Morven South Offshore Wind Array Project

Environmental Impact Assessment Report

Volume 3, Annex 5.2: Offshore Ornithology Impact Estimates Using Natural England Approaches

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1 Introduction

1.1.1.1 Morven Offshore Wind Limited (MvOWL) (hereafter referred to as the 'Applicant') has conducted pre-application consultation with Natural England for the Morven North Offshore Wind Array Project (hereafter 'Morven North') and the Morven South Offshore Wind Array Project (hereafter 'Morven South'). As part of the pre-application consultation, and in recognition of the fact that ornithology advice from Natural England differs slightly from that provided by NatureScot, the Applicant has proposed providing Natural England with impact estimates for Morven North and Morven South calculated using Natural England's advocated parameters and approaches.

1.1.1.2 This annex presents impact estimates for Morven South, following Natural England's advocated parameters and approaches. The specific methods and parameters to be used were confirmed through further consultation with Natural England, in a letter dated 04 December 2025.

1.1.1.3 Environmental Impact Assessment (EIA) impacts from collision risk and displacement are presented for all species considered for these analyses in the Morven South EIA Report (see Volume 2, Chapter 11: Offshore Ornithology). In the context of Habitat Regulations[1] Assessment,[2] this annex presents impact estimates apportioned to English Special Protection Areas (SPAs) following Natural England's recommended methods. Following Natural England's advice during consultation, this includes the additional identification of the potential for Likely Significant Effects for guillemot at the Farne Islands SPA and Flamborough and Filey Coast SPA for Habitat Regulations Assessment.

[1] The collective term for The Conservation (Natural Habitats, & C.) Regulations 1994 (relevant only to Scotland), The Conservation of Habitats and Species Regulations 2017 (relevant only to England), and the Conservation of Offshore Marine Habitats and Species 2017 (relevant to both).

[2] Known as 'Habitat Regulations Appraisal' in Scotland.

2 Methodology

2.1 Species and Special Protection Areass for consideration

2.1.1 Environmental Impact Assessment

2.1.1.1 Valued Ornithological Receptors (VORs) to be included for impact assessment for Morven South were identified during baseline characterisation, presented within Volume 3, Annex 11.1: Offshore Ornithology Baseline Characterisation Report and Volume 2, Chapter 11: Offshore Ornithology. All seabird features recorded within the Morven South Offshore Ornithology Study Area have been evaluated in order to classify VORs.

2.1.1.2 A VOR was identified where the numbers present within the Morven South Offshore Ornithology Baseline Characterisation Study Area breached the 1% threshold of the regional population (adults and immatures) in any season. It is considered that any impacts on species occurring in numbers of less than 1% of the relevant regional population will not be significant. This criterion is not however applied as a definitive threshold. In addition, expert judgement is used to identify species for which this threshold may not be applicable and therefore ensure that species are not erroneously omitted from further assessment. This is especially relevant to migratory seabirds (species of tern, petrel, skua and little gull) which are identified as VORs despite generally having not been recorded in high enough numbers to warrant inclusion when applying the criteria discussed above. Traditional survey methods are unlikely to capture the movements of migratory seabirds due to the ephemeral nature of their movements. As these species could have been under-recorded, extra consideration has been given to potential impacts on this species during migratory periods.

2.1.1.3 The VORs identified for impact assessment for Morven South are:

- Kittiwake (*Rissa tridactyla*);
- Little gull (*Hydrocoloeus minutus*);
- Great black-backed gull (*Larus marinus*);
- Sandwich tern (*Thalasseus sandvicensis*);
- Little tern (*Sternula albifrons*);
- Roseate tern (*Sterna dougallii*);
- Common tern (*Sterna hirundo*);
- Arctic tern (*Sterna paradisaea*);
- Great skua (*Stercorarius skua*);
- Arctic skua (*Stercorarius parasiticus*);
- Common guillemot, hereafter 'guillemot' (*Uria aalge*);
- Razorbill (*Alca torda*);
- Puffin (*Fratercula arctica*);
- European storm-petrel (*Hydrobates pelagicus*);
- Leach's petrel (*Hydrobates leucorhous*);
- Fulmar (*Fulmarus glacialis*);
- Manx shearwater (*Puffinus puffinus*);
- Gannet (*Morus bassanus*).

2.1.2 Habitats Regulations Assessment

2.1.2.1 Habitats Regulation Appraisal (HRA) Screening was carried out for Morven South to identify SPAs designated for ornithological features for which Likely Significant Effect (LSE[2]) could not be ruled out. These SPAs and associated qualifying features were advanced to the Report to Inform Appropriate Assessment (RIAA). The full details of screening outcomes for Morven South alone are contained within the RIAA (Volume 2, Chapter 3: Report to Inform Appropriate Assessment Part 3: SPA and Ramsar Site Assessments of the HRA; hereafter referred to as 'RIAA Part 3').

2.1.2.2 Table 2.1 presents the English SPAs and associated designated features screened in for assessment in relation to Morven South for the purpose of this annex. This include those identified in Volume 2, Chapter 1:Report to Inform Appropriate Assessment Part 1: Introduction of the HRA, as well as guillemot at Farne Islands SPA and Flamborough and Filey Coast SPA as advised by Natural England during pre-application consultation. Analyses have been undertaken for these SPAs and features in order to produce impact numbers following Natural England's advised parameters and approaches.

Table 2.1: English Special Protection Areas and associated features screened in for assessment in relation to Morven South, and the potential impacts assessed within this annex

Site ID	Site name	Distance to Morven South (km)[3]	Relevant qualifying features	Potential impact considered within this annex
UK9006031	Coquet Island SPA	132	Kittiwake	Collision
			Puffin	Displacement
			Fulmar	Displacement
UK9006021	Farne Islands SPA	103	Kittiwake	Collision
			Puffin	Displacement
			Guillemot (non-breeding seasons only)	Displacement
UK9006101	Flamborough and Filey Coast SPA	243	Kittiwake	Collision
			Guillemot (non-breeding seasons only)	Displacement
			Razorbill (non-breeding seasons only)	Displacement
			Puffin	Displacement
			Fulmar	Displacement
			Gannet (non-breeding seasons only)	Collision; Displacement
UK9020325	Northumberland Marine SPA	93	Kittiwake	Collision
			Razorbill	Displacement
			Puffin	Displacement
			Fulmar	Displacement

[3] Distances measured from the edge of Morven South to the edge of the respective SPA boundary.

2.2 Seasonal definitions

2.2.1.1 Table 2.2 presents the seasonal definitions used for each species considered in this annex. Seasonal extents for each species have been defined according to the breeding, non-breeding and migratory periods (autumn and spring migration) defined in Furness (2015). If a month fell within two seasons (e.g. March for gannet is included in both the pre-breeding and breeding seasons in Furness (2015)), priority was given to the breeding season. The only exception to this is fulmar where the migration-free breeding season has been used. For species identified as VORs in paragraph 2.1.1.3 but not included in Table 2.2, seasonal extents are not required as consideration of potential impacts on these species is only needed in migratory periods.

Table 2.2: Seasonal definitions used for each of the species considered in this annex

Species	Breeding season	Post-breeding season	Non-breeding season	Pre-breeding season
Kittiwake	March to August	September to December	n/a	January to February
Herring gull	March to August	n/a	September to February	n/a
Great black-backed gull	March to August	n/a	September to February	n/a
Guillemot	March to July	n/a	August to February	n/a
Razorbill	April to July	August to October	November to December	January to March
Puffin	April to August	n/a	September to March	n/a
Fulmar	April to August	September to October	November	December to March
Gannet	March to September	October to November	n/a	December to February

2.3 Collision risk modelling

2.3.1 Species for consideration

2.3.1.1 Collision risk modelling has been carried out for VORs identified as being potentially affected by collision risk. These VORs are identified in Volume 3, Annex 11.2 Offshore Ornithology Collision Risk Modelling Report. In summary, the following species were selected for collision risk modelling:

- Kittiwake (high vulnerability, species recorded in all surveys);
- Great black-backed gull (very high vulnerability, species recorded in multiple baseline surveys);
- Gannet (high vulnerability, species recorded in majority of surveys).

