# Spiorad na Mara Offshore Wind Farm

## Offshore Project

## Environmental Impact Assessment Report

## Appendix 14.4: Migratory Collision Risk Modelling Report, Volume 2c

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# 1 INTRODUCTION

## 1.1 OVERVIEW

1.1.1.1 This appendix of the Environmental Impact Assessment Report (EIAR) presents the migratory collision risk modelling (mCRM) approach undertaken for the offshore (i.e. seaward of Mean High Water Springs (MHWS)) components of the proposed Spiorad na Mara Offshore Wind Farm (hereafter referred to as 'the Offshore Project'), with respect to marine ornithology. This appendix accompanies **Chapter 14: Marine and Nearshore Ornithology, Volume 2a** of the EIAR.

1.1.1.2 This appendix should be read in conjunction with the project description provided in **Chapter 3: Project Description, Volume 1a**, and the relevant parts of the following chapters and appendices:

- **Appendix 14.1: Ornithology Baseline Report, Volume 2c**;
- **Appendix 14.6: EIA Ornithology Consultation, Volume 2c**;
- **Offshore Report to Inform Appropriate Assessment (RIAA)**.

1.1.1.3 This appendix focusses on migratory collision risk for migrant seabird, waterbird, and terrestrial bird species, with collision risk modelling for regularly occurring seabirds presented in **Appendix 14.3: Collision Risk Modelling Report, Volume 2c**.

### 1.1.2 PROJECT BACKGROUND

1.1.2.1 Spiorad na Mara Limited (hereafter referred to as 'the Applicant') is proposing to develop the Project. The Project is an offshore wind farm (OWF) that will consist of up to 60 fixed-bottom wind turbine generators (WTGs).

1.1.2.2 The Project will include both offshore and onshore infrastructure. This Offshore EIAR supports the application for the offshore components of the Project as outlined in **Chapter 1: Introduction, Volume 1a**. The offshore components of the Project (the Offshore Project) includes all infrastructure and activities located seaward of MHWS) within the Array Area and Offshore Cable Area of Search (OCAS) (**Figure 1.2: Offshore Project Location, Volume 1b**). Further detailed information is provided in **Chapter 3, Volume 1a**.

1.1.2.3 The Offshore Project is situated off the northwest coast of Isle of Lewis/*Eilean Leòdhais* and the Array Area is located approximately 5-13 km offshore and is approximately 161 km$^2$ in size. It will comprise WTGs, foundations, Offshore Cables, Offshore Substation Platform (OSP) (if required), and Landfall. The Array Area combined with the OCAS is defined as the Offshore Project Boundary. The water depths across the Array Area range from 37 m-67 m with the southwest corner of the Array Area reaching 72 m. The proposed WTGs, OSP (if required) and fixed foundations will be located within a Turbine Area of approximately 140 km$^2$, within the Array Area.

## 1.2 PURPOSE AND SCOPE OF THIS APPENDIX

1.2.1.1 During the operation and maintenance phase of the Offshore Project, the turning rotors of the wind turbines may present a risk of collision for seabirds. Stationary structures, such as the tower, nacelle, or rotors when they are not operating, are not anticipated to present a material risk of collision. When a collision occurs between a turning rotor blade and a bird, it is assumed to result in direct mortality of the bird. This could potentially result in population level impacts.

1.2.1.2 Species differ in their susceptibility to collision risk depending on their flight behaviour, avoidance responses, and the vulnerability of their populations (Garthe and Hüppop, 2004; Furness *et al*., 2013; Bradbury *et al*., 2014; Wade *et al*., 2016). The structure and operation of the wind turbines can also affect the risk to birds; factors influencing the magnitude of risk include rotor speed, blade size, pitch angle, and height above the sea surface. Artificial lighting may also affect the risk for some species (e.g. shearwaters and petrels), although there is little available evidence to quantify the extent of change to the risk. The ability of seabirds to detect and manoeuvre around wind turbine blades is also a factor that is considered when modelling and assessing the risk. It is therefore standard practice to calculate differing levels of avoidance for different species or species groups. Avoidance rates are applied to collision risk models based on available literature and expert advice regarding seabird behaviour and species' flight response to wind turbines in order to predict more realistic levels of impact.

