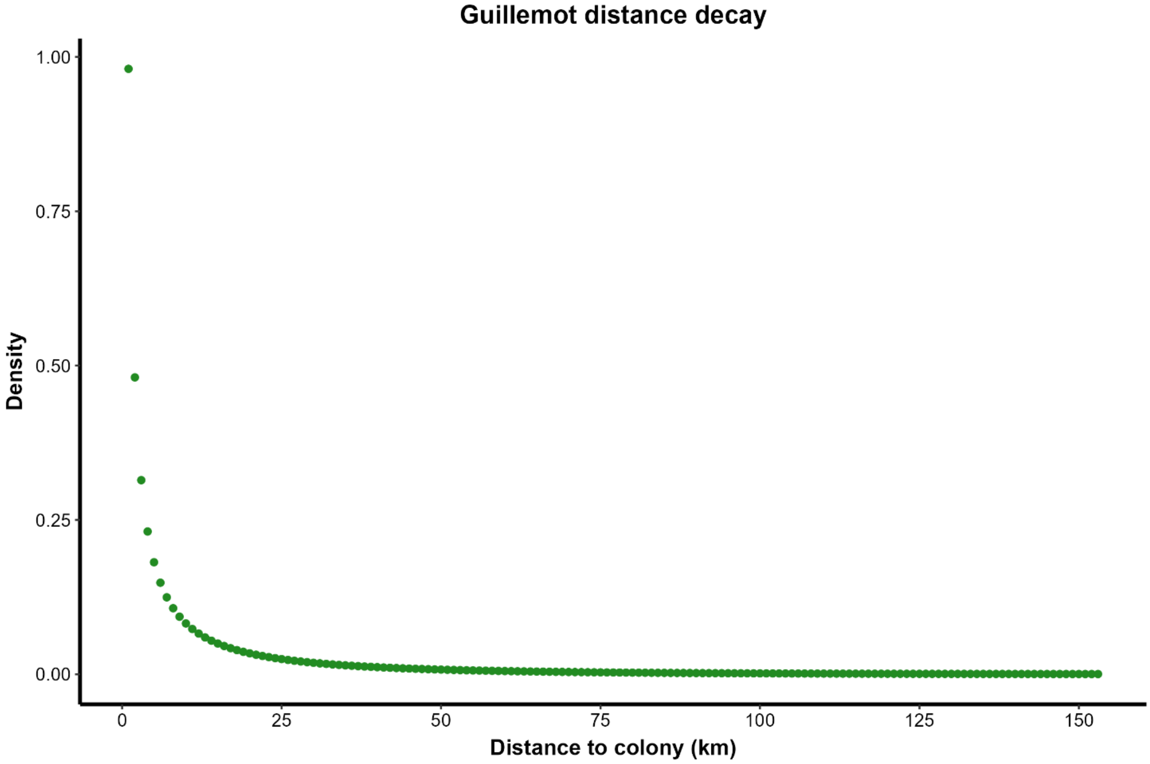

Figure B.1: Distance decay function used within SeabORD for guillemot runs.