2.3.2 Methodology and species parameters

2.3.2.1 In line with the guidance in Parker *et al.* (2025) and Joint Nature Conservation Committee (JNCC) *et al*. (2024), collision risk modelling was undertaken using the Stochastic Collision Risk Model (sCRM) (Caneco and Humphries, 2022) which is based on the stochLAB R package. The sCRM allows for variability in input parameters to be incorporated into the model, producing predicted collision estimates with associated uncertainty. Additionally, the sCRM provides a useful audit trail of input

parameters and outputs, enabling reviewers to easily assess and reproduce the results of any modelling scenario.

2.3.2.2 The collision risk models incorporate Natural England's guidance on recommended avoidance rates, bird size, flight speed, flight type, and nocturnal activity scores, using the values presented in JNCC *et al*. (2024). All species, turbine, wind farm and other modelling parameters are set out in Volume 3, Annex 11.2 Offshore Ornithology Collision Risk Modelling Report.

2.3.2.3 It should be noted that the flight type for gannet recommended by JNCC *et al*. (2024) ('flapping') is different to that recommended by NatureScot (2025) ('gliding'). As the project is in Scottish waters, collision risk modelling has been run using a 'gliding' flight type for gannet, as advised by NatureScot (2025). Collision risk modelling in this annex has not been updated to account for this difference, and uses a 'gliding' flight type for gannet as this is not considered to cause a material difference in the resulting collision risk estimates.

2.3.2.4 Gannet exhibit a strong macro-avoidance response to offshore wind farms which is not currently captured in available avoidance rates. The joint Statutory Nature Conservation Body (SNCB) Collision Risk Modelling (CRM) guidance (JNCC et al., 2024) and NatureScot (2025) guidance both discuss this issue and suggest that it should be accounted for by applying a percentage reduction to input densities for gannet. NatureScot (2025) recommends the application of a 70% reduction in the non-breeding season only as it is considered that there is insufficient evidence regarding gannet behaviour around wind farms near to Scottish SPAs although the NatureScot (2025) guidance does not state what constitutes 'near'. JNCC *et al*. (2024) does not provide specific advice on the magnitude of the reduction to apply but Natural England have recommended the use of a 70% reduction for all seasons for recent projects in English waters e.g. the Mona offshore wind farm (RPS, 2024a) and the Morgan Generation Assets (RPS, 2024b)). Given that these two pieces of advice are in conflict with one another, CRM for Morven South has been undertaken utilising uncorrected density data (i.e. not reduced by 70% in any season), with corrections then applied to the resulting collision risk estimates for relevant seasons, providing the same results as if the reduction were applied to density data but simplifying the modelling process. Accordingly, for the purpose of this annex, CRM results for gannet have been reduced by 70% for all seasons, following Natural England advice.

2.3.3 Density estimates

2.3.3.1 Digital aerial surveys of Morven South were undertaken between January 2021 and September 2023. Further information on the aerial surveys undertaken for Morven South and the methodologies used to derive density estimates is provided in the Volume 3, Annex 11.1: Offshore Ornithology Baseline Characterisation Report. During pre-application consultation with NatureScot (see Volume 1, Chapter 5: Consultation) it was advised that due to the planned application date for Morven South (Quarter 2, 2026) only data from October 2021 to September 2023 (representing the standard 24 months of baseline data) should be used for baseline characterisation to avoid data being older than the five year data cut-off at the point of application. The same subset of aerial survey data has been used in the collision risk modelling in this annex. To inform collision risk modelling, data for flying birds from within the Morven South Boundary has been used.

2.3.3.2 Monthly bird density data was input into collision risk models in the form of a bootstrapped distribution (1,000 resamples). Full details of the methodology applied for bootstrapping can be found in Volume 3, Annex 11.2: Offshore Ornithology Collision Risk Modelling Technical Report.

2.4 Displacement

2.4.1 Species for consideration

2.4.1.1 Displacement analysis has been carried out for VORs identified as being potentially affected by displacement. These VORs are identified in Volume 3, Annex 11.4 Offshore Ornithology

Displacement Modelling Report (Matrix Approach). In summary, the following species were selected for displacement analysis:

- Guillemot (high vulnerability, national population importance);
- Razorbill (high vulnerability, national population importance);
- Puffin (moderate vulnerability, regional population importance);
- Fulmar (included on the advice of NatureScot and therefore retained in this annex);
- Gannet (high vulnerability and although only of local population importance, species recorded in the majority of surveys).

2.4.1.2 In addition to the species identified above, kittiwake was also included for displacement analysis in Volume 3, Annex 11.4 Offshore Ornithology Displacement Modelling Report (Matrix Approach). Natural England do not consider kittiwake vulnerable to displacement effects and therefore the species is not considered in the displacement analyses presented in this annex.

2.4.2 Seasonality and abundance estimates

2.4.2.1 Digital aerial surveys of Morven North and Morven South were undertaken between January 2021 and September 2023. Further information on the aerial surveys undertaken for Morven South and the methodologies used to derive population estimates is provided in the Volume 3, Annex 11.1: Offshore Ornithology Baseline Characterisation Report. During pre-application consultation with NatureScot (see Volume 1, Annex 5.1: Consultation) it was advised that due to the planned application date for Morven South (Quarter 2, 2026), only data from October 2021 to September 2023 (representing the standard 24 months of baseline data) should be used for baseline characterisation to avoid data being older than the five year data cut-off at the point of application (NatureScot, 2023). Whilst this temporal extent corresponds with the seasonal extents for gannet it foreshortens the non-breeding seasons defined for other species. The Applicant has therefore agreed with NatureScot through additional targeted consultation (14 April 2025) and consultation meetings (28 May 2025) that data prior to October 2021 can be used to allow for the consideration of two complete seasonal extents for each species (see Volume 1, Chapter 5: Consultation). This therefore leads to a dataset with a temporal extent of July 2021 to September 2023 providing two full seasonal extents for each species identified in Section 2.4.1. This same approach has been applied to the displacement analyses within this annex.

2.4.2.2 As described in Section 0, seasonal extents for each species have been defined according to the breeding, non-breeding and migratory periods (autumn and spring migration) defined in Furness (2015), with priority given to the breeding season if a month fell within two seasons. The only exception to this is fulmar where the migration-free breeding season has been used. Seasons are provided in Table 2.3, along with the specific months of digital aerial survey data that have been used to calculate the mean-peak abundances for use in displacement analyses.

Table 2.3: Seasonal definitions as the basis for displacement analysis, from Furness (2015) and, following the exclusion of certain digital aerial survey data due to data age, taking into account the date each baseline survey was flown

Species	Pre-breeding season/spring migration	Breeding season	Post breeding season/autumn migration	Non-breeding/winter season
Guillemot	n/a	March to July 2022 and 2023	n/a	August to February 2021/22 and 2022/23
Razorbill	January to March 2022 and 2023	April to July 2022 and 2023	August to October 2021 and 2022	November to December 2021 and 2022

Species	Pre-breeding season/spring migration	Breeding season	Post breeding season/autumn migration	Non-breeding/winter season
Puffin	n/a	April to August 2022 and 2023	n/a	September to March 2021/22 and 2022/23
Fulmar	December to March 2021/22 and 2022/23	April to August 2022 and 2023	September to October 2021 and 2022	November 2021 and 2022
Gannet	December to February 2021/22 and 2022/23	March to September 2022 and 2023	October to November 2021 and 2022	n/a

2.4.2.3 The remaining methodological aspects of the process used to calculate population estimates are identical to those described in Volume 3, Annex 11.4: Offshore Ornithology Displacement Modelling Report (Matrix Approach). The seasonal mean-peak population estimates in displacement analyses in this annex are presented in Table 2.4.