1.2.1.3 The effects of increased mortality on populations due to collisions with turbines are generally considered to be long-term, lasting throughout the operational wind farm's lifespan. In the model, it is assumed that collision rate does not decrease in response to losses in the population. In reality, effects may change over time. For example, birds may become habituated to the presence of turbines, particularly if they are resident near the wind farm. Additionally, external factors such as changes in fishing activities may alter the attractiveness of the wind farm area to birds, thereby changing activity levels within the wind farm area.

1.2.1.4 This mCRM appendix covers the potential impacts of collision risk on migratory waterbirds, seabirds, and terrestrial birds that migrate over the open sea and are features of United Kingdom (UK) Special Protection Areas (SPAs). The only species considered in this analysis are those which are not adequately characterised through the site-specific Digital Aerial Surveys (DAS) (i.e. migratory species where sufficient coverage was not obtained during the DAS to enable their potential status as a valued ornithological receptor (VOR)), as determined in **Appendix 14.1, Volume 2c**. Refer to **Table 2** for a list of species included in **Appendix 14.1, Volume 2c**.

1.2.1.5 For the purposes of this analysis, migratory waterbirds refer to species of ducks and geese (Anatidae) and waders (Charadriiformes) that are features of UK SPAs (**Table 2**). Migratory seabirds refer to species of tern (Sternidae), petrel (Procellariidae), skua (Stercorariidae), and little gull *Hydrocoloeus minutus* (**Table 3**). In addition, a small number of terrestrial birds known to migrate across waters (making them potentially at risk of collision with wind turbines) are also included, such as hen harrier *Circus cyaneus* and short-eared owl *Asio flammeus*; these are considered alongside migratory waterbirds for the purposes of this appendix (**Table 2**). This appendix provides numbers of predicted collisions for migratory waterbird, seabird, and terrestrial bird species based on the species/populations identified that could potentially cross the Offshore Project's Turbine Area. The results of collision risk modelling for regularly occurring seabirds are provided in **Appendix 14.3, Volume 2c**.

1.2.1.6 This appendix is set out with the following sections:

- Section 2 explains the full methodology used for mCRM for both migratory waterbirds and migratory seabirds;
  - Migratory waterbirds;
  - Section 2.2: Migratory seabirds;
- SResults;
  - SMigratory waterbirds;
  - SMigratory seabirds;
- SReferences;
- AAnnex 14.4.1 – Species-specific inputs for migratory waterbirds.

# 2 METHODOLOGY

## 2.1 MIGRATORY WATERBIRDS

### 2.1.1 OVERVIEW

2.1.1.1 The modelling for migratory waterbirds undertaken for this report used the stochastic mCRM shiny app developed by HiDef Aerial Surveying for Marine Scotland Science (HiDef, 2022). This approach to modelling was agreed with NatureScot in pre-application consultation (NatureScot "Answers to further post-scoping questions", by email dated 8 May 2025).

2.1.1.2 The mCRM Shiny application is a stochastic adaptation of the Band (2012) migration collision risk worksheet. The underlying functionality of the model is driven by the stochLAB package (Caneco *et al.*, 2022). The stochLAB package is a stochastic implementation of the collision risk modelling approach developed by Band (2012). The mCRM was accessed via the 'Shiny App' interface, which is a user-friendly graphical interface accessible via a standard web-browser or within R statistical software (v. 4.4.2, R Core Team, 2024) that uses an R code to estimate migratory collision risk.

2.1.1.3 The mCRM tool provides 2 functions:

- Creates population estimates in offshore wind farms by sampling migratory pathways via straight lines drawn between the UK and non-UK destination countries;
- Runs a stochastic version of the migratory collision risk model based on the population estimates and use-input parameters.

### 2.1.2 TURBINE AND TURBINE AREA PARAMETERS

2.1.2.1 A GIS shapefile of the Turbine Area was added to the mCRM Shiny application. The Turbine Area and turbine parameters used in the mCRM are presented in **Table 1**. The parameters presented within **Table 1** are taken from **Chapter 3, Volume 1a** and use the 'smaller turbine type'. The smaller turbine type results in the largest predicted impact on migratory birds. Further details on the Offshore Project design are given **Chapter 3, Volume 1a** but only the parameters given in **Table 1** are relevant for the CRM carried out for this appendix (NB: **Table 1** includes some parameters that are required for the Band (2012) CRM used for migratory seabirds as discussed in Section 2.2 which are not required for the HiDef (2022) mCRM Shiny App). Some of the parameters presented in **Table 1** are not presented within **Chapter 3, Volume 1a** but are a requirement of the mCRM and therefore provided here.