Source: Natural Power

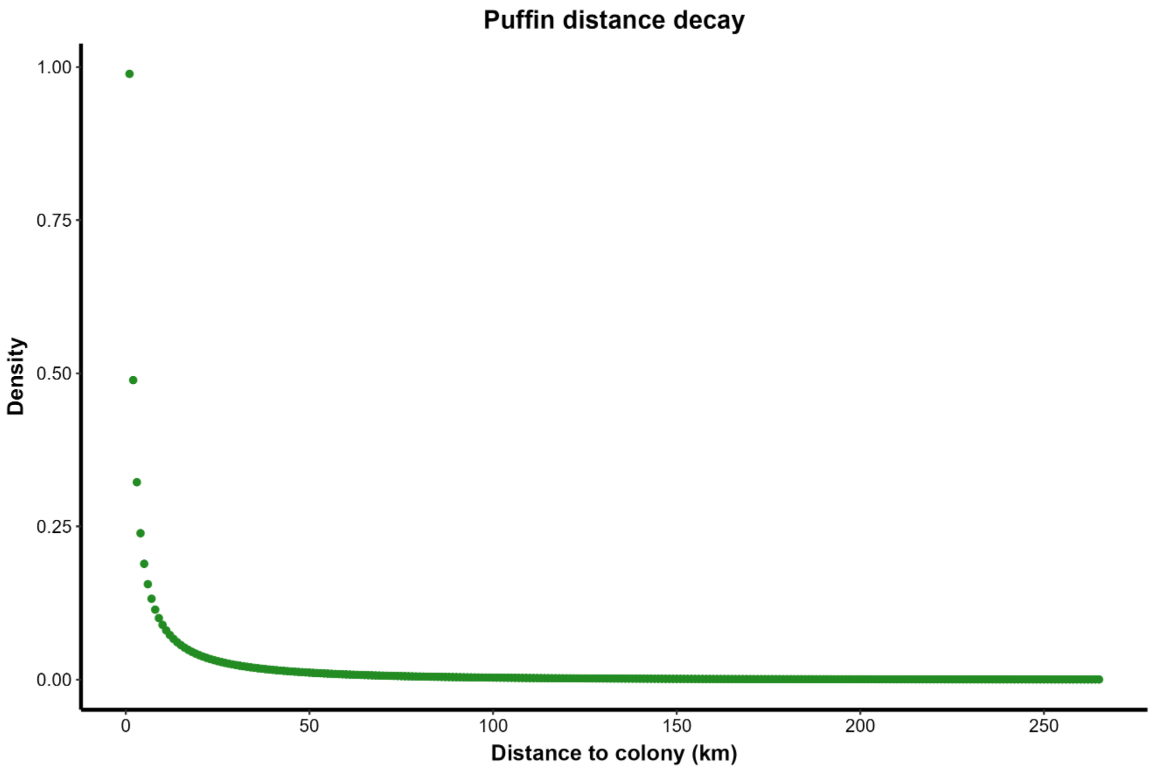

Figure B.2: Distance decay function used within SeabORD for puffin runs

Source: SeabORD output

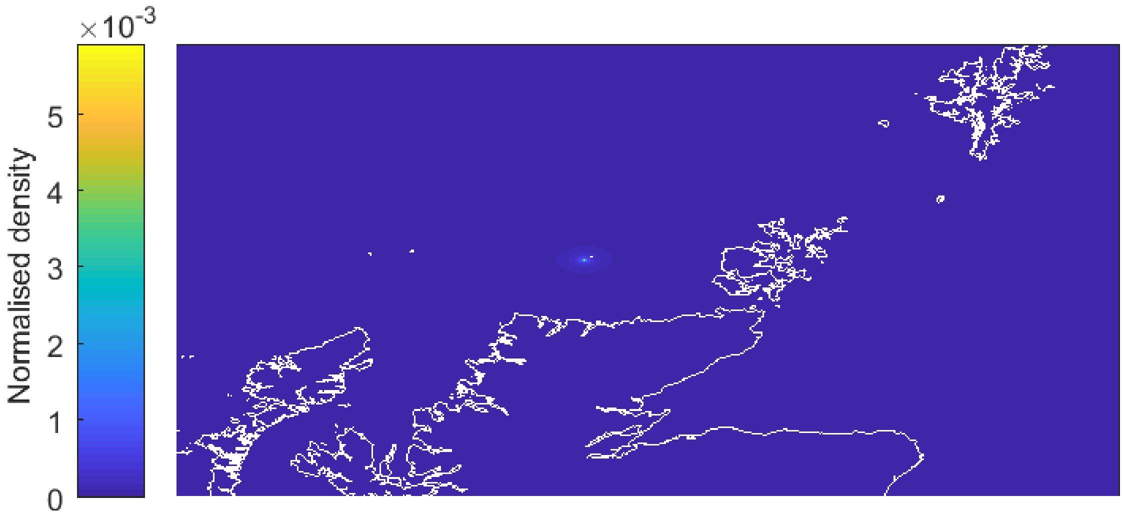

Figure B.3: Normalised Guillemot density at Sule Skerry and Sule Stack.

Source: SeabORD output

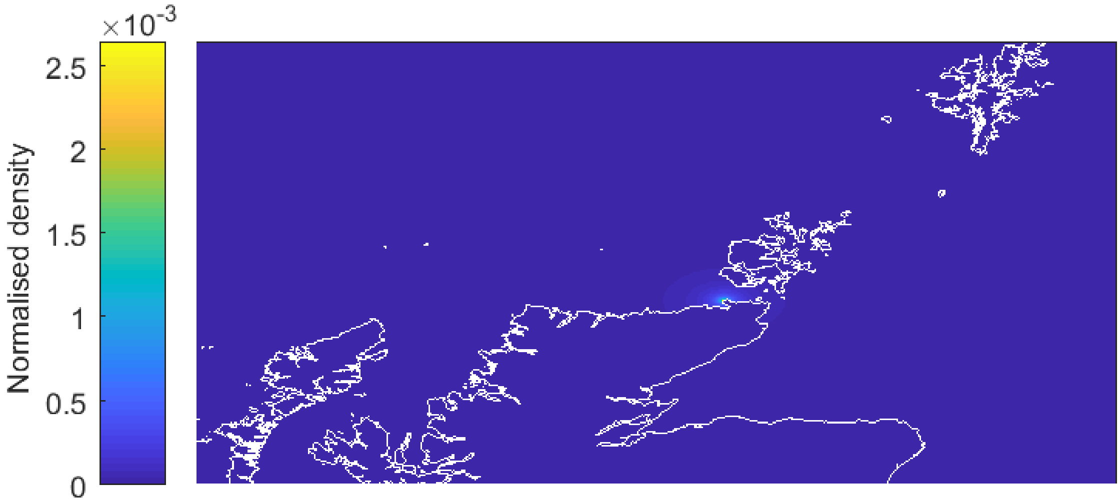

Figure B.4: Normalised Guillemot density at North Caithness Cliffs.