Table 2.4: Mean-peak abundances for use in the assessment for each season from model-based abundance estimation

Species	Pre-breeding season/spring migration	Breeding season	Post breeding season/autumn migration	Non-breeding/winter season
Guillemot	n/a	4,797	n/a	8,388
Razorbill	89	456	2,275	403
Puffin	n/a	106	n/a	433
Fulmar	182	239	279	299
Gannet	22	366	89	n/a

2.4.3 Displacement and mortality rates

2.4.3.1 Potential displacement impacts for each species are presented based on a wide range of potential displacement (0% to 100%) and mortality rates (0% to 100%), following UK SNCBs' guidance (JNCC *et al.*, 2022). In addition, the displacement and mortality rates identified following the guidance in JNCC *et al*. (2022) (Table 2.5) are highlighted in each matrix.

Table 2.5: Displacement and mortality rates applied for each species

Species	Displacement rate (%)	Mortality rate (%)
Guillemot	30 to 70	1 to 10
Razorbill	30 to 70	1 to 10
Puffin	30 to 70	1 to 10
Fulmar	1 to 10	1 to 10
Gannet	60 to 80	1 to 10

2.5 Apportioning

2.5.1 Identification of species

2.5.1.1 Table 2.6 identifies the English designated sites and associated features for which potential LSE[2] has been identified and where apportioning values are therefore required, in order to apportion potential impacts from Morven South to each relevant designated site.

2.5.1.2 In addition to those SPAs included in Table 2.6, LSE[2] was also identified for the Northumberland Marine SPA. This SPA is designated to protect sea areas used by kittiwake, razorbill, puffin and fulmar from adjacent breeding colonies. This includes the Coquet Island SPA and Farne Islands SPA (Natural England, 2025). As the Northumberland Marine SPA protects sea areas it is not appropriate to apply the apportioning approaches defined below. As the populations protected as part of this SPA designation are already included in the apportioning process as part of the adjacent breeding colony SPAs, it is also not necessary to calculate an impact for the Northumberland Marine SPA as any conclusion reached for the adjacent breeding colony SPAs is also applicable to the Northumberland Marine SPA. This approach is consistent with the approach applied for recent projects in both Scottish and English waters.

Table 2.6: English Special Protection Areas and associated features for which potential Likely Significant Effect[2] has been identified and where apportioning values are therefore required

SPA	Qualifying feature	Season of relevance
Coquet Island	Kittiwake	All
	Puffin	All
	Fulmar	All
Farne Islands	Kittiwake	All
	Guillemot	Non-breeding seasons only
	Puffin	All
Flamborough and Filey Coast	Kittiwake	All
	Guillemot	Non-breeding seasons only
	Razorbill	Non-breeding seasons only
	Puffin	All
	Fulmar	All
	Gannet	Non-breeding seasons only

2.5.2 Breeding and non-breeding season apportioning methods

2.5.2.1 Apportioning undertaken for the breeding season is based on the NatureScot 'theoretical approach' method for the breeding season (NatureScot, 2018). A detailed methodology is provided in the RIAA Part 3.

2.5.2.2 Apportioning during the non-breeding seasons (i.e. autumn and spring migration seasons and in winter) utilises population data from Furness (2015) for all species. For this approach, the contribution of adult birds from an individual designated site, as estimated by Furness (2015), to the relevant Biologically Defined Minimum Population Scale (BDMPS) population for each species/season combination is divided by the total BDMPS population. The calculated value is the proportion of the BDMPS population represented by adult birds from the designated site under

consideration. It should be noted that no updates have been made to the population data presented in Furness (2015). For any designated site not named in Furness (2015), the proportion of birds present in the relevant BDMPS areas in each season has been taken from the nearest named designated site.

2.5.3 Immature and sabbatical birds

2.5.3.1 A major part of any seabird population comprises immature birds. A proportion of immature birds return to natal waters during the breeding season, with the proportion of each immature age class increasing as individuals get closer to breeding age.

2.5.3.2 To determine the proportion of immature birds present within the Morven South Offshore Ornithology Baseline Characterisation Study Area (as defined in Volume 3, Chapter 11.1: Offshore Ornithology Baseline Characterisation Report) during the breeding season, data from the site specific digital aerial surveys have been analysed (Table 2.7). This approach can only be used for gannet, kittiwake, and large gull species, as it is not possible to identify the age class of birds of other species from digital aerial surveys. Only those birds assigned to an age class have been included in the calculation in Table 2.7; however, the number of birds for which an age class was not assigned is also provided.

2.5.3.3 For Morven South, calculations were only possible for kittiwake and gannet, with sample sizes of birds classified to an age class being too small for large gull species. For all species without estimates of immature proportions, apportioning does not take immature birds into account and there is no such removal of immature proportions during the apportioning of potential impacts. Where relevant, apportioned impacts estimates are presented with and without the removal of immature age classes.

2.5.3.4 The identification of kittiwake age classes at sea is difficult and, in most cases, impossible (with exception of birds that are in either juvenile, first winter or first summer plumage). Whilst one year old kittiwakes can be easily identified due to differences in plumage, two and three year old birds, which have not yet reached the age of first breeding (which is typically at four years old), cannot be easily identified (Coulson, 2011; Olsen and Larsson, 2003). Therefore, data on age class collected during digital aerial surveys will potentially represent a considerable overestimate of the proportion of breeding adults present at Morven South.

Table 2.7: Number of birds assigned to different age class categories during site specific surveys of the Morven South survey area

Species	Breeding season (Months)	Birds for which age was not identified (number of animals)	Total bird for which age was identified (number of animals)	Number of adult-type birds identified	Number of immature birds identified	Proportion of Immature Birds (%)[4]
Kittiwake	March to August	145	215	196	19	8.8
Gannet	March to September	61	321	304	17	5.3

[4] Rounded to one decimal place.

2.5.3.5 Following consultation with Natural England (November 2025), sabbatical birds have not been removed from apportioned impacts.

2.5.4 Apportioning values

2.5.4.1 The tables in the following sections present the apportioning values for each English SPA feature. For some species, SPAs are beyond the mean-maximum foraging range plus one Standard Deviation (SD) used when apportioning in the breeding season and, as such, these colonies would not form part of the regional population. These SPAs are not included for assessment but are nevertheless provided within the tables below for completion purposes.

Kittiwake

2.5.4.2 Table 2.8 presents the calculation of apportioning values for English SPAs for kittiwake in the breeding season. Table 2.9 presents the calculation of apportioning values for English SPAs for kittiwake in the non-breeding seasons.

Table 2.8: Calculation of apportioning values for kittiwake in the breeding season, without the consideration of immature birds, for English Special Protection Areas for which potential Likely Significant Effect[2] was identified

SPA	Distance to Morven South[5] (km)[6], [7]	Population (No. of breeding adults)	Proportion of foraging range at sea[5]	Resulting weight for colony	Proportional weight of colony
Coquet Island	145	932	0.599	0.007	0.004
Farne Islands	116	8,804	0.617	0.103	0.059
Flamborough and Filey Coast	259	103,070	0.587	0.230	0.132

Table 2.9: Calculation of non-breeding season apportioning values for kittiwake, for English Special Protection Areas for which potential Likely Significant Effect[2] was identified

SPA	Apportioning values					
	Autumn migration (August to December)			Spring migration (January to April)		
	BDMPS population (No. of Individuals)	Number of breeding adults in BDMPS population from SPA	Apportioning value	BDMPS population (No. of individuals)	Number of breeding adults in BDMPS population from SPA	Apportioning value
Coquet Island	829,937	222	<0.001	627,816	222	<0.001

[5] Where a colony consists of multiple subsites average values are provided for distance to Morven South and proportion of foraging range at sea.

[6] The mean-maximum foraging range plus one standard deviation for kittiwake is 156.1 + 144.5km (Woodward *et al.*, 2019).

[7] Distances measured from the centre of Morven South to the centre of each site.