Table 1: Turbine Area details and turbine parameters required for mCRM or Band (2012) CRM

| **Parameter used in the mCRM** | **Parameter value** | |
|---|---|---|
| **Wind farm** | | |
| Latitude | 58.42 | |
| Maximum number of wind turbines | 60 | |
| Tidal offset (m) | 2.27 | |
| Wind farm width (E-W) (km) | 21.3 | |
| Operational downtime (all months) | 2% | |
| Wind availability (%) | January | 98.4 |
| | February | 98.1 |
| | March | 97.4 |
| | April | 94.4 |
| | May | 93.2 |
| | June | 92.6 |
| | July | 89.9 |
| | August | 92.2 |
| | September | 94.5 |
| | October | 97.8 |
| | November | 98.3 |
| | December | 96.8 |
| **Turbine** | | |
| Number of rotor blades per wind turbine | 3 | |
| Chord width (m) | 5.3 | |
| Average blade pitch (degrees) | 4.8 (± 6.2) | |
| Rotor radius (m) | 118 | |
| Average rotation speed (rpm) | 8.4 (±1.98) | |
| Upper blade tip height (above Mean Sea Level (MSL)) | 293.8 m | |

| Parameter used in the mCRM | Parameter value |
|---|---|
| Air gap (Highest Astronomical Tide (HAT)) (m) | 27.73 |
| Air gap (Mean Sea Level (MSL)) (m) | 30 |

### 2.1.3 IDENTIFICATION OF MIGRATORY WATERBIRD SPECIES

2.1.3.1 The identification of migratory waterbird species (and terrestrial bird species known to migrate across waters) for which collision risk modelling was required utilised the migratory polygons associated with the mCRM. Where the species' migratory polygon overlaps with the Turbine Area, then collision risk modelling has been undertaken for that species. The species included in **Table 2** are those taken forward for mCRM.

Table 2: Migratory waterbird species included in collision risk modelling

| Species | Scientific name | Biogeographic population used in mCRM model | Biogeographic subpopulations |
|---|---|---|---|
| **Accipitridae** | | | |
| Hen Harrier | *Circus cyaneus* | 108,800 | N/A |
| Honey Buzzard | *Pernis apivorus* | 342,000 | N/A |
| Marsh Harrier | *Circus aeruginosus* | 368,000 | N/A |
| Montagu's Harrier | *Circus pygargus* | 184,000 | N/A |
| White-tailed Eagle | *Haliaeetus albicilla* | 12,300 | N/A |
| **Anatidae** | | | |
| Icelandic Greylag Goose | *Anser anser* | 76,000 | N/A |
| Long-tailed Duck | *Clangula hyemalis* | 1,600,000 | N/A |
| Mallard | *Anas platyrhynchos* | 7,100,000 | N/A |
| Pink-footed Goose | *Anser brachyrhynchus* | 510,000 | N/A |
| Pintail | *Anas acuta* | 74,000 | N/A |
| Pochard | *Aythya ferina* | 150,000 | N/A |
| Red-breasted Merganser | *Mergus serrator* | 160,000 | N/A |
| Scaup | *Aythya marila* | 280,000 | N/A |
| Shelduck | *Tadorna tadorna* | 310,000 | N/A |
| Shoveler | *Spatula clypeata* | 80,000 | N/A |
| Svalbard Barnacle Goose | *Branta leucopsis* | 43,500 | N/A |
| Svalbard Light-Bellied Brent Goose | *Branta bernicla* | 13,400 | N/A |
| Teal | *Anas crecca* | 670,000 | N/A |