Source: SeabORD output

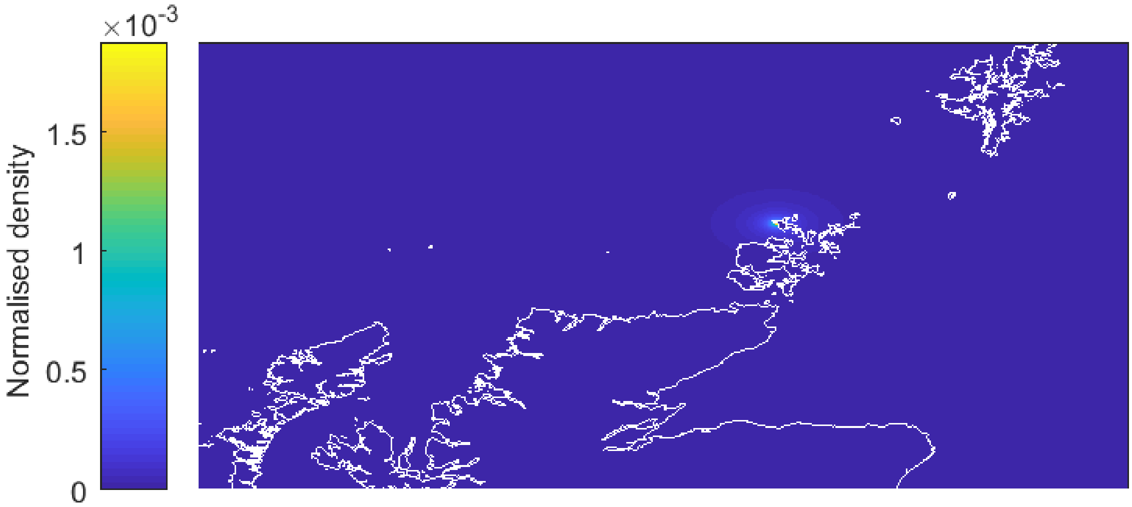

Figure B.5: Normalised Guillemot density at West Westray.

Source: SeabORD output

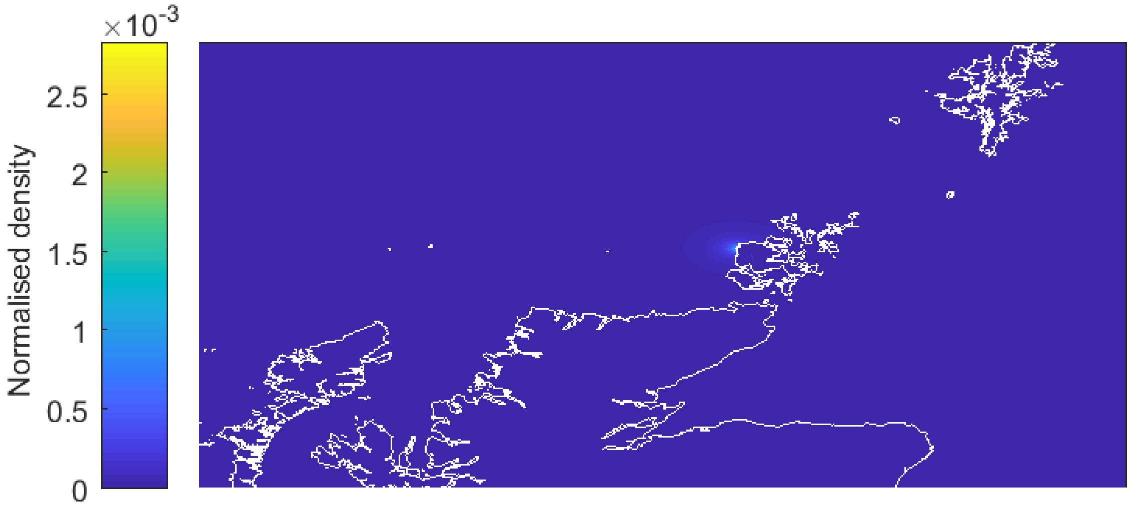

Figure B.6: Normalised Guillemot density at Marwick Head.

Source: SeabORD output

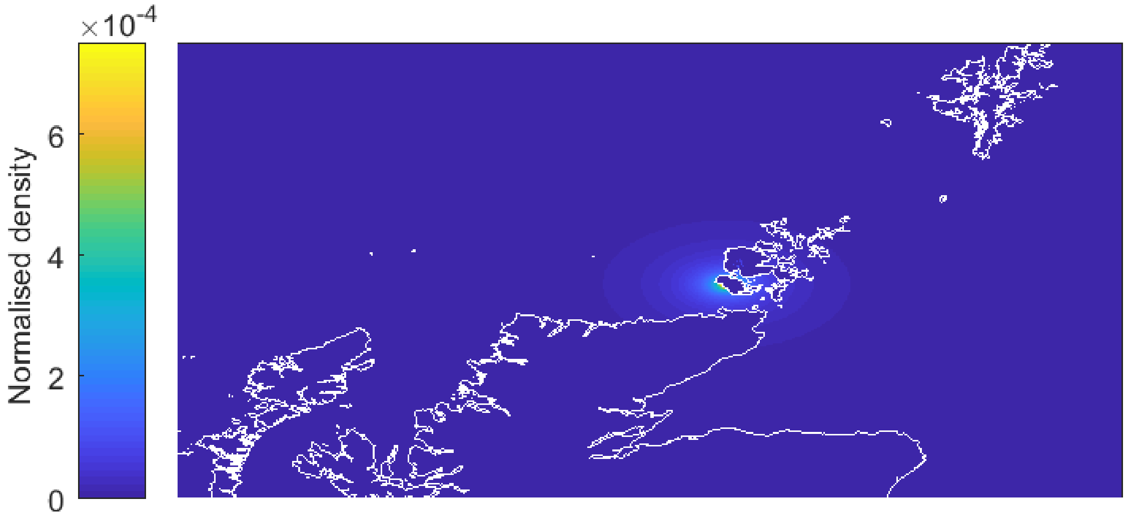

Figure B.7: Normalised Guillemot density at Hoy.