SPA	Apportioning values					
	Autumn migration (August to December)			Spring migration (January to April)		
	BDMPS population (No. of Individuals)	Number of breeding adults in BDMPS population from SPA	Apportioning value	BDMPS population (No. of individuals)	Number of breeding adults in BDMPS population from SPA	Apportioning value
Farne Islands		4132	0.005		4,132	0.007
Flamborough and Filey Coast		45,140	0.054		45,140	0.072

Guillemot

2.5.4.3 Morven South is beyond the mean-maximum foraging range plus one SD of guillemot (55.5 + 39.7km; Woodward *et al*., 2019) from those English SPAs for which LSE[2] was identified in relation to impacts on guillemot. As such apportioning values in the breeding season are zero. Table 2.10 presents the calculation of apportioning values for English SPAs for guillemot in the non-breeding season.

Table 2.10: Calculation of apportioning values for guillemot in the non-breeding season, for English Special Protection Areas for which potential Likely Significant Effect[2] was identified

SPA	Apportioning values		
	Non-breeding season (August to February)		
	BDMPS population (No. of individuals)	No. of breeding adults in BDMPS population from SPA	Apportioning value
Farne Islands	1,617,306	60,538	0.037
Flamborough and Filey Coast		71,354	0.044

Razorbill

2.5.4.4 Morven South is beyond the mean-maximum foraging range plus one SD of razorbill (73.8 + 48.4km; Woodward *et al*., 2019) from those English SPAs for which LSE[2] was identified in relation to impacts on razorbill . As such apportioning values in the breeding season are zero. Table 2.11 presents the calculation of apportioning values for English SPAs for razorbill in the non-breeding seasons.

Table 2.11: Calculation of non-breeding season apportioning values for razorbill, for English Special Protection Areas for which potential Likely Significant Effect[2] was identified

SPA	Apportioning values					
	Migration seasons (August to October and January to March)			Winter (November and December)		
	BDMPS population (No. of Individuals)	Number of breeding adults in BDMPS population from SPA	Apportioning value	BDMPS Population (no. of Individuals)	Number of breeding adults in BDMPS population from SPA	Apportioning value
Flamborough and Filey Coast	591,874	20,002	0.034	218,622	6,001	0.027

Puffin

2.5.4.5 Table 2.12 presents the calculation of apportioning values for English SPAs for which potential LSE[2] has been identified for puffin in the breeding season.

2.5.4.6 Table 2.13 presents the calculation of apportioning values for English SPAs for puffin in the non-breeding seasons.

Table 2.12: Calculation of apportioning values for puffin in the breeding season for English Special Protection Areas for which potential Likely Significant Effect[2] was identified

SPA	Distance to Morven South[5] (km) [8, 9]	Population (No. of breeding adults)	Proportion of foraging range at sea[5]	Resulting weight for colony	Proportional weight of colony
Coquet Island	145	50,058	0.580	0.398	0.161
Farne Islands	116	87,504	0.591	1.052	0.426
Flamborough and Filey Coast	274	This SPA is beyond the mean-maximum foraging range for puffin and, as such, has an apportioning value of 0.			

[8] The mean-maximum foraging range plus one standard deviation for puffin is 119.6 + 131.2km (Woodward *et al.*, 2019).

[9] Distances measured from the centre of Morven South to the centre of each site.

Table 2.13: Calculation of non-breeding season apportioning values for puffin, for English Special Protection Areas for which potential Likely Significant Effect[2] was Identified

SPA	Apportioning values		
	Non-breeding season (August to February)		
	BDMPS population (No. of individuals)	Number of breeding adults in BDMPS population from SPA	Apportioning value
Coquet Island	231,957	12,344	0.053
Farne Islands		39,962	0.172
Flamborough and Filey Coast		958	0.004

Fulmar

2.5.4.7 Table 2.14 presents the calculation of apportioning values for English SPAs for fulmar in the breeding season.

2.5.4.8 Table 2.15 presents the calculation of apportioning values for English SPAs for fulmar in the non-breeding seasons.

Table 2.14: Calculation of apportioning values for fulmar in the breeding season, for English special Protection Areas for which potential Likely Significant Effect[2] was identified

SPA	Distance to Morven South[5] (km) [10, 11]	Population (No. of breeding adults)	Proportion of foraging range at sea[5]	Resulting weight for colony	Proportional weight of colony
Coquet Island	145	106	0.688	0.003	0.001
Flamborough and Filey Coast	259	2,514	0.666	0.022	0.008

[10] The mean-maximum foraging range plus one standard deviation for fulmar is 542.3 + 657.9km (Woodward *et al.*, 2019).

[11] Distances measured from the centre of Morven South to the centre of each site.

Table 2.15: Calculation of non-breeding apportioning values for fulmar, for English Special Protection Areas for which potential Likely Significant Effect[2] was identified

SPA	Apportioning values					
	Migration seasons (September to October and December to March)			Winter (November)		
	BDMPS population (No. of Individuals)	Number of breeding adults in BDMPS population from SPA	Apportioning value	BDMPS population (No. of Individuals)	Number of breeding adults in BDMPS population from SPA	Apportioning value
Coquet Island	957,702	108	<0.001	568,736	76	<0.001
Flamborough and Filey Coast		1,756	0.002		1,229	0.002

Gannet

2.5.4.9 Evidence from tracking studies of adult gannets at multiple colonies during the breeding season suggests that gannets demonstrate 'space partitioning', such that adjacent colonies do not have overlapping foraging ranges in the breeding season and are instead spatially segregated (Wakefield *et al*., 2013). The closest gannet colonies to Morven South are located within the Forth Islands SPA and, as a result, 100% of gannets at Morven South have been apportioned to the Forth Islands SPA in the RIAA Part 3. Therefore, the Flamborough and Filey Coast SPA, the only SPA for gannet considered within this annex, has been attributed an apportioning value of zero in the breeding season.

2.5.4.10 Table 2.16 presents the calculation of apportioning values for English SPAs for gannet in the non-breeding seasons.

Table 2.16: Calculation of non-breeding season apportioning values for gannet, for English Special Protection Areas for which potential Likely Significant Effect[2] was identified

SPA	Apportioning values					
	Autumn (October to November)			Spring (December to February)		
	BDMPS population (No. of Individuals)	Number of breeding adults in BDMPS population from SPA	Apportioning value	BDMPS population (No. of Individuals)	Number of breeding adults in BDMPS population from SPA	Apportioning value
Flamborough and Filey Coast	456,299	22,122	0.048	248,385	15,485	0.062

3 Results

3.1 Environmental Impact Assessment impact estimates

3.1.1.1 The following sections present the results of collision risk modelling and displacement analysis for the species identified in Sections 2.3 and 2.4.

3.1.2 Kittiwake

Collision

3.1.2.1 Table 3.1 presents the predicted number of collisions for kittiwake using a stochastic model, along with associated confidence metrics. The mean estimates are those considered within the Habitats Regulations Assessment calculations in Section 3.2.

Table 3.1: Predicted collisions for kittiwake associated with Morven South using a stochastic model

Species	Model Option	Flight speed (m/s)	Avoidance rate	Metric	Collision risk estimate (no. of collisions)												
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Kittiwake	2	13.1	0.9929	Mean	0.3	0.2	0.5	1.1	2.0	2.6	1.6	0.4	0.0	0.3	0.3	1.0	10.2
				Median	0.2	0.2	0.4	1.1	1.9	2.5	1.6	0.4	0.0	0.3	0.3	0.9	9.8
				SD	0.1	0.1	0.2	0.3	0.6	0.7	0.6	0.3	0.0	0.2	0.2	0.3	-
				2.5% percentile	0.1	0.0	0.1	0.6	1.0	1.4	0.7	0.0	0.0	0.0	0.1	0.4	-
				97.5% percentile	0.5	0.4	1.0	1.8	3.3	4.2	2.9	1.2	0.0	0.8	0.6	1.7	-

3.1.3 Great black-backed gull

Collision

3.1.3.1 Table 3.2 presents the predicted number of collisions for great black-backed gull using a stochastic model, along with associated confidence metrics.