| Species | Scientific name | Biogeographic population used in mCRM model | Biogeographic subpopulations |
|---|---|---|---|
| Tufted Duck | *Aythya fuligula* | 1,000,000 | N/A |
| Velvet Scoter | *Melanitta fusca* | 315,000 | N/A |
| Whooper Swan | *Cygnus cygnus* | 43,000 | N/A |
| Wigeon | *Mareca penelope* | 1,600,000 | N/A |
| **Ardeidae** | | | |
| Bittern | *Botaurus stellaris* | 8,200 | NA |
| **Burhinidae** | | | |
| Stone Curlew | *Burhinus oedicnemus* | 176,000 | N/A |
| **Caprimulgidae** | | | |
| Nightjar | *Caprimulgus europaeus* | 1,100,000 | N/A |
| **Charadriidae** | | | |
| Dotterel | *Charadrius morinellus* | 65,000 | N/A |
| Golden Plover (wintering) | *Pluvialis apricaria altifrons* | 3,640,000 | 3,470,000 |
| Golden Plover (breeding) | *Pluvialis apricaria apricaria* | | 170,000 |
| Grey Plover | *Pluvialis squatarola* | 200,000 | N/A |
| Lapwing | *Vanellus vanellus* | 9,500,000 | N/A |
| Ringed Plover (breeding) | *Charadrius hiaticula hiaticula* | 308,000 | 68,000 |
| Ringed Plover (passage) | *Charadrius hiaticula tundrae* | | 240,000 |
| **Falconidae** | | | |
| Merlin | *Falco columbarius* | 103,200 | N/A |
| **Gaviidae** | | | |
| Black-throated Diver (wintering) | *Gavia arctica* | 765,600 | 590,000 |
| Black-throated Diver (breeding) | | | 175,600 |
| Great Northern Diver | *Gavia immer* | 11,000 | N/A |
| Red-throated Diver (wintering) | *Gavia stellata* | 526,000 | 340,000 |
| Red-throated Diver (breeding) | | | 186,000 |
| **Haematopodidae** | | | |

| Species | Scientific name | Biogeographic population used in mCRM model | Biogeographic subpopulations |
|---|---|---|---|
| Oystercatcher (breeding) | *Haematopus ostralegus* | 1,813,512 | 843,512 |
| Oystercatcher (wintering) | | | 970,000 |
| **Pandionidae** | | | |
| Osprey | *Pandion haliaetus* | 24,600 | N/A |
| **Podicipedidae** | | | |
| Great Crested Grebe | *Podiceps cristatus* | 690,000 | N/A |
| Slavonian Grebe (breeding) | *Podiceps auritus* | 41,600 | 5,300 |
| Slavonian Grebe (wintering) | | | 36,300 |
| **Rallidae** | | | |
| Corncrake | *Crex crex* | 2,120,000 | N/A |
| Spotted Crake | *Porzana porzana* | 251,000 | N/A |
| **Recurvirostridae** | | | |
| Avocet | *Recurvirostra avosetta* | 110,000 | N/A |
| **Scolopacidae** | | | |
| Bar-tailed Godwit (wintering) | *Limosa lapponica lapponica* | 680,000 | 180,000 |
| Bar-tailed Godwit (passage) | *Limosa lapponica taymyrensis* | | 500,000 |
| Curlew | *Numenius arquata* | 830,000 | N/A |
| Dunlin (*schinzii*, wintering) | *Calidris alpina schinzii* | 2,308,000 | 32,000 |
| Dunlin (*schinzii*, passage) | | | 830,000 |
| Dunlin (*arctica*, passage) | *Calidris alpina arctica* | | 46,000 |
| Dunlin (*alpina*, wintering) | *Calidris alpina alpina* | | 1,400,000 |
| Greenshank | *Tringa nebularia* | 360,000 | N/A |
| Knot | *Calidris canutus* | 360,000 | N/A |
| Purple Sandpiper (N Europe) | *Calidris maritima* | 122,000 | 110,000 |
| Purple Sandpiper (Canada) | | | 12,000 |

| Species | Scientific name | Biogeographic population used in mCRM model | Biogeographic subpopulations |
|---|---|---|---|
| Red-necked Phalarope | *Phalaropus lobatus* | 3,200,000 | N/A |
| Redshank | *Tringa totanus* | 420,000 | N/A |
| Ruff | *Calidris pugnax* | 6,200,000 | N/A |
| Sanderling | *Calidris alba* | 200,000 | N/A |
| Snipe (*faeroeensis*) | *Gallinago gallinago faeroeensis* | 21,100,000 | 11,100,000 |
| Snipe (*gallinago*) | *Gallinago gallinago gallinago* | | 10,000,000 |
| Turnstone | *Arenaria interpres* | 260,000 | N/A |
| Whimbrel | *Numenius phaeopus* | 780,000 | N/A |
| Wood Sandpiper | *Tringa glareola* | 1,800,000 | N/A |
| **Strigidae** | | | |
| Short-eared Owl | *Asio flammeus* | 372,000 | N/A |

### 2.1.4 SPECIES PARAMETERS

2.1.4.1 The mCRM tool includes pre-populated inputs for all species identified in **Table 2** using data that the User Guide indicates were supplied by the British Trust for Ornithology (HiDef, 2022). This includes:

- Migratory pathways;
- Biogeographic population size;
- Proportion of biogeographic population migrating through UK waters;
- Flight style (flapping/gliding);
- Wingspan;
- Flight speed;
- Avoidance rate;
- Proportion at Potential Collision Height (PCH);
- Timing of migratory periods.