Source: SeabORD output

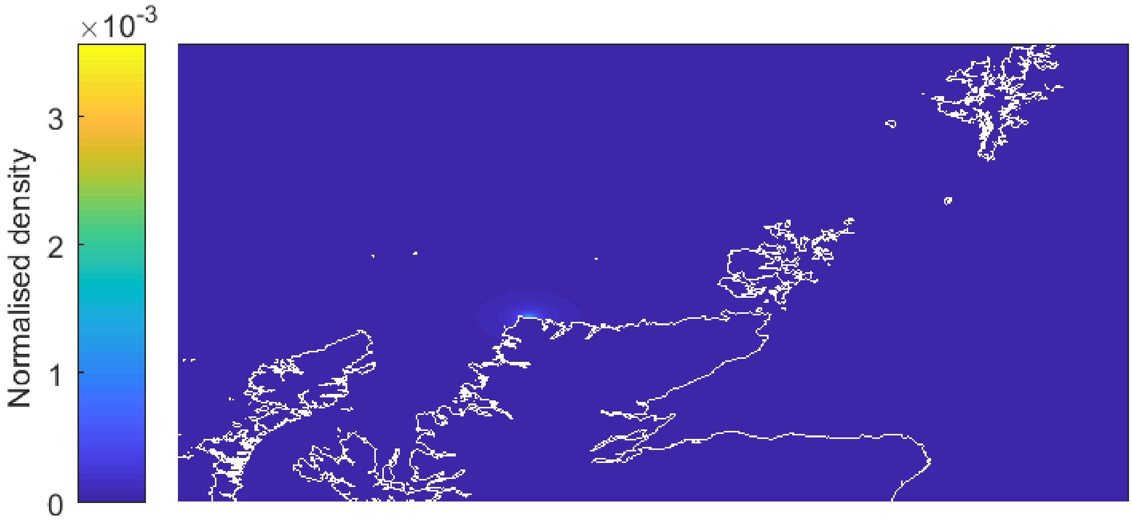

Figure B.8: Normalised Guillemot density at Cape Wrath.

Source: SeabORD output

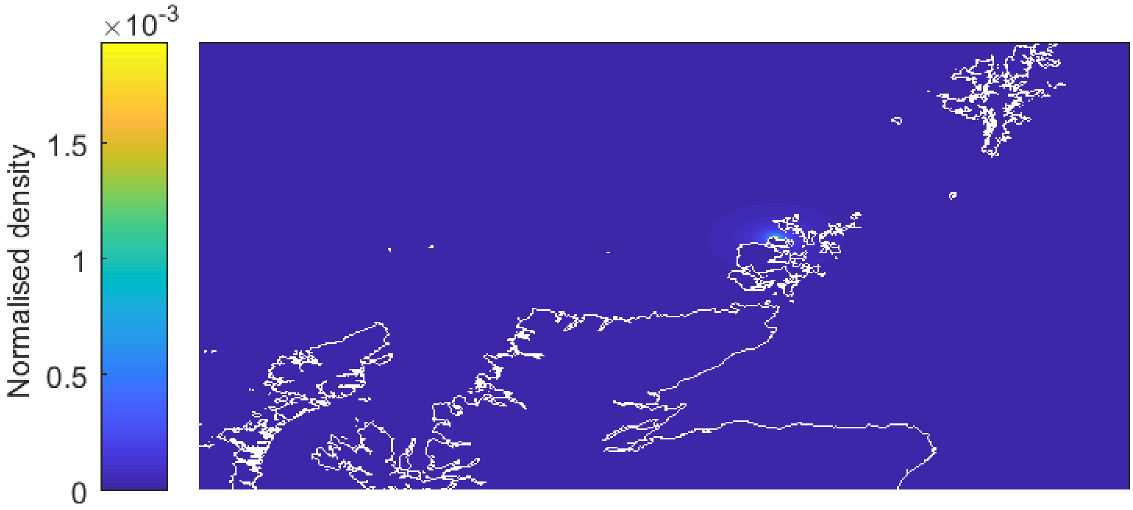

Figure B.9: Normalised Guillemot density at Rousay.

Source: SeabORD output

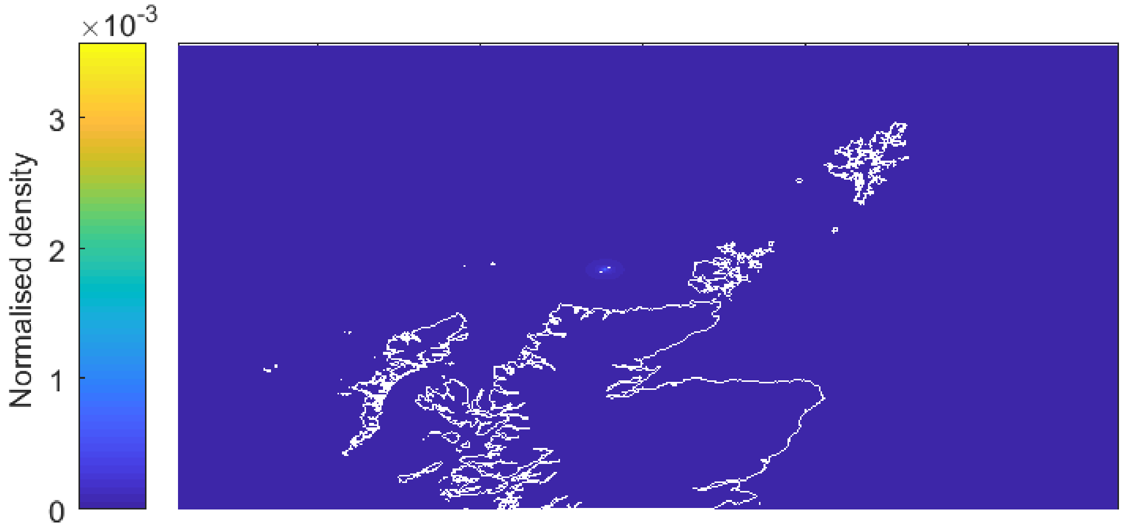

Figure B.10: Normalised Puffin density at Sule Skerry and Sule Stack.

Source: SeabORD output

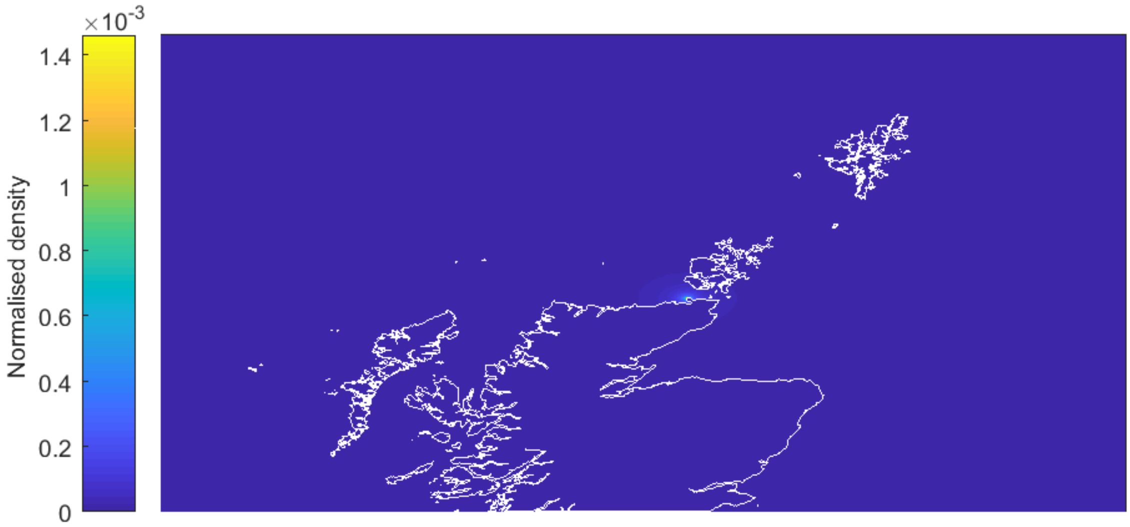

Figure B.11: Normalised Puffin density at North Caithness Cliffs.

Source: SeabORD output

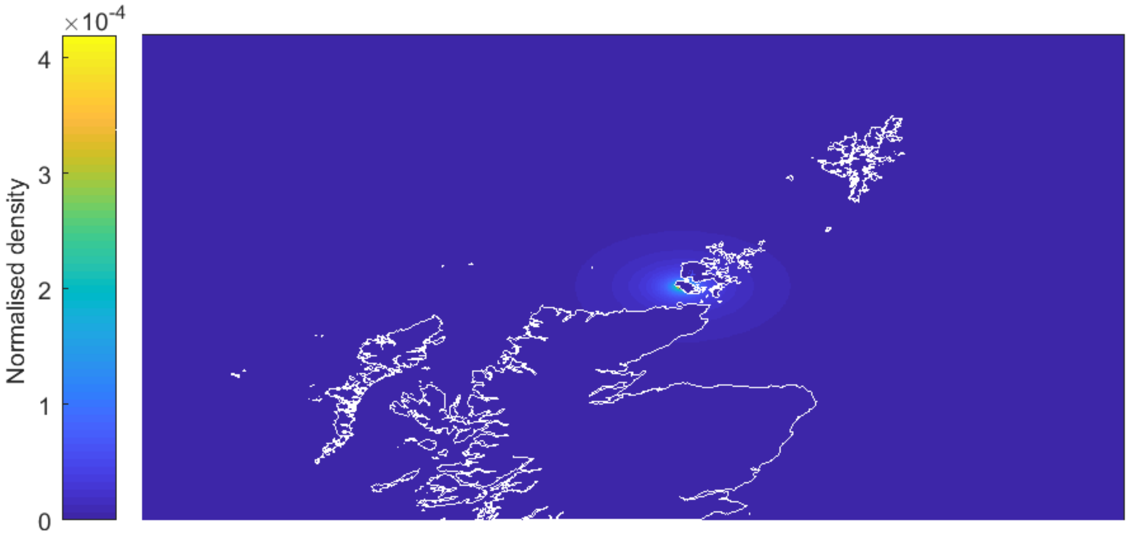

Figure B.12: Normalised Puffin density at Hoy.

Source: SeabORD output

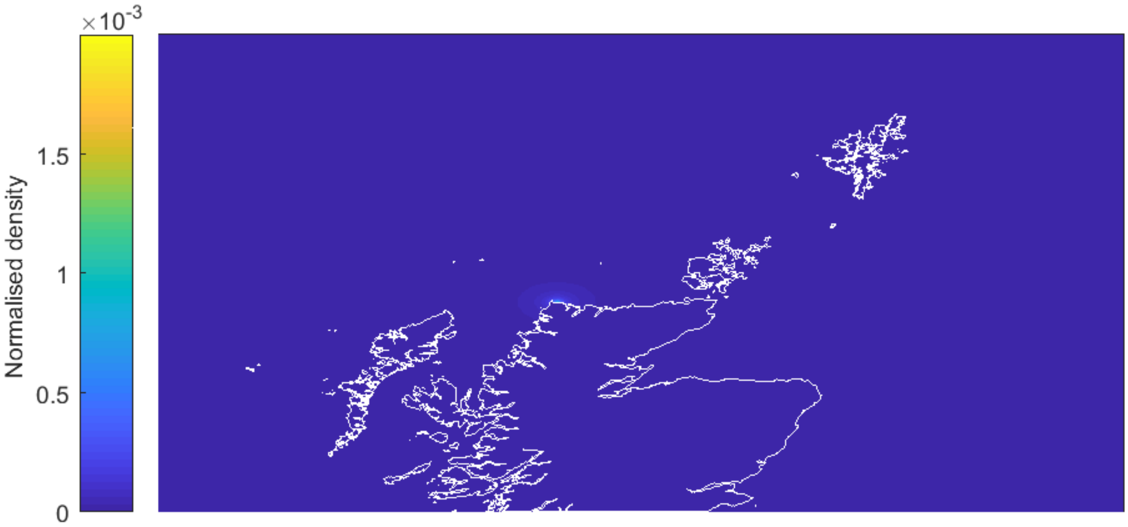

Figure B.13: Normalised Puffin density at Cape Wrath.

C. Detailed SeabORD outputs

A selection of additional metrics produced by SeabORD are presented in Table C.1 – Table C.6. These values are provided to allow comparison with other instances where SeabORD has been used and to provide insight into the underlying mechanisms determining additional mortality.

Additional metrics presented include:

- Unscaled mortality rates indicating the total number of mortalities predicted by SeabORD for each colony
- Percent additional mortality between the baseline and impact scenarios across the ten runs calculated as:

  $$AM = 100 * \frac{Mortalities\ when\ the\ wind\ farm\ is\ present - Mortalities\ when\ the\ wind\ farm\ is\ absent}{Population\ size}$$

  Where population size is the number of individuals simulated if runs are carried out for less than 100% of the total population. Percent additional mortality is presented as mean, standard deviation and upper and lower confidence intervals. (Note that these values are the same as the percentage point reduction in survival rates presented in the main text).
- Adult survival during the chick-rearing period, presented as a mean and standard deviation.
- The initial adult mass within the simulations (mean and standard deviation).
- Adult mass at the end of the chick-rearing season both for the baseline and impact scenarios (mean and standard deviation).
- The percentage of adults directly impacted by the windfarm (i.e. birds that are displaced or barriered as a result of the windfarm at least once during a simulated season).
- The difference in the number of trips flown by simulated birds between the baseline and impact scenarios (mean and standard deviation), determined as a result of simulated birds optimising trip number to minimise time spent foraging/maximise energetic gain (Searle *et al.*, 2018).
- The difference in the total distance flown between the baseline and impact scenarios (mean and standard deviation).

Table C.1: Adult annual mortality predicted by SeabORD for guillemot colonies with and without barrier and displacement effects from the offshore Project

Colony	Birds simulated	Year type	Baseline Model (no ORD)			Impact Model (with ORD)			Additional Mortality			
			Mean mortality	Standard deviation	Scaled mortality	Mean mortality	Standard deviation	Scaled mortality	Percent additional mortality	Standard deviation	Lower 95% CI	Upper 95% CI
Sule Skerry and Sule Stack	2618	Poor	500.7	14.072	2503.5	516.0	12.101	2580.0	0.584	0.182	0.153	1.106
		Moderate	**238.0**	**7.330**	**1190.0**	**245.9**	**5.152**	**1229.5**	**0.302**	**0.123**	**0.011**	**0.593**
		Good	213.2	5.308	1066.0	216.7	3.592	1083.5	0.134	0.135	-0.187	0.454
North Caithness Cliffs	10114	Poor	2444.1	11.200	12220.5	2471.5	16.514	12357.5	0.271	0.098	0.038	0.504
		Moderate	**1190.4**	**5.232**	**5952.0**	**1209.0**	**13.638**	**6045.0**	**0.184**	**0.100**	**-0.054**	**0.421**
		Good	972.3	13.466	4861.5	989.0	11.719	4945.0	0.165	0.037	0.078	0.252
Hoy	3172	Poor	742.1	6.437	3710.5	751.0	6.446	3755.0	0.281	0.138	-0.047	0.608
		Moderate	**351.5**	**3.808**	**1757.5**	**356.9**	**4.483**	**1784.5**	**0.170**	**0.087**	**-0.036**	**0.376**
		Good	302.2	2.700	1511.0	306.1	4.306	1530.5	0.123	0.082	-0.072	0.318
Marwick Head	3116	Poor	700.3	3.335	3501.5	703.9	3.107	3519.5	0.116	0.068	-0.046	0.277
		Moderate	**353.9**	**5.724**	**1769.5**	**357.2**	**6.015**	**1786.0**	**0.106**	**0.087**	**-0.100**	**0.312**
		Good	267.3	3.020	1336.5	269.8	2.616	1349.0	0.080	0.082	-0.114	0.274
Rousay	1536	Poor	338.4	4.300	1692.0	341.8	3.765	1709.0	0.221	0.190	-0.229	0.671
		Moderate	**189.3**	**3.302**	**946.5**	**190.4**	**3.502**	**952.0**	**0.072**	**0.104**	**-0.175**	**0.318**
		Good	134.4	2.633	672.0	135.1	1.912	675.5	0.046	0.081	-0.148	0.239
Cape Wrath	9908	Poor	2212.4	22.677	11062.0	2224.2	18.341	11121.0	0.119	0.061	-0.026	0.264
		Moderate	**1071.2**	**10.358**	**5356.0**	**1083.9**	**11.484**	**5419.5**	**0.128**	**0.075**	**-0.049**	**0.305**
		Good	843.6	5.854	4218.0	855.2	5.903	4276.0	0.117	0.073	-0.055	0.289