Table 3.2: Predicted collisions for great black-backed gull associated with Morven South using a stochastic model

Species	Model Option	Flight speed (m/s)	Avoidance rate	Metric	Collision risk estimate (no. of collisions)												
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Great black-backed gull	2	13.7	0.9940	Mean	0.5	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	1.5
				Median	0.4	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	1.3
				SD	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	-
				2.5% percentile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-
				97.5% percentile	1.3	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	-

3.1.4 Guillemot

Displacement

3.1.4.1 Displacement matrices for guillemot in the breeding and non-breeding seasons are presented in Table 3.3 and Table 3.4, respectively. The displacement and mortality rates advised by Natural England for the species (Table 2.5) are highlighted by the purple box in each matrix.

Table 3.3: Predicted guillemot mortality for Morven South plus 2km buffer during the breeding season

Guillemot (breeding)		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	5	10	24	48	96	144	192	240	288	336	384	432	480
	20	10	19	48	96	192	288	384	480	576	672	768	863	959
	30	14	29	72	144	288	432	576	720	863	1,007	1,151	1,295	1,439
	40	19	38	96	192	384	576	768	959	1,151	1,343	1,535	1,727	1,919
	50	24	48	120	240	480	720	959	1,199	1,439	1,679	1,919	2,159	2,399
	60	29	58	144	288	576	863	1,151	1,439	1,727	2,015	2,303	2,590	2,878
	70	34	67	168	336	672	1,007	1,343	1,679	2,015	2,351	2,686	3,022	3,358
	80	38	77	192	384	768	1,151	1,535	1,919	2,303	2,686	3,070	3,454	3,838
	90	43	86	216	432	863	1,295	1,727	2,159	2,590	3,022	3,454	3,886	4,317
	100	48	96	240	480	959	1,439	1,919	2,399	2,878	3,358	3,838	4,317	4,797

Table 3.4: Predicted guillemot mortality for Morven South plus 2km buffer during the non-breeding season

Guillemot (non-breeding)		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	8	17	42	84	168	252	336	419	503	587	671	755	839
	20	17	34	84	168	336	503	671	839	1,007	1,174	1,342	1,510	1,678
	30	25	50	126	252	503	755	1,007	1,258	1,510	1,762	2,013	2,265	2,516
	40	34	67	168	336	671	1,007	1,342	1,678	2,013	2,349	2,684	3,020	3,355
	50	42	84	210	419	839	1,258	1,678	2,097	2,516	2,936	3,355	3,775	4,194
	60	50	101	252	503	1,007	1,510	2,013	2,516	3,020	3,523	4,026	4,530	5,033
	70	59	117	294	587	1,174	1,762	2,349	2,936	3,523	4,110	4,697	5,285	5,872
	80	67	134	336	671	1,342	2,013	2,684	3,355	4,026	4,697	5,368	6,039	6,711
	90	75	151	377	755	1,510	2,265	3,020	3,775	4,530	5,285	6,039	6,794	7,549
	100	84	168	419	839	1,678	2,516	3,355	4,194	5,033	5,872	6,711	7,549	8,388

3.1.5 Razorbill

Displacement

3.1.5.1 Displacement matrices for razorbill in the pre-breeding, breeding, post-breeding, and non-breeding seasons are presented in Table 3.5, Table 3.6, Table 3.7, and Table 3.8, respectively. The displacement and mortality rates advised by Natural England for the species (Table 2.5) are highlighted by the purple box in each matrix.

Table 3.5: Predicted razorbill mortality for Morven South plus 2km buffer during the pre-breeding season

Razorbill (pre-breeding)		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	1	2	3	4	4	5	6	7	8	9
	20	0	0	1	2	4	5	7	9	11	13	14	16	18
	30	0	1	1	3	5	8	11	13	16	19	21	24	27
	40	0	1	2	4	7	11	14	18	21	25	29	32	36
	50	0	1	2	4	9	13	18	22	27	31	36	40	45
	60	1	1	3	5	11	16	21	27	32	38	43	48	54
	70	1	1	3	6	13	19	25	31	38	44	50	56	63
	80	1	1	4	7	14	21	29	36	43	50	57	64	71
	90	1	2	4	8	16	24	32	40	48	56	64	72	80
	100	1	2	4	9	18	27	36	45	54	63	71	80	89

Table 3.6: Predicted razorbill mortality for Morven South plus 2km buffer during the breeding season

Razorbill (breeding)		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	1	2	5	9	14	18	23	27	32	36	41	46
	20	1	2	5	9	18	27	36	46	55	64	73	82	91
	30	1	3	7	14	27	41	55	68	82	96	109	123	137
	40	2	4	9	18	36	55	73	91	109	128	146	164	182
	50	2	5	11	23	46	68	91	114	137	160	182	205	228
	60	3	5	14	27	55	82	109	137	164	192	219	246	274
	70	3	6	16	32	64	96	128	160	192	224	255	287	319
	80	4	7	18	36	73	109	146	182	219	255	292	328	365
	90	4	8	21	41	82	123	164	205	246	287	328	370	411
	100	5	9	23	46	91	137	182	228	274	319	365	411	456

Table 3.7: Predicted razorbill mortality for Morven South plus 2km buffer during the post-breeding season

Razorbill (post-breeding)		Mortality rate (%)												
		1	3	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	2	5	11	23	45	68	91	114	136	159	182	205	227
	20	5	9	23	45	91	136	182	227	273	318	364	409	455
	30	7	14	34	68	136	205	273	341	409	478	546	614	682
	40	9	18	45	91	182	273	364	455	546	637	728	819	910
	50	11	23	57	114	227	341	455	569	682	796	910	1,024	1,137
	60	14	27	68	136	273	409	546	682	819	955	1,092	1,228	1,365
	70	16	32	80	159	318	478	637	796	955	1,115	1,274	1,433	1,592
	80	18	36	91	182	364	546	728	910	1,092	1,274	1,456	1,638	1,820
	90	20	41	102	205	409	614	819	1,024	1,228	1,433	1,638	1,843	2,047
	100	23	45	114	227	455	682	910	1,137	1,365	1,592	1,820	2,047	2,275

Table 3.8: Predicted razorbill mortality for Morven South plus 2km buffer during the non-breeding season

Razorbill (non-breeding)		Mortality rate (%)												
		1	3	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	1	2	4	8	12	16	20	24	28	32	36	40
	20	1	2	4	8	16	24	32	40	48	56	65	73	81
	30	1	2	6	12	24	36	48	61	73	85	97	109	121
	40	2	3	8	16	32	48	65	81	97	113	129	145	161
	50	2	4	10	20	40	61	81	101	121	141	161	182	202
	60	2	5	12	24	48	73	97	121	145	169	194	218	242
	70	3	6	14	28	56	85	113	141	169	198	226	254	282
	80	3	6	16	32	65	97	129	161	194	226	258	290	323
	90	4	7	18	36	73	109	145	182	218	254	290	327	363
	100	4	8	20	40	81	121	161	202	242	282	323	363	403

3.1.6 Puffin

Displacement

3.1.6.1 Displacement matrices for puffin in the breeding and non-breeding seasons are presented in Table 3.9 and Table 3.10, respectively. The displacement and mortality rates advised by Natural England for the species (Table 2.5) are highlighted by the purple box in each matrix.

Table 3.9: Predicted puffin mortality for Morven South plus 2km buffer during the breeding season

Puffin (breeding)		Mortality rate (%)												
		1	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Displacement rate (%)	**10**	0	0	1	1	2	3	4	5	6	7	8	10	11
	20	0	0	1	2	4	6	8	11	13	15	17	19	21
	30	0	1	2	3	6	10	13	16	19	22	25	29	32
	40	0	1	2	4	8	13	17	21	25	30	34	38	42
	50	1	1	3	5	11	16	21	27	32	37	42	48	53
	60	1	1	3	6	13	19	25	32	38	45	51	57	64
	70	1	1	4	7	15	22	30	37	45	52	59	67	74
	80	1	2	4	8	17	25	34	42	51	59	68	76	85
	90	1	2	5	10	19	29	38	48	57	67	76	86	96
	100	1	2	5	11	21	32	42	53	64	74	85	96	106

Table 3.10: Predicted puffin mortality for Morven South plus 2km buffer during the non-breeding season

Puffin (non-breeding)		Mortality rate (%)												
		1	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Displacement rate (%)	**10**	0	1	2	4	9	13	17	22	26	30	35	39	43
	20	1	2	4	9	17	26	35	43	52	61	69	78	87
	30	1	3	6	13	26	39	52	65	78	91	104	117	130
	40	2	3	9	17	35	52	69	87	104	121	139	156	173
	50	2	4	11	22	43	65	87	108	130	152	173	195	217
	60	3	5	13	26	52	78	104	130	156	182	208	234	260
	70	3	6	15	30	61	91	121	152	182	212	243	273	303
	80	3	7	17	35	69	104	139	173	208	243	277	312	347
	90	4	8	19	39	78	117	156	195	234	273	312	351	390
	100	4	9	22	43	87	130	173	217	260	303	347	390	433

3.1.7 Fulmar

Displacement

3.1.7.1 Displacement matrices for fulmar in the pre-breeding, breeding, post-breeding, and non-breeding seasons are presented in Table 3.11, Table 3.12, Table 3.13, and Table 3.14, respectively. The displacement and mortality rates advised by Natural England for the species (Table 2.5) are highlighted by the purple box in each matrix.

Table 3.11: Predicted fulmar mortality for Morven South plus 2km buffer during the pre-breeding season

Fulmar (pre-breeding)		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	1	0	0	0	0	0	1	1	1	1	1	1	2	2
	2	0	0	0	0	1	1	1	2	2	3	3	3	4
	5	0	0	0	1	2	3	4	5	5	6	7	8	9
	10	0	0	1	2	4	5	7	9	11	13	15	16	18
	20	0	1	2	4	7	11	15	18	22	26	29	33	36
	30	1	1	3	5	11	16	22	27	33	38	44	49	55
	40	1	1	4	7	15	22	29	36	44	51	58	66	73
	50	1	2	5	9	18	27	36	46	55	64	73	82	91
	60	1	2	5	11	22	33	44	55	66	77	87	98	109
	70	1	3	6	13	26	38	51	64	77	89	102	115	128
	80	1	3	7	15	29	44	58	73	87	102	117	131	146
	90	2	3	8	16	33	49	66	82	98	115	131	148	164
	100	2	4	9	18	36	55	73	91	109	128	146	164	182

Table 3.12: Predicted fulmar mortality for Morven South plus 2km buffer during the breeding season

Fulmar (breeding)		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	1	0	0	0	0	0	1	1	1	1	2	2	2	2
	2	0	0	0	0	1	1	2	2	3	3	4	4	5
	5	0	0	1	1	2	4	5	6	7	8	10	11	12
	10	0	0	1	2	5	7	10	12	14	17	19	22	24
	20	0	1	2	5	10	14	19	24	29	33	38	43	48
	30	1	1	4	7	14	22	29	36	43	50	57	65	72
	40	1	2	5	10	19	29	38	48	57	67	76	86	96
	50	1	2	6	12	24	36	48	60	72	84	96	108	119
	60	1	3	7	14	29	43	57	72	86	100	115	129	143
	70	2	3	8	17	33	50	67	84	100	117	134	151	167
	80	2	4	10	19	38	57	76	96	115	134	153	172	191
	90	2	4	11	22	43	65	86	108	129	151	172	194	215
	100	2	5	12	24	48	72	96	119	143	167	191	215	239

Table 3.13: Predicted fulmar mortality for Morven South plus 2km buffer during the post-breeding season

Fulmar (post-breeding)		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	1	0	0	0	0	1	1	1	1	2	2	2	3	3
	2	0	0	0	1	1	2	2	3	3	4	4	5	6
	5	0	0	1	1	3	4	6	7	8	10	11	13	14
	10	0	0	1	3	6	8	11	14	17	20	22	25	28
	20	1	1	3	6	11	17	22	28	33	39	45	50	56
	30	1	1	4	8	17	25	33	42	50	59	67	75	84
	40	1	2	6	11	22	33	45	56	67	78	89	100	112
	50	1	2	7	14	28	42	56	70	84	98	112	126	139
	60	2	3	8	17	33	50	67	84	100	117	134	151	167
	70	2	3	10	20	39	59	78	98	117	137	156	176	195
	80	2	4	11	22	45	67	89	112	134	156	179	201	223
	90	3	4	13	25	50	75	100	126	151	176	201	226	251
	100	3	5	14	28	56	84	112	139	167	195	223	251	279

Table 3.14: Predicted fulmar mortality for Morven South plus 2km buffer during the non-breeding season

Fulmar (non-breeding)		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	1	0	0	0	0	1	1	1	1	2	2	2	3	3
	2	0	0	0	1	1	2	2	3	4	4	5	5	6
	5	0	0	1	1	3	4	6	7	9	10	12	13	15
	10	0	1	1	3	6	9	12	15	18	21	24	27	30
	20	1	1	3	6	12	18	24	30	36	42	48	54	60
	30	1	2	4	9	18	27	36	45	54	63	72	81	90
	40	1	2	6	12	24	36	48	60	72	84	96	108	120
	50	1	3	7	15	30	45	60	75	90	105	120	135	149
	60	2	4	9	18	36	54	72	90	108	126	143	161	179
	70	2	4	10	21	42	63	84	105	126	146	167	188	209
	80	2	5	12	24	48	72	96	120	143	167	191	215	239
	90	3	5	13	27	54	81	108	135	161	188	215	242	269
	100	3	6	15	30	60	90	120	149	179	209	239	269	299

3.1.8 Gannet

Collision

3.1.8.1 Table 3.15 presents the predicted number of collisions for gannet using a stochastic model, along with associated confidence metrics. Collision risk estimates applying a 70% reduction for macro-avoidance in all months are provided in Table 3.16. The estimates in Table 3.16 are those considered within the Habitat Regulations Assessment calculations in Section 3.2.

Table 3.15: Predicted collisions for gannet associated with Morven South using a stochastic model

Species	Model Option	Flight speed (m/s)	Avoidance rate	Metric	Collision risk estimate (no. of collisions)												
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Gannet	2	14.9	0.9929	Mean	0.1	0.0	0.5	1.0	2.5	2.0	3.5	3.3	0.4	0.6	0.0	0.1	13.9
				Median	0.0	0.0	0.4	0.8	2.2	1.7	2.9	3.0	0.3	0.5	0.0	0.0	12.0
				SD	0.1	0.1	0.3	0.7	1.6	1.4	2.3	1.7	0.3	0.4	0.0	0.1	-
				2.5% percentile	0.0	0.0	0.1	0.1	0.5	0.3	0.6	0.8	0.1	0.1	0.0	0.0	-
				97.5% percentile	0.3	0.2	1.3	2.9	6.3	5.7	8.9	7.0	1.1	1.6	0.0	0.2	-

Table 3.16: Predicted collisions for gannet associated with Morven South using a stochastic model and applying a 70% reduction for macro-avoidance in all months

Species	Model Option	Flight speed (m/s)	Avoidance rate	Metric	Collision risk estimate (no. of collisions)												
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Gannet	2	14.9	0.9929	Mean	0.0	0.0	0.1	0.3	0.8	0.6	1.0	1.0	0.1	0.2	0.0	0.0	4.2

Displacement

3.1.8.2 Displacement matrices for gannet in the pre-breeding, breeding, and post-breeding seasons are presented in Table 3.17, Table 3.18, and Table 3.19, respectively. The displacement and mortality rates advised by Natural England for the species (Table 2.5) are highlighted by the purple box in each matrix.

Table 3.17: Predicted gannet mortality for Morven South plus 2km buffer during the pre-breeding season

Gannet (pre-breeding)		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	0	0	1	1	1	1	2	2	2	2
	20	0	0	0	0	1	1	2	2	3	3	3	4	4
	30	0	0	0	1	1	2	3	3	4	5	5	6	6
	40	0	0	0	1	2	3	3	4	5	6	7	8	9
	50	0	0	1	1	2	3	4	5	6	8	9	10	11
	60	0	0	1	1	3	4	5	6	8	9	10	12	13
	70	0	0	1	2	3	5	6	8	9	11	12	14	15
	80	0	0	1	2	3	5	7	9	10	12	14	16	17
	90	0	0	1	2	4	6	8	10	12	14	16	17	19
	100	0	0	1	2	4	6	9	11	13	15	17	19	22

Table 3.18: Predicted gannet mortality for Morven South plus 2km buffer during the breeding season

Gannet (breeding)		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	1	2	4	7	11	15	18	22	26	29	33	37
	20	1	1	4	7	15	22	29	37	44	51	59	66	73
	30	1	2	5	11	22	33	44	55	66	77	88	99	110
	40	1	3	7	15	29	44	59	73	88	103	117	132	147
	50	2	4	9	18	37	55	73	92	110	128	147	165	183
	60	2	4	11	22	44	66	88	110	132	154	176	198	220
	70	3	5	13	26	51	77	103	128	154	179	205	231	256
	80	3	6	15	29	59	88	117	147	176	205	234	264	293
	90	3	7	16	33	66	99	132	165	198	231	264	297	330
	100	4	7	18	37	73	110	147	183	220	256	293	330	366

Table 3.19: Predicted gannet mortality for Morven South plus 2km buffer during the post-breeding season

Gannet (post-breeding)		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	1	2	3	4	4	5	6	7	8	9
	20	0	0	1	2	4	5	7	9	11	13	14	16	18
	30	0	1	1	3	5	8	11	13	16	19	21	24	27
	40	0	1	2	4	7	11	14	18	21	25	29	32	36
	50	0	1	2	4	9	13	18	22	27	31	36	40	45
	60	1	1	3	5	11	16	21	27	32	38	43	48	54
	70	1	1	3	6	13	19	25	31	38	44	50	56	63
	80	1	1	4	7	14	21	29	36	43	50	57	64	72
	90	1	2	4	8	16	24	32	40	48	56	64	72	81
	100	1	2	4	9	18	27	36	45	54	63	72	81	89

Combined collision and displacement

3.1.8.3 Gannet is the only species considered within this annex for which both collision risk modelling and displacement analysis is required and has been carried out. For this species, impacts must be combined in order for the combined magnitude of impact to be understood.

3.1.8.4 It is recognised that assessing these two potential impacts together could amount to double counting, as birds that are subject to displacement could not be subject to potential collision risk as they are already assumed to have not entered Morven South. Equally, birds estimated to be subject to collision risk mortality would not be subjected to displacement mortality as well. The methods used to estimate collision risk and displacement mortality for gannet go some way to take this into account (through the reduction of gannet densities in collision risk modelling by 70%).

3.1.8.5 Table 3.20 presents the assessment of combined collision and displacement mortality for gannet on seasonal and annual bases. Calculations are presented for both the minimum and maximum Natural England displacement and mortality scenarios (60% displacement, 1% mortality; 80% displacement, 10% mortality).

Table 3.20: Combined collision and displacement impacts for gannet associated with Morven South. Both the minimum and maximum Natural England displacement and mortality scenarios are displayed

Season	Collision mortality (no. of birds)	Displacement mortality (no. of birds)		Total impact (no. of birds
		60% displacement, 1% mortality	80% displacement, 10% mortality	
Pre-breeding	0.1	0.1	1.7	0.2 to 1.8
Breeding	4.0	2.2	29.3	6.2 to 33.3
Post-breeding	0.2	0.5	7.2	0.7 to 7.3
Annual	4.2	2.9	38.2	7.0 to 42.4

3.2 Habitats Regulations Assessment impact estimates

3.2.1.1 The following sections present the apportioned impact results for each English SPA and qualifying feature identified in Table 2.1.

3.2.1.2 For displacement, impacts are presented for the upper and lower Natural England displacement and mortality scenarios for each species, that is, the minimum and maximum displacement and mortality rates advised for each species, as presented in Table 2.5. For kittiwake, impacts are presented after apportioning without consideration of immature birds in the breeding season, and after apportioning taking into account immature proportions observed during site specific digital aerial surveys. While site specific immature data is also available for gannet (Table 2.7), breeding season impacts on gannets at English SPAs are not assessed due to Flamborough and Filey Coast SPA being located outside of the mean-max foraging range plus one SD for gannet (Section 3.2.7).

3.2.2 Kittiwake

Collision

3.2.2.1 The tables below present predicted collision impacts for kittiwake apportioned to each English SPA screened in with kittiwake as a qualifying feature. Table 3.21 presents impacts with the removal of immature age classes included during apportioning and Table 3.22 presents impacts without the removal of immature age classes during apportioning.

Table 3.21: Predicted collision impacts associated with Morven South for kittiwake from each English Special Protection Area screened in for the species, with the removal of immature age classes during apportioning (B = breeding season, Post = post-breeding season, NB = non-breeding season, Pre = pre-breeding season, any seasons not applicable to the species are shaded in grey)

Feature	European site	Unapportioned seasonal collision risk estimates (no. of birds)				Apportioning value						Apportioned collision risk estimate (no. of birds)				Total apportioned impact (no. of birds)
		B	Post	NB	Pre	B			Post	NB	Pre	B	Post	NB	Pre	
						Colony proportion	Adult proportion	Value								
Kittiwake (flight speed 13.1m/s, avoidance rate 0.9929, immature age classes removed in the breeding season)	Coquet Island SPA	8.2	1.6		0.4	0.004	0.912	0.004	<0.001		<0.001	<0.1	<0.1		<0.1	<0.1
	Farne Islands SPA	8.2	1.6		0.4	0.059	0.912	0.054	0.005		0.007	0.4	<0.1		<0.1	0.5
	Flamborough and Filey Coast SPA	8.2	1.6		0.4	0.132	0.912	0.121	0.054		0.072	1.0	0.1		<0.1	1.1

Table 3.22: Predicted collision impacts associated with Morven South for kittiwake from each English Special Protection Area considered for the species within this annex, without the removal of immature age classes during apportioning (B = breeding season, Post = post-breeding season, NB = non-breeding season, Pre = pre-breeding season, any seasons not applicable to the species are shaded in grey)

Feature	European site	Unapportioned seasonal collision risk estimates (no. of birds)				Apportioning value				Apportioned collision risk estimate (no. of birds)				Total apportioned impact (no. of birds)
		B	Post	NB	Pre	B	Post	NB	Pre	B	Post	NB	Pre	
Kittiwake (flight speed 13.1m/s, avoidance rate 0.9929, immature age classes not removed)	Coquet Island SPA	8.2	1.6		0.4	0.004	<0.001		<0.001	<0.1	<0.1		<0.1	<0.1
	Farne Islands SPA	8.2	1.6		0.4	0.059	0.005		0.007	0.5	<0.1		<0.1	0.5
	Flamborough and Filey Coast SPA	8.2	1.6		0.4	0.132	0.054		0.072	1.1	0.1		<0.1	1.2

3.2.3 Guillemot

Displacement

3.2.3.1 Table 3.23 presents the predicted displacement impacts for guillemot apportioned to each English SPA screened in with guillemot as a qualifying feature.

Table 3.23: Predicted displacement impacts associated with Morven South for guillemot from each English Special Protection Area screened in for the species (B = breeding season, Post = post-breeding season, NB = non-breeding season, Pre = pre-breeding season, any seasons not applicable to the species are shaded in grey)

Feature	European site	Unapportioned seasonal displacement mortality estimates (no. of birds)				Apportioning value				Apportioned displacement mortality estimate (no. of birds)				Total apportioned impact (no. of birds)
		B	Post	NB	Pre	B	Post	NB	Pre	B	Post	NB	Pre	
Guillemot (30% displacement, 1% mortality)	Farne Islands SPA (non-breeding seasons only)	n/a		25.2		n/a		0.037		n/a		0.9		0.9
	Flamborough and Filey Coast SPA (non-breeding seasons only)	n/a		25.2		n/a		0.044		n/a		1.1		1.1
Guillemot (70% displacement, 10% mortality)	Farne Islands SPA (non-breeding seasons only)	n/a		587.2		n/a		0.037		n/a		21.9		21.9
	Flamborough and Filey Coast SPA (non-breeding seasons only)	n/a		587.2		n/a		0.044		n/a		25.9		25.9

3.2.4 Razorbill

Displacement

3.2.4.1 Table 3.24 presents the predicted displacement impacts for razorbill apportioned to each English SPA screened in with razorbill as a qualifying feature (Flamborough and Filey Coast SPA in the non-breeding seasons).

Table 3.24: Predicted displacement impacts associated with Morven South for razorbill from each English Special Protection Area screened in for the species (B = breeding season, Post = post-breeding season, NB = non-breeding season, Pre = pre-breeding season, any seasons not applicable to the species are shaded in grey)

Feature	European site	Unapportioned seasonal displacement mortality estimates (no. of birds)				Apportioning value				Apportioned displacement mortality estimate (no. of birds)				Total apportioned impact (no. of birds)
		B	Post	NB	Pre	B	Post	NB	Pre	B	Post	NB	Pre	
Razorbill (30% displacement, 1% mortality)	Flamborough and Filey Coast SPA (non-breeding seasons only)	n/a	6.8	1.2	0.3	n/a	0.034	0.027	0.034	n/a	0.2	<0.1	<0.1	0.3
Razorbill (70% displacement, 10% mortality)	Flamborough and Filey Coast SPA (non-breeding seasons only)	n/a	159.2	28.2	6.3	n/a	0.034	0.027	0.034	n/a	5.4	0.8	0.2	6.4

3.2.5 Puffin

Displacement

3.2.5.1 Table 3.25 presents the predicted displacement impacts for puffin apportioned to each English SPA screened in with puffin as a qualifying feature.

Table 3.25: Predicted displacement impacts associated with Morven South for puffin from each English Special Protection Area screened in for the species (B = breeding season, Post = post-breeding season, NB = non-breeding season, Pre = pre-breeding season, any seasons not applicable to the species are shaded in grey)

Feature	European site	Unapportioned seasonal displacement mortality estimates (no. of birds)				Apportioning value				Apportioned displacement mortality estimate (no. of birds)				Total apportioned impact (no. of birds)
		B	Post	NB	Pre	B	Post	NB	Pre	B	Post	NB	Pre	
Puffin (30% displacement, 1% mortality)	Coquet Island SPA	0.3		1.3		0.161		0.053		0.1		0.1		0.1
	Farne Islands SPA	0.3		1.3		0.426		0.172		0.1		0.2		0.4
	Flamborough and Filey Coast SPA	0.3		1.3		n/a		0.004		n/a		<0.1		<0.1
Puffin (70% displacement, 10% mortality)	Coquet Island SPA	7.4		30.3		0.161		0.053		1.2		1.6		2.8
	Farne Islands SPA	7.4		30.3		0.426		0.172		3.2		5.2		8.4
	Flamborough and Filey Coast SPA	7.4		30.3		n/a		0.004		n/a		0.1		0.1

3.2.6 Fulmar

Displacement

3.2.6.1 Table 3.26 presents the predicted displacement impacts for fulmar apportioned to each English SPA screened in with fulmar as a qualifying feature.

Table 3.26: Predicted displacement impacts associated with Morven South for fulmar from each English Special Protection Area screened in for the species (B = breeding season, Post = post-breeding season, NB = non-breeding season, Pre = pre-breeding season)

Feature	European site	Unapportioned seasonal displacement mortality estimates (no. of birds)				Apportioning value				Apportioned displacement mortality estimate (no. of birds)				Total apportioned impact (no. of birds)
		B	Post	NB	Pre	B	Post	NB	Pre	B	Post	NB	Pre	
Fulmar (1% displacement, 1% mortality)	Coquet Island SPA	<0.1	<0.1	<0.1	<0.1	0.001	<0.001	<0.001	<0.001	<0.1	<0.1	<0.1	<0.1	<0.1
	Flamborough and Filey Coast SPA	<0.1	<0.1	<0.1	<0.1	0.008	0.002	0.002	0.002	<0.1	<0.1	<0.1	<0.1	<0.1
Fulmar (10% displacement, 10% mortality)	Coquet Island SPA	2.4	2.8	3.0	1.8	0.001	<0.001	<0.001	<0.001	<0.1	<0.1	<0.1	<0.1	<0.1
	Flamborough and Filey Coast SPA	2.4	2.8	3.0	1.8	0.008	0.002	0.002	0.002	<0.1	<0.1	<0.1	<0.1	<0.1

3.2.7 Gannet

Collision

3.2.7.1 Table 3.27 presents predicted collision impacts for gannet apportioned to each English SPA screened in with gannet as a qualifying feature (Flamborough and Filey Coast SPA in the non-breeding seasons).

Table 3.27: Predicted collision impacts associated with Morven South for gannet from each English Special Protection Area screened in for the species (B = breeding season, Post = post-breeding season, NB = non-breeding season, Pre = pre-breeding season, any seasons not applicable to the species are shaded in grey)

Feature	European site	Unapportioned seasonal collision risk estimates (no. of birds)				Apportioning value				Apportioned collision risk estimate (no. of birds)				Total apportioned impact (no. of birds)
		B	Post	NB	Pre	B	Post	NB	Pre	B	Post	NB	Pre	
Gannet (flight speed 14.9m/s, avoidance rate 0.9929)	Flamborough and Filey Coast SPA (non-breeding seasons only)	n/a	0.2		0.1	n/a	0.048		0.062	n/a	<0.1		<0.1	<0.1

Displacement

3.2.7.2 Table 3.28 presents predicted displacement impacts for gannet apportioned to each English SPA screened in with gannet as a qualifying feature (Flamborough and Filey Coast SPA in the non-breeding seasons).

Table 3.28: Predicted displacement impacts associated with Morven South for gannet from each English Special Protection Area screened in for the species (B = breeding season, Post = post-breeding season, NB = non-breeding season, Pre = pre-breeding season, any seasons not applicable to the species are shaded in grey)

Feature	European site	Unapportioned seasonal displacement mortality estimates (no. of birds)				Apportioning value				Apportioned displacement mortality estimate (no. of birds)				Total apportioned impact (no. of birds)
		B	Post	NB	Pre	B	Post	NB	Pre	B	Post	NB	Pre	
Gannet (60% displacement, 1% mortality)	Flamborough and Filey Coast SPA (non-breeding seasons only)	n/a	0.5		0.1	n/a	0.048		0.062	n/a	<0.1		<0.1	<0.1
Gannet (80% displacement, 10% mortality)	Flamborough and Filey Coast SPA (non-breeding seasons only)	n/a	7.2		1.7	n/a	0.048		0.062	n/a	0.3		0.1	0.5

Combined collision and displacement

3.2.7.3 Table 3.29 combines the apportioned collision and displacement impacts from Table 3.27 and Table 3.28, to present the predicted impact of collision and displacement combined on gannets at Flamborough and Filey Coast SPA during the non-breeding seasons.

Table 3.29: Predicted impacts of collision and displacement combined on gannet from each English Special Protection Area screened in for the species (B = breeding season, Post = post-breeding season, NB = non-breeding season, Pre = pre-breeding season, any seasons not applicable to the species are shaded in grey)

Feature	European site	Apportioned seasonal collision risk estimates (no. of birds)				Apportioned displacement mortality estimate (no. of birds)				Apportioned impact collision and displacement combined (no. of birds)				Total apportioned impact (no. of birds)
		B	Post	NB	Pre	B	Post	NB	Pre	B	Post	NB	Pre	
Gannet (60% displacement, 1% mortality)	Flamborough and Filey Coast SPA (non-breeding seasons only)	n/a	0.01		<0.01	n/a	0.03		0.01	n/a	0.04		0.01	<0.1
Gannet (80% displacement, 10% mortality)	Flamborough and Filey Coast SPA (non-breeding seasons only)	n/a	0.01		<0.01	n/a	0.35		0.11	n/a	0.36		0.11	0.5

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