2.1.4.2 Following review of the pre-populated parameters, it was identified that a number of the pre-populated values included in the mCRM do not match the values presented in Woodward *et al.* (2023). NatureScot has advised that migratory CRM should follow Woodward *et al.* (2023) for the species included in that study (NatureScot advice on the EIA Scoping Report; by email only, dated 18 December 2023 and 17 June 2025). These values were therefore updated to align with Woodward *et al.* (2023). Values used within the mCRM are presented in **Annex 14.4.1, Volume 2c**. Where Woodward *et al.* (2023) presents a range of values, the most precautionary option was chosen (e.g. the upper end of the population range, or the greatest proportion of the population using UK waters).

2.1.4.3 Where Woodward *et al.* (2023) defines distinct sub-populations, all sub-populations are considered. However, the current implementation of the mCRM Shiny app does not allow custom shapefiles for migratory routes, and only provides a single shapefile per species; i.e. it does not allow different migratory routes to be applied separately to each sub-population. Therefore, the biogeographic population used in the mCRM model is calculated as the sum of all sub-populations for a given species (**Table 2**).

### 2.1.5 OPERATIONAL CONDITIONS FOR THE MCRM TOOL

2.1.5.1 The boundary of the Turbine Area was uploaded as a shapefile. The model was run with the large array correction applied and 5,000 iterations.

## 2.2 MIGRATORY SEABIRDS

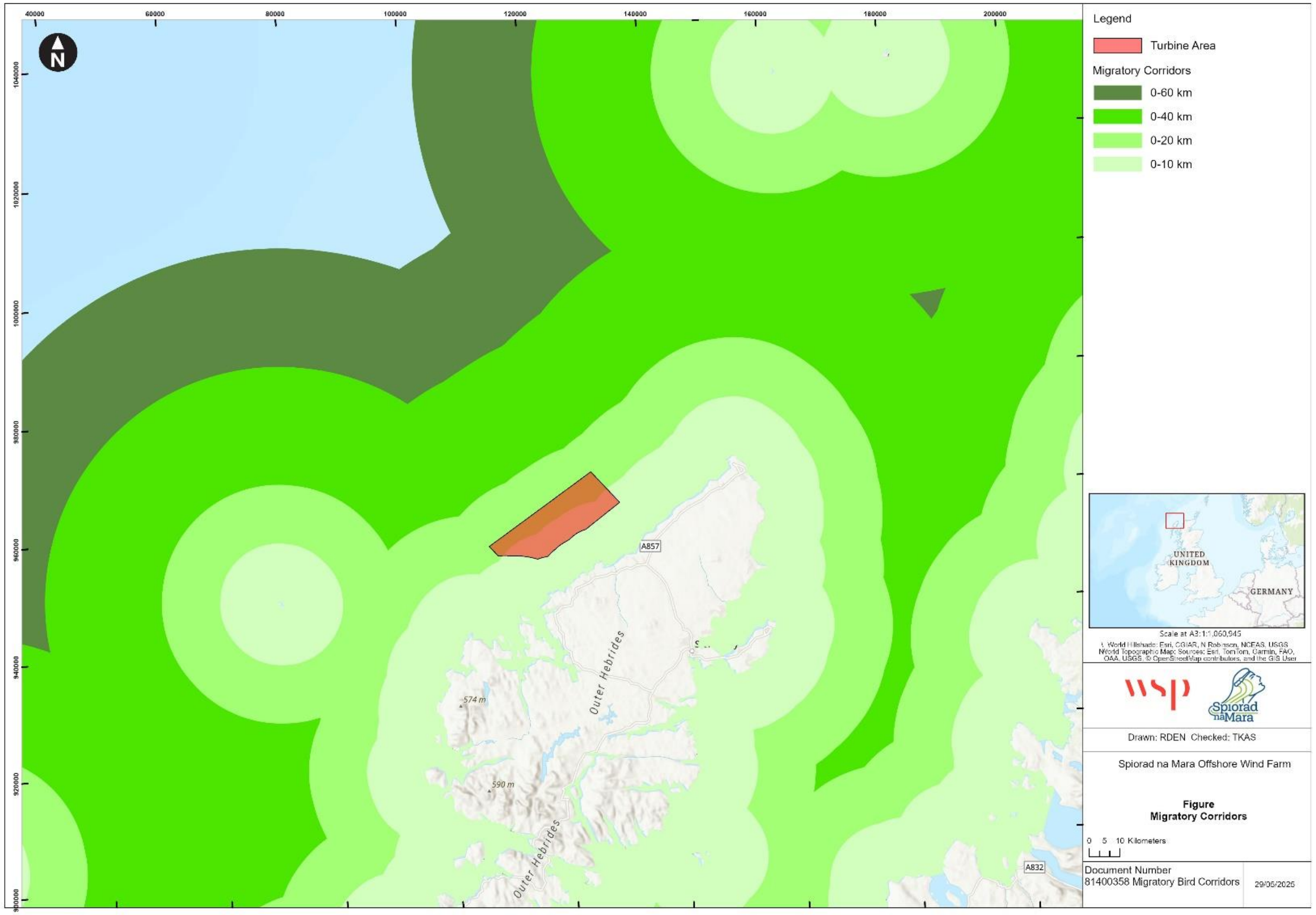
2.2.1.1 Seabird species are considered within mCRM primarily due to their extensive use of offshore areas during migration, breeding, and foraging. The Scottish Government's strategic assessment (Wildfowl and Wetlands Trust (WWT) Consulting and MacArthur Green, 2014) highlights that many of the proposed offshore wind development areas overlap with key migratory routes and habitats used by seabirds. These birds are at risk of colliding with turbine blades, particularly during migration when they may be flying at altitudes that intersect with rotor-swept zones (WWT Consulting and MacArthur Green, 2014).