Colony	Birds simulated	Year type	Baseline Model (no ORD)			Impact Model (with ORD)			Additional Mortality			
			Mean mortality	Standard deviation	Scaled mortality	Mean mortality	Standard deviation	Scaled mortality	Percent additional mortality	Standard deviation	Lower 95% CI	Upper 95% CI
West Westray	7462	Poor	1656.5	17.927	8282.5	1666.1	16.333	8330.5	0.129	0.064	-0.024	0.281
		Moderate	**803.3**	**7.704**	**4016.5**	**805.8**	**6.443**	**4029.0**	**0.034**	**0.041**	**-0.063**	**0.130**
		Good	646.7	5.187	3233.5	648.1	4.408	3240.5	0.047	0.047	-0.093	0.130

Source: Natural Power

Table C.2: Chick mortality during the chick-rearing season predicted by SeabORD for guillemot colonies with and without barrier and displacement effects from the offshore Project

Colony	Baseline Model (no ORD)			Impact Model (with ORD)			Additional Mortality			
	Mean mortality	Standard deviation	Scaled mortality	Mean mortality	Standard deviation	Scaled mortality	Percent additional mortality	Standard deviation	Lower confidence interval	Upper confidence interval
Sule Skerry and Sule Stack	255.2	177.904	1276.0	285.0	196.912	1425.0	2.277	1.490	-1.258	5.811
North Caithness Cliffs	956.4	655.581	4782.0	1000.5	679.122	5002.5	0.872	0.493	-0.298	2.042
Hoy	318.1	215.268	1590.5	330.7	219.094	1653.5	0.794	0.326	0.021	1.568
Marwick Head	304.7	216.805	1523.5	310.9	222.511	1554.5	0.398	0.393	-0.535	1.331
Rousay	158.0	108.788	790.0	161.3	111.223	806.5	0.430	0.342	-0.382	1.241
Cape Wrath	903.3	653.970	4516.5	936.3	663.685	4681.5	0.666	0.315	-0.082	1.414
West Westray	699.0	498.662	3495	712.2	502.948	3561.0	0.354	0.168	-0.045	0.752

Source: Natural Power

Table C.3: Additional output metrics from SeabORD modelling for guillemot colonies with and without barrier and displacement effects from the offshore Project. Numbers in brackets are standard deviations.

Colony	Scenario	Mean adult survival during chick-rearing (%)	Initial adult mass (g)	Mean adult mass at the end of the chick-rearing season (g)	Mass loss during the chick-rearing season (g)	Mean adults directly impacted by the windfarm (%)	Mean difference in the number of trips flown	Mean difference in the distance flown (km)
Sule Skerry and Sule Stack	Baseline (no ORD)	100 (0.00)	920.085 (0.000)	862.622 (16.589)	57.463	N/A	0.125 (0.080)	35.496 (11.507)
	Impact (ORD)	100 (0.00)	920.085 (0.000)	860.103 (16.469)	59.982	59.47		
North Caithness Cliffs	Baseline (no ORD)	100 (0.00)	919.404 (0.000)	862.554 (16.687)	56.850	N/A	-0.013 (0.022)	16.059 (1.504)
	Impact (ORD)	100 (0.00)	919.404 (0.000)	861.511 (16.409)	57.893	48.40		
Hoy	Baseline (no ORD)	100 (0.00)	921.350 (0.000)	863.601 (16.308)	57.749	N/A	-0.048 (0.016)	10.835 (1.491)
	Impact (ORD)	100 (0.00)	921.350 (0.000)	862.669 (16.092)	58.681	49.40		
Marwick Head	Baseline (no ORD)	100 (0.00)	921.421 (0.000)	863.403 (16.581)	58.018	N/A	-0.027 (0.016)	8.022 (1.451)
	Impact (ORD)	100 (0.00)	921.421 (0.000)	862.767 (16.425)	58.654	44.40		
Rousay	Baseline (no ORD)	100 (0.00)	919.970 (0.000)	859.670 (16.529)	60.300	N/A	0.004 (0.010)	7.604 (1.031)

Colony	Scenario	Mean adult survival during chick-rearing (%)	Initial adult mass (g)	Mean adult mass at the end of the chick-rearing season (g)	Mass loss during the chick-rearing season (g)	Mean adults directly impacted by the windfarm (%)	Mean difference in the number of trips flown	Mean difference in the distance flown (km)
	Impact (ORD)	100 (0.00)	919.970 (0.000)	859.200 (16.394)	60.770	29.60		
Cape Wrath	Baseline (no ORD)	100 (0.00)	920.184 (0.000)	864.164 (16.356)	56.020	N/A	-0.016 (0.015)	9.074 (0.949)
	Impact (ORD)	100 (0.00)	920.184 (0.000)	863.466 (16.149)	56.717	46.70		
West Westray	Baseline (no ORD)	100 (0.00)	921.172 (0.000)	863.703 (16.650)	57.469	N/A	0.008 (0.005)	5.457 (0.402)
	Impact (ORD)	100 (0.00)	921.172 (0.000)	863.383 (16.554)	57.789	23.20		

Source: Natural Power

Table C.4: Adult annual mortality predicted by SeabORD for puffin colonies with and without barrier and displacement effects from the offshore Project

Colony	Adult birds simulated	Year type	Baseline Model (no ORD)			Impact Model (with ORD)			Additional Mortality			
			Mortality	Standard deviation	Scaled mortality	Mortality	Standard deviation	Scaled mortality	Percent additional mortality	Standard deviation	Lower 95% CI	Upper 95% CI
Sule Skerry and Sule Stack	9548	Poor	1789.2	11.419	17,892	1826.5	9.490	18,265	0.391	0.200	-0.084	0.865
		Moderate	**1251.1**	**8.130**	**12,511**	**1298.4**	**15.180**	**12,984**	**0.495**	**0.092**	**0.277**	**0.713**
		Good	731.9	7.852	7,319	763.0	4.640	7,630	0.326	0.083	0.130	0.522
North Caithness Cliffs	306	Poor	66.1	5.087	661	67.1	4.383	671	0.327	0.436	-0.707	1.361
		Moderate	**41.2**	**2.700**	**412**	**42.0**	**3.055**	**420**	**0.261**	**0.258**	**-0.350**	**0.873**
		Good	32.6	3.307	326	33.1	4.332	331	0.163	0.469	-0.948	1.275
Hoy	300	Poor	65.1	4.122	651	66.2	4.803	662	0.367	0.399	-0.580	1.681
		Moderate	**53.0**	**5.055**	**530**	**54.2**	**4.614**	**542**	**0.400**	**0.540**	**-0.881**	**1.681**
		Good	34.0	1.330	340	34.1	1.370	341	0.033	0.246	-0.550	0.617
Cape Wrath	224	Poor	49.8	0.919	498	50.9	1.524	509	0.491	0.491	-0.675	1.657
		Moderate	**36.0**	**1.700**	**360**	**35.6**	**1.506**	**356**	**-0.179**	**0.431**	**-1.202**	**0.845**
		Good	14.8	2.098	148	15.5	1.900	155	0.313	0.301	-0.402	1.027

Source: Natural Power

Table C.5: Chick mortality during the chick-rearing season predicted by SeabORD for puffin colonies with and without barrier and displacement effects from the offshore Project

Colony	Baseline Model (no ORD)			Impact Model (with ORD)			Additional Mortality			
	Mean mortality	Standard deviation	Scaled mortality	Mean mortality	Standard deviation	Scaled mortality	Percent additional mortality	Standard deviation	Lower confidence interval	Upper confidence interval
Sule Skerry and Sule Stack	502.4	241.645	5024	537.8	271.403	5378	0.742	0.636	-0.768	2.251
North Caithness Cliffs	20.8	6.893	208	21.1	7.712	211	0.196	0.316	-0.553	0.945
Hoy	17.0	6.377	170	17.4	6.835	174	0.267	0.344	-0.550	1.083
Cape Wrath	7.8	5.391	78	8.0	5.437	80	0.179	0.565	-1.161	1.518

Source: Natural Power

Table C.6: Additional output metrics from SeabORD modelling for puffin colonies with and without barrier and displacement effects from the offshore Project. Numbers in brackets are standard deviations.

Colony	Scenario	Mean adult survival during chick-rearing (%)	Initial adult mass (g)	Mean adult mass at the end of the chick-rearing season (g)	Mass loss during the chick-rearing season (g)	Mean adults directly impacted by the windfarm (%)	Mean difference in the number of trips flown	Mean difference in the distance flown (km)
Sule Skerry and Sule Stack	Baseline (no ORD)	100 (0.000)	392.963 (0.000)	368.704 (7.821)	24.259	N/A	0.192 (0.024)	103.199 (7.747)
	Impact (ORD)	100 (0.000)	392.963 (0.000)	367.622 (8.161)	25.071	59.6		
North Caithness Cliffs	Baseline (no ORD)	100 (0.000)	393.695 (0.000)	369.466 (7.866)	24.229	N/A	0.098 (0.105)	87.535 (9.948)
	Impact (ORD)	100 (0.000)	393.695 (0.000)	368.663 (7.985)	28.032	63.4		
Hoy	Baseline (no ORD)	100 (0.000)	390.647 (0.000)	367.334 (7.464)	23.313	N/A	0.025 (0.103)	62.443 (10.606)
	Impact (ORD)	100 (0.000)	390.647 (0.000)	366.679 (7.668)	23.968	60.7		
Cape Wrath	Baseline (no ORD)	100 (0.000)	395.002 (0.000)	370.909 (7.906)	24.093	N/A	0.025 (0.105)	47.995 (13.734)
	Impact (ORD)	100 (0.000)	395.002 (0.000)	370.412 (8.112)	24.590	65.2		

Source: Natural Power

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