Morven North 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 North, 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 North 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 Areas for consideration

2.1.1 Environmental Impact Assessment

2.1.1.1 Valued Ornithological Receptors (VORs) to be included for impact assessment for Morven North 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 North 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 North 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 these species during migratory periods.

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

- Kittiwake (*Rissa tridactyla*);
- Little gull (*Hydrocoloeus minutus*);
- Great black-backed gull (*Larus marinus*);
- Herring gull (*Larus argentatus*);
- 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 Regulations Appraisal (HRA) Screening was carried out for Morven North 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 North 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 North for the purpose of this annex. This includes 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 North, and the potential impacts assessed within this annex

Site ID	Site name	Distance to Morven North (km)[3]	Relevant qualifying features	Potential impact considered within this annex
UK9006031	Coquet Island SPA	143	Kittiwake	Collision
			Puffin	Displacement
			Fulmar	Displacement
UK9006021	Farne Islands SPA	111	Kittiwake	Collision
			Puffin	Displacement
			Guillemot (non-breeding seasons only)	Displacement
UK9006101	Flamborough and Filey Coast SPA	260	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	102	Kittiwake	Collision
			Razorbill	Displacement
			Puffin	Displacement
			Fulmar	Displacement

[3] Distances measured from the edge of Morven North 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);
- Herring gull (very high vulnerability, regional population importance);
- 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 North 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 North were undertaken between January 2021 and September 2023. Further information on the aerial surveys undertaken for Morven North 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 North (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 North 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 North 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 North (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	23,080	n/a	13,324
Razorbill	109	3,887	2,195	530
Puffin	n/a	625	n/a	1385
Fulmar	330	2,879	251	515
Gannet	24	796	349	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 North 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 North 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 North, 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 impact 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 North.

Table 2.7: Number of birds assigned to different age class categories during site specific surveys of the Morven North 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	769	564	535	29	5.1
Gannet	March to September	139	465	446	19	4.1

[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 North[5], [6] (km)[7]	Population (No. of breeding adults)	Proportion of foraging range at sea[5]	Resulting weight for colony	Proportional weight of colony
Coquet Island	160	932	0.599	0.006	0.003
Farne Islands	129	8,804	0.617	0.084	0.036
Flamborough and Filey Coast	282	103,070	0.587	0.196	0.084

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 North and proportion of foraging range at sea.

[6] Distances measured from the centre of Morven North to the centre of each site.

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

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 North 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 North 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 North[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	160	50,058	0.580	0.343	0.139
Farne Islands	129	87,504	0.591	0.903	0.365
Flamborough and Filey Coast	298	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 North 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 North[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	160	106	0.688	0.003	0.001
Flamborough and Filey Coast	282	2,514	0.666	0.019	0.005

[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 North 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 North are located within the Forth Islands SPA and, as a result, 100% of gannets at Morven North 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 North 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	0.2	0.7	0.8	1.2	2.4	7.4	9.4	0.6	0.1	1.3	0.3	0.6	25.0
				Median	0.2	0.6	0.8	1.2	2.3	7.3	9.0	0.5	0.1	1.2	0.3	0.6	24.1
				SD	0.1	0.3	0.3	0.4	0.6	2.0	3.0	0.5	0.1	0.5	0.2	0.2	-
				2.5% percentile	0.0	0.2	0.3	0.6	1.4	4.1	4.5	0.0	0.0	0.5	0.1	0.3	-
				97.5% percentile	0.4	1.3	1.4	2.0	3.6	11.8	16.0	1.8	0.2	2.6	0.7	1.1	-

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 North 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	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.2	0.9
				Median	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.8
				SD	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.2	-
				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	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.6	-

3.1.4 Herring gull

Collision

3.1.4.1 Table 3.3 presents the predicted number of collisions for herring gull using a stochastic model, along with associated confidence metrics.

Table 3.3: Predicted collisions for herring gull associated with Morven North, 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
Herring gull	2	12.8	0.9940	Mean	0.0	0.0	0.0	0.0	0.4	0.2	0.0	0.0	0.0	0.2	0.2	0.0	0.9
				Median	0.0	0.0	0.0	0.0	0.4	0.2	0.0	0.0	0.0	0.1	0.1	0.0	0.8
				SD	0.0	0.0	0.0	0.0	0.3	0.2	0.0	0.0	0.0	0.2	0.2	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	0.0	0.0	0.0	0.0	1.1	0.7	0.0	0.0	0.0	0.6	0.5	0.0	-

3.1.5 Guillemot

Displacement

3.1.5.1 Displacement matrices for guillemot in the breeding and non-breeding seasons are presented in Table 3.4 and Table 3.5, 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 3.4: Predicted guillemot mortality for Morven North 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	23	46	115	231	462	692	923	1,154	1,385	1,616	1,846	2,077	2,308
	20	46	92	231	462	923	1,385	1,846	2,308	2,770	3,231	3,693	4,154	4,616
	30	69	138	346	692	1,385	2,077	2,770	3,462	4,154	4,847	5,539	6,232	6,924
	40	92	185	462	923	1,846	2,770	3,693	4,616	5,539	6,462	7,386	8,309	9,232
	50	115	231	577	1,154	2,308	3,462	4,616	5,770	6,924	8,078	9,232	10,386	11,540
	60	138	277	692	1,385	2,770	4,154	5,539	6,924	8,309	9,694	11,078	12,463	13,848
	70	162	323	808	1,616	3,231	4,847	6,462	8,078	9,694	11,309	12,925	14,540	16,156
	80	185	369	923	1,846	3,693	5,539	7,386	9,232	11,078	12,925	14,771	16,617	18,464
	90	208	415	1,039	2,077	4,154	6,232	8,309	10,386	12,463	14,540	16,617	18,695	20,772
	100	231	462	1,154	2,308	4,616	6,924	9,232	11,540	13,848	16,156	18,464	20,772	23,080

Table 3.5: Predicted guillemot mortality for Morven North 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	13	27	67	133	266	400	533	666	799	933	1,066	1,199	1,332
	20	27	53	133	266	533	799	1,066	1,332	1,599	1,865	2,132	2,398	2,665
	30	40	80	200	400	799	1,199	1,599	1,999	2,398	2,798	3,198	3,597	3,997
	40	53	107	266	533	1,066	1,599	2,132	2,665	3,198	3,731	4,264	4,796	5,329
	50	67	133	333	666	1,332	1,999	2,665	3,331	3,997	4,663	5,329	5,996	6,662
	60	80	160	400	799	1,599	2,398	3,198	3,997	4,796	5,596	6,395	7,195	7,994
	70	93	187	466	933	1,865	2,798	3,731	4,663	5,596	6,529	7,461	8,394	9,327
	80	107	213	533	1,066	2,132	3,198	4,264	5,329	6,395	7,461	8,527	9,593	10,659
	90	120	240	600	1,199	2,398	3,597	4,796	5,996	7,195	8,394	9,593	10,792	11,991
	100	133	266	666	1,332	2,665	3,997	5,329	6,662	7,994	9,327	10,659	11,991	13,324

3.1.6 Razorbill

Displacement

3.1.6.1 Displacement matrices for razorbill in the pre-breeding, breeding, post-breeding, and non-breeding seasons are presented in Table 3.6, Table 3.7, Table 3.8, and Table 3.9, 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 3.6: Predicted razorbill mortality for Morven North 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	1	1	2	3	4	5	7	8	9	10	11
	20	0	0	1	2	4	7	9	11	13	15	18	20	22
	30	0	1	2	3	7	10	13	16	20	23	26	30	33
	40	0	1	2	4	9	13	18	22	26	31	35	39	44
	50	1	1	3	5	11	16	22	27	33	38	44	49	55
	60	1	1	3	7	13	20	26	33	39	46	53	59	66
	70	1	2	4	8	15	23	31	38	46	54	61	69	77
	80	1	2	4	9	18	26	35	44	53	61	70	79	88
	90	1	2	5	10	20	30	39	49	59	69	79	89	99
	100	1	2	5	11	22	33	44	55	66	77	88	99	109

Table 3.7: Predicted razorbill mortality for Morven North 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	4	8	19	39	78	117	155	194	233	272	311	350	389
	20	8	16	39	78	155	233	311	389	466	544	622	700	777
	30	12	23	58	117	233	350	466	583	700	816	933	1,050	1,166
	40	16	31	78	155	311	466	622	777	933	1,088	1,244	1,399	1,555
	50	19	39	97	194	389	583	777	972	1,166	1,361	1,555	1,749	1,944
	60	23	47	117	233	466	700	933	1,166	1,399	1,633	1,866	2,099	2,332
	70	27	54	136	272	544	816	1,088	1,361	1,633	1,905	2,177	2,449	2,721
	80	31	62	155	311	622	933	1,244	1,555	1,866	2,177	2,488	2,799	3,110
	90	35	70	175	350	700	1,050	1,399	1,749	2,099	2,449	2,799	3,149	3,498
	100	39	78	194	389	777	1,166	1,555	1,944	2,332	2,721	3,110	3,498	3,887

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

Razorbill (post-breeding)		Mortality rate (%)												
		1	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Displacement rate (%)	**10**	2	4	11	22	44	66	88	110	132	154	176	198	219
	20	4	9	22	44	88	132	176	219	263	307	351	395	439
	30	7	13	33	66	132	198	263	329	395	461	527	593	658
	40	9	18	44	88	176	263	351	439	527	615	702	790	878
	50	11	22	55	110	219	329	439	549	658	768	878	988	1,097
	60	13	26	66	132	263	395	527	658	790	922	1,053	1,185	1,317
	70	15	31	77	154	307	461	615	768	922	1,075	1,229	1,383	1,536
	80	18	35	88	176	351	527	702	878	1,053	1,229	1,405	1,580	1,756
	90	20	40	99	198	395	593	790	988	1,185	1,383	1,580	1,778	1,975
	100	22	44	110	219	439	658	878	1,097	1,317	1,536	1,756	1,975	2,195

Table 3.9: Predicted razorbill mortality for Morven North plus 2km buffer during the non-breeding season

Razorbill (non-breeding)		Mortality rate (%)												
		1	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Displacement rate (%)	**10**	1	1	3	5	11	16	21	26	32	37	42	48	53
	20	1	2	5	11	21	32	42	53	64	74	85	95	106
	30	2	3	8	16	32	48	64	79	95	111	127	143	159
	40	2	4	11	21	42	64	85	106	127	148	169	191	212
	50	3	5	13	26	53	79	106	132	159	185	212	238	265
	60	3	6	16	32	64	95	127	159	191	222	254	286	318
	70	4	7	19	37	74	111	148	185	222	259	297	334	371
	80	4	8	21	42	85	127	169	212	254	297	339	381	424
	90	5	10	24	48	95	143	191	238	286	334	381	429	477
	100	5	11	26	53	106	159	212	265	318	371	424	477	530

3.1.7 Puffin

Displacement

3.1.7.1 Displacement matrices for puffin in the breeding and non-breeding seasons are presented in Table 3.10 and Table 3.11, 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 3.10: Predicted puffin mortality for Morven North 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**	1	1	3	6	13	19	25	31	38	44	50	56	63
	20	1	3	6	13	25	38	50	63	75	88	100	113	125
	30	2	4	9	19	38	56	75	94	113	131	150	169	188
	40	3	5	13	25	50	75	100	125	150	175	200	225	250
	50	3	6	16	31	63	94	125	156	188	219	250	281	313
	60	4	8	19	38	75	113	150	188	225	263	300	338	375
	70	4	9	22	44	88	131	175	219	263	306	350	394	438
	80	5	10	25	50	100	150	200	250	300	350	400	450	500
	90	6	11	28	56	113	169	225	281	338	394	450	506	563
	100	6	13	31	63	125	188	250	313	375	438	500	563	625

Table 3.11: Predicted puffin mortality for Morven North 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**	1	3	7	14	28	42	55	69	83	97	111	125	139
	20	3	6	14	28	55	83	111	139	166	194	222	249	277
	30	4	8	21	42	83	125	166	208	249	291	332	374	416
	40	6	11	28	55	111	166	222	277	332	388	443	499	554
	50	7	14	35	69	139	208	277	346	416	485	554	623	693
	60	8	17	42	83	166	249	332	416	499	582	665	748	831
	70	10	19	48	97	194	291	388	485	582	679	776	873	970
	80	11	22	55	111	222	332	443	554	665	776	886	997	1,108
	90	12	25	62	125	249	374	499	623	748	873	997	1,122	1,247
	100	14	28	69	139	277	416	554	693	831	970	1,108	1,247	1,385

3.1.8 Fulmar

Displacement

3.1.8.1 Displacement matrices for fulmar in the pre-breeding, breeding, post-breeding, and non-breeding seasons are presented in Table 3.12, Table 3.13, Table 3.14, and Table 3.15, 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 3.12: Predicted fulmar mortality for Morven North 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	1	1	1	2	2	2	3	3	3
	2	0	0	0	1	1	2	3	3	4	5	5	6	7
	5	0	0	1	2	3	5	7	8	10	12	13	15	17
	10	0	1	2	3	7	10	13	17	20	23	26	30	33
	20	1	1	3	7	13	20	26	33	40	46	53	59	66
	30	1	2	5	10	20	30	40	50	59	69	79	89	99
	40	1	3	7	13	26	40	53	66	79	92	106	119	132
	50	2	3	8	17	33	50	66	83	99	116	132	149	165
	60	2	4	10	20	40	59	79	99	119	139	159	178	198
	70	2	5	12	23	46	69	92	116	139	162	185	208	231
	80	3	5	13	26	53	79	106	132	159	185	211	238	264
	90	3	6	15	30	59	89	119	149	178	208	238	268	297
	100	3	7	17	33	66	99	132	165	198	231	264	297	330

Table 3.13: Predicted fulmar mortality for Morven North 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	1	1	3	6	9	12	14	17	20	23	26	29
	2	1	1	3	6	12	17	23	29	35	40	46	52	58
	5	1	3	7	14	29	43	58	72	86	101	115	130	144
	10	3	6	14	29	58	86	115	144	173	202	230	259	288
	20	6	12	29	58	115	173	230	288	345	403	461	518	576
	30	9	17	43	86	173	259	345	432	518	605	691	777	864
	40	12	23	58	115	230	345	461	576	691	806	921	1,036	1,152
	50	14	29	72	144	288	432	576	720	864	1,008	1,152	1,295	1,439
	60	17	35	86	173	345	518	691	864	1,036	1,209	1,382	1,555	1,727
	70	20	40	101	202	403	605	806	1,008	1,209	1,411	1,612	1,814	2,015
	80	23	46	115	230	461	691	921	1,152	1,382	1,612	1,842	2,073	2,303
	90	26	52	130	259	518	777	1,036	1,295	1,555	1,814	2,073	2,332	2,591
	100	29	58	144	288	576	864	1,152	1,439	1,727	2,015	2,303	2,591	2,879

Table 3.14: Predicted fulmar mortality for Morven North 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	2	3
	2	0	0	0	1	1	2	2	3	3	4	4	5	5
	5	0	0	1	1	3	4	5	6	8	9	10	11	13
	10	0	1	1	3	5	8	10	13	15	18	20	23	25
	20	1	1	3	5	10	15	20	25	30	35	40	45	50
	30	1	2	4	8	15	23	30	38	45	53	60	68	75
	40	1	2	5	10	20	30	40	50	60	70	80	90	100
	50	1	3	6	13	25	38	50	63	75	88	100	113	125
	60	2	3	8	15	30	45	60	75	90	105	120	135	151
	70	2	4	9	18	35	53	70	88	105	123	140	158	176
	80	2	4	10	20	40	60	80	100	120	140	161	181	201
	90	2	5	11	23	45	68	90	113	135	158	181	203	226
	100	3	5	13	25	50	75	100	125	151	176	201	226	251

Table 3.15: Predicted fulmar mortality for Morven North 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	1	1	2	2	3	3	4	4	5	5
	2	0	0	1	1	2	3	4	5	6	7	8	9	10
	5	0	1	1	3	5	8	10	13	15	18	21	23	26
	10	1	1	3	5	10	15	21	26	31	36	41	46	51
	20	1	2	5	10	21	31	41	51	62	72	82	93	103
	30	2	3	8	15	31	46	62	77	93	108	124	139	154
	40	2	4	10	21	41	62	82	103	124	144	165	185	206
	50	3	5	13	26	51	77	103	129	154	180	206	232	257
	60	3	6	15	31	62	93	124	154	185	216	247	278	309
	70	4	7	18	36	72	108	144	180	216	252	288	324	360
	80	4	8	21	41	82	124	165	206	247	288	329	371	412
	90	5	9	23	46	93	139	185	232	278	324	371	417	463
	100	5	10	26	51	103	154	206	257	309	360	412	463	515

3.1.9 Gannet

Collision

3.1.9.1 Table 3.16 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 3.17. The estimates in Table 3.17 are those considered within the Habitat Regulations Assessment calculation in Section 3.2.

Table 3.16: Predicted collisions for gannet associated with Morven North 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	0.0	0.2	0.3	0.5	2.0	3.4	1.7	1.4	0.7	2.2	0.1	0.2	12.6
				Median	0.0	0.1	0.2	0.4	1.8	3.1	1.5	1.3	0.6	2.0	0.1	0.1	11.2
				SD	0.0	0.1	0.2	0.4	1.2	1.9	1.0	0.9	0.4	1.3	0.1	0.1	-
				2.5% percentile	0.0	0.0	0.0	0.1	0.5	0.8	0.4	0.3	0.1	0.5	0.0	0.0	-
				97.5% percentile	0.0	0.5	0.7	1.4	4.9	7.4	3.8	3.6	1.7	5.2	0.3	0.5	-

Table 3.17: Predicted collisions for gannet associated with Morven North 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	0.2	0.6	1.0	0.5	0.4	0.2	0.7	0.0	0.0	3.8

Displacement

3.1.9.2 Displacement matrices for gannet in the pre-breeding, breeding, and post-breeding seasons are presented in Table 3.18, Table 3.19, and Table 3.20, 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 3.18: Predicted gannet mortality for Morven North 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	4	4	5
	30	0	0	0	1	1	2	3	4	4	5	6	6	7
	40	0	0	0	1	2	3	4	5	6	7	8	8	9
	50	0	0	1	1	2	4	5	6	7	8	9	11	12
	60	0	0	1	1	3	4	6	7	8	10	11	13	14
	70	0	0	1	2	3	5	7	8	10	12	13	15	17
	80	0	0	1	2	4	6	8	9	11	13	15	17	19
	90	0	0	1	2	4	6	8	11	13	15	17	19	21
	100	0	0	1	2	5	7	9	12	14	17	19	21	24

Table 3.19: Predicted gannet mortality for Morven North 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	1	2	4	8	16	24	32	40	48	56	64	72	80
	20	2	3	8	16	32	48	64	80	96	111	127	143	159
	30	2	5	12	24	48	72	96	119	143	167	191	215	239
	40	3	6	16	32	64	96	127	159	191	223	255	287	319
	50	4	8	20	40	80	119	159	199	239	279	319	358	398
	60	5	10	24	48	96	143	191	239	287	334	382	430	478
	70	6	11	28	56	111	167	223	279	334	390	446	502	557
	80	6	13	32	64	127	191	255	319	382	446	510	573	637
	90	7	14	36	72	143	215	287	358	430	502	573	645	717
	100	8	16	40	80	159	239	319	398	478	557	637	717	796

Table 3.20: Predicted gannet mortality for Morven North 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	1	2	3	7	10	14	17	21	24	28	31	35
	20	1	1	3	7	14	21	28	35	42	49	56	63	70
	30	1	2	5	10	21	31	42	52	63	73	84	94	105
	40	1	3	7	14	28	42	56	70	84	98	112	126	139
	50	2	3	9	17	35	52	70	87	105	122	139	157	174
	60	2	4	10	21	42	63	84	105	126	146	167	188	209
	70	2	5	12	24	49	73	98	122	146	171	195	220	244
	80	3	6	14	28	56	84	112	139	167	195	223	251	279
	90	3	6	16	31	63	94	126	157	188	220	251	282	314
	100	3	7	17	35	70	105	139	174	209	244	279	314	349

Combined collision and displacement

3.1.9.3 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.

3.1.9.4 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 North. 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%).

3.1.9.5 Table 3.21 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 3.21: Combined collision and displacement impacts for gannet associated with Morven North. 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	2	0.1 to 2.1
Breeding	3.0	5	64	8.0 to 67.0
Post-breeding	0.7	2	28	2.7 to 28.7
Annual	3.8	7	94	10.8 to 97.8

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 3.22 presents impacts with the removal of immature age classes included during apportioning and Table 3.23 presents impacts without the removal of immature age classes during apportioning.

Table 3.22: Predicted collision impacts associated with Morven North 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	21.8	2.3		0.8	0.003	0.949	0.002	<0.001		<0.001	0.1	<0.1		<0.1	0.1
	Farne Islands SPA	21.8	2.3		0.8	0.036	0.949	0.034	0.005		0.007	0.7	<0.1		<0.1	0.8
	Flamborough and Filey Coast SPA	21.8	2.3		0.8	0.084	0.949	0.080	0.054		0.072	1.7	0.1		0.1	1.9

Table 3.23: Predicted collision impacts associated with Morven North 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	21.8	2.3		0.8	0.003	<0.001		<0.001	0.1	<0.1		<0.1	0.1
	Farne Islands SPA	21.8	2.3		0.8	0.036	0.005		0.007	0.8	<0.1		<0.1	0.8
	Flamborough and Filey Coast SPA	21.8	2.3		0.8	0.084	0.054		0.072	1.8	0.1		0.1	2.0

3.2.3 Guillemot

Displacement

3.2.3.1 Table 3.24 presents the predicted displacement impacts for guillemot apportioned to each English SPA screened in with guillemot as a qualifying feature.

Table 3.24: Predicted displacement impacts associated with Morven North 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		40.0		n/a		0.037		n/a		1.5		1.5
	Flamborough and Filey Coast SPA (non-breeding seasons only)	n/a		40.0		n/a		0.044		n/a		1.8		1.8
Guillemot (70% displacement, 10% mortality)	Farne Islands SPA (non-breeding seasons only)	n/a		932.7		n/a		0.037		n/a		34.8		34.8
	Flamborough and Filey Coast SPA (non-breeding seasons only)	n/a		932.7		n/a		0.044		n/a		41.1		41.1

3.2.4 Razorbill

Displacement

3.2.4.1 Table 3.25 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 3.25: Predicted displacement impacts associated with Morven North 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	6.6	1.6	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	153.6	37.1	7.7	n/a	0.034	0.027	0.034	n/a	5.2	1.0	0.3	6.5

3.2.5 Puffin

Displacement

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

Table 3.26: Predicted displacement impacts associated with Morven North 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	1.9		4.2		0.139		0.053		0.3		0.2		0.5
	Farne Islands SPA	1.9		4.2		0.365		0.172		0.7		0.7		1.4
	Flamborough and Filey Coast SPA	1.9		4.2		n/a		0.004		n/a		<0.1		<0.1
Puffin (70% displacement, 10% mortality)	Coquet Island SPA	43.8		97.0		0.139		0.053		6.1		5.2		11.2
	Farne Islands SPA	43.8		97.0		0.365		0.172		16.0		16.7		32.7
	Flamborough and Filey Coast SPA	43.8		97.0		0		0.004		n/a		0.4		0.4

3.2.6 Fulmar

Displacement

3.2.6.1 Table 3.27 presents the predicted displacement impacts for fulmar apportioned to each English SPA screened in with fulmar as a qualifying feature.

Table 3.27: Predicted displacement impacts associated with Morven North 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	0.3	0.0	0.1	0.0	0.001	<0.001	<0.001	<0.001	<0.1	<0.1	<0.1	<0.1	<0.1
	Flamborough and Filey Coast SPA	0.3	0.0	0.1	0.0	0.005	0.002	0.002	0.002	<0.1	<0.1	<0.1	<0.1	<0.1
Fulmar (10% displacement, 10% mortality)	Coquet Island SPA	28.8	2.5	5.1	3.3	0.001	<0.001	<0.001	<0.001	<0.1	<0.1	<0.1	<0.1	<0.1
	Flamborough and Filey Coast SPA	28.8	2.5	5.1	3.3	0.005	0.002	0.002	0.002	0.2	0.0	0.0	0.0	0.2

3.2.7 Gannet

Collision

3.2.7.1 Table 3.28 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 3.28: Predicted collision impacts associated with Morven North 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	0.7		0.1	n/a	0.048		0.062	n/a	<0.1		<0.1	<0.1

Displacement

3.2.7.2 Table 3.29 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 3.29: Predicted displacement impacts associated with Morven North 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	2.1		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	27.9		1.9	n/a	0.048		0.062	n/a	1.4		0.1	1.5

Combined collision and displacement

3.2.7.3 Table 3.30 combines the apportioned collision and displacement impacts from Table 3.28 and Table 3.29, to present the predicted impact of collision and displacement combined on gannets at Flamborough and Filey Coast SPA during the non-breeding seasons.

Table 3.30: 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	0.03		0.01	n/a	0.1		0.0	n/a	0.1		<0.1	0.2
Gannet (80% displacement, 10% mortality)	Flamborough and Filey Coast SPA (non-breeding seasons only)	n/a	0.03		0.01	n/a	1.4		0.1	n/a	1.4		0.1	1.5

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