### 2.2.2 IDENTIFICATION OF MIGRATORY SEABIRD SPECIES

2.2.2.1 The identification of migratory seabird species for which collision risk modelling is required has utilised the migratory corridors defined in WWT Consulting and MacArthur Green (2014) (**Plate 2-1**). These corridors reflect that seabird species migrate at different distances from the UK coast, and can thus be assigned to 1 of 4 defined migration bands relevant to the species of interest in this report:

- 0-10 km offshore;
- 0-20 km offshore;
- 0-40 km offshore;
- 0-60 km offshore.

Plate 2-1: Migratory seabirds migratory corridors (migratory distance bands from the coastline)



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2.2.2.2 Several seabird species have been scoped out from further analysis because their numbers migrating through Scottish waters represent less than 1% of the relevant population, and so impacts of offshore wind farm collision mortality would be negligible at the population level. Based on data compiled in Forrester *et al*. (2007), this applied to: yellow-billed diver *Gavia adamsii*, Sabine's gull *Xema sabini,* Mediterranean gull *Ichthyaetus melanocephalus*, Iceland gull *Larus glaucoides*, glaucous gull *Larus hyperboreus*, black tern *Chlidonias niger*, and little auk *Alle alle*. Due to the fact that there are also no roseate tern *Sterna dougallii* breeding colonies in the vicinity of the Offshore Project or to the north and therefore no migratory connectivity, roseate tern was also excluded.

2.2.2.3 Several seabird species have also been scoped out from further analysis because they fly only at heights below collision risk height, so will be at no risk of collision with offshore wind turbine blades. Based on data in Furness *et al*. (2013), this applied to Manx shearwater *Puffinus puffinus*, Cory's shearwater *Calonectris borealis*, great shearwater *Ardenna gravis*, and sooty shearwater *Ardenna grisea.* This left a total of 25 seabird species where analysis of collision risk for migrating populations were initially considered within the Spiorad na Mara assessment (**Table 3**).

**Table 3: Identification of migratory seabird species based on WWT Consulting, MacArthur Green (2014) Forrester *et al*. (2007) and Furness *et al*. (2013)**

| Species | Scientific name | Width of migratory corridor out from shore (km) | Overlap with Turbine Area (Yes/No) |
|---|---|---|---|
| Black-legged Kittiwake | *Rissa tridactyla* | 0-60 | Yes |
| Black-headed Gull | *Chroicocephalus ridibundus* | 0-60 | Yes |
| Little Gull | *Hydrocoloeus minutus* | 0-20 | Yes |
| Common Gull | *Larus canus* | 0-20 | Yes |
| Herring Gull | *Larus argentatus* | 0-20 | Yes |
| Lesser Black-backed Gull | *Larus fuscus* | 0-60 | Yes |
| Great Black-backed Gull | *Larus marinus* | 0-20 | Yes |
| Sandwich Tern | *Thalasseus sandvicensis* | 0-10 | Yes |
| Little Tern | *Sternula albifrons* | 0-10 | Yes |
| Common Tern | *Sterna hirundo* | 0-10 | Yes |
| Arctic Tern | *Sterna paradisaea* | 0-10 | Yes |
| Great Skua | *Stercorarius skua* | 0-40 | Yes |
| Pomarine Skua | *Stercorarius pomarinus* | 0-40 | Yes |
| Arctic Skua | *Stercorarius parasiticus* | 0-20 | Yes |
| Long-tailed Skua | *Stercorarius longicaudus* | 0-60 | Yes |
| Guillemot | *Uria aalge* | 0-20 | Yes |
| Razorbill | *Alca torda* | 0-20 | Yes |
| Puffin | *Fratercula arctica* | 0-60 | Yes |

| Species | Scientific name | Width of migratory corridor out from shore (km) | Overlap with Turbine Area (Yes/No) |
|---|---|---|---|
| Great Northern Diver | *Gavia immer* | 0-40 | Yes |
| European Storm Petrel | *Hydrobates pelagicus* | 0-60 | Yes |
| Leach's Petrel | *Hydrobates leucorhous* | 0-60 | Yes |
| Fulmar | *Fulmarus glacialis* | 0-60 | Yes |
| Gannet | *Morus bassanus* | 0-40 | Yes |
| Cormorant | *Phalacrocorax carbo* | 0-10 | Yes |
| Shag | *Gulosus aristotelis* | 0-10 | Yes |

2.2.2.4 For black-headed gull, black-legged kittiwake, common gull, fulmar, gannet, great black-backed gull, herring gull, and lesser black-backed gull, it is considered that these species are adequately captured through DAS and are therefore assessed within **Appendix 14.3, Volume 2c.** As such, these species have been excluded from the mCRM presented in this appendix, to avoid duplication.

2.2.2.5 For puffin, guillemot, razorbill, and cormorant, mCRM was not undertaken due to their low or very low vulnerability scores to collision impacts (Bradbury *et al.,* 2014), as detailed in **Appendix 14.3, Volume 2c.**

2.2.2.6 Shags were excluded from further consideration in mCRM due to their predominantly low flight heights and surface-based behaviours. Shags are coastal, benthic foragers that typically fly low over the water and dive frequently, further reducing their exposure to turbine collision risk. Tracking studies from the Isle of May/*Eilean Mhàigh* recorded over 1,100 foraging trips by 322 individual shags, confirming their preference for nearshore, low-altitude flight paths (Daunt *et al*., 2015). These behavioural characteristics for shag mean that DAS are effective in capturing their abundance and distribution, allowing for robust spatial assessments without the need for inclusion in migratory collision risk models. As such, this species was not taken forward for mCRM analysis.

2.2.2.7 This resulted in a total of 11 remaining species requiring assessment through mCRM. These species are listed in **Table 4** and are considered further in this appendix.

Table 4 Migratory seabird species included within mCRM for the Turbine Area

| Species | Width of migratory corridor out from shore (km) |
|---|---|
| Little Gull | 0-20 |
| Sandwich Tern | 0-10 |
| Little Tern | 0-10 |
| Common Tern | 0-10 |
| Arctic Tern | 0-10 |
| Great Skua | 0-40 |
| Pomarine Skua | 0-40 |
| Arctic Skua | 0-20 |

| Species | Width of migratory corridor out from shore (km) |
|---|---|
| Long-tailed Skua | 0-60 |
| European Storm Petrel | 0-60 |
| Leach's Petrel | 0-60 |

### 2.2.3 METHODOLOGY

2.2.3.1 Unlike the collision risk modelling approach applied for regularly occurring seabird species, density data collected during site-specific surveys is deemed to be unsuitable to estimate the impact of collision for the migratory seabird species assessed in this report. This is due to the 'snapshot' nature of site-specific surveys and the consequential limitations for recording sporadic movements of migratory species.

2.2.3.2 Therefore, the collision risk modelling approach used for migratory seabirds incorporates species-specific information relating to population estimates and migratory behaviour (WWT Consulting and MacArthur Green, 2014). A generic 'migratory front' is defined, which is used to calculate the number of birds that have the potential to interact with the Turbine Area during spring and autumn migration.

2.2.3.3 In order to identify the interacting population for use in collision risk modelling, the following stages are applied:

- Define relevant seasonal Biologically Defined Minimum Population Scales (BDMPS) populations for each species considered;
- Define a migratory front that incorporates the longest width of the Turbine Area across which migration will occur;
- Calculate the proportion of the migratory front represented by the Turbine Area;
- Calculate interacting populations for each species in each migratory season.

2.2.3.4 The interacting populations are then incorporated into collision risk modelling to provide a collision risk estimate for each species.

2.2.3.5 Collision risk modelling has been undertaken using the Band (2012) CRM which allows for consideration of birds on migration.

### 2.2.4 CALCULATION OF INTERACTING POPULATIONS

2.2.4.1 For all species interacting with the Turbine Area that are mentioned in Furness (2015), the BDMPS population used as part of the modelling process is that defined in Furness (2015) covering the 'UK Western Waters' (**Table 5**). Little gull, European storm petrel, and Leach's petrel were not mentioned in Furness (2015), so the BDMPS populations for these species were taken from WWT Consulting and MacArthur Green (2014), using the 'passage population' (**Table 5**).

2.2.4.2 The proportion of this population that may interact with the Turbine Area is calculated based on the proportion of the migratory front intersected by the Turbine Area. The migratory front represents a hypothetical line across which the entire BDMPS population will cross, incorporating the greatest width of the Turbine Area. It is assumed that birds are equally distributed across this front.

2.2.4.3 The populations of migratory seabird species considered to have potential to interact with the Turbine Area are calculated using the following formula:

*Interacting population = (width of development area/width of migration route) * species populations*

2.2.4.4 For species where the width of migratory corridor out from shore is >10 km (**Table 3**), the width of the development area is 7.5 km, which is the width of the Turbine Area as measured perpendicular from the shore. For species where the width of migratory corridor out from shore is 0-10 km (**Table 3**), the width of the development area is for the purpose of the formula above is specified as 4 km, as the rest of the development area does not overlap with the 0-10 km migratory corridor.

2.2.4.5 This proportion is applied to the BDMPS populations in **Table 5**.

**Table 5: Migratory seabird BDMPS populations and the proportion of these populations predicted to have potential to interact with the Turbine Area**

| Species | Season | BDMPS/passage population | Interacting population |
|---|---|---|---|
| Little Gull | Autumn | 3,000 | 1,125.00 |
| | Spring | 400 | 150.00 |
| Sandwich Tern | Autumn | 10,761 | 4,304.40 |
| | Spring | 10,761 | 4,304.40 |
| Little Tern | Autumn | 1,602 | 640.80 |
| | Spring | 1,602 | 640.80 |
| Common Tern | Autumn | 64,659 | 25,863.60 |
| | Spring | 64,659 | 25,863.60 |
| Arctic Tern | Autumn | 71,398 | 28,559.20 |
| | Spring | 71,398 | 28,559.20 |
| Great Skua | Autumn | 16,336 | 3,063.00 |
| | Spring | 25,090 | 4,704.38 |
| Pomarine Skua | Autumn | 2,000 | 375.00 |
| | Spring | 3,000 | 562.50 |
| Arctic Skua | Autumn | 5,287 | 1,982.63 |
| | Spring | 5,111 | 1,916.63 |
| Long-tailed Skua | Autumn | 1,000 | 125.00 |
| | Spring | 1,000 | 125.00 |
| European Storm Petrel | Autumn | 200,000 | 25,000.00 |
| | Spring | 100,000 | 12,500.00 |
| Leach's Petrel | Autumn | 500,000 | 62,500.00 |

| Species | Season | BDMPS/passage population | Interacting population |
|---|---|---|---|
| | Spring | 200,000 | 25,000.00 |

### 2.2.5 PEAK MIGRATORY MOVEMENTS

2.2.5.1 To populate a collision risk model, single months are selected to represent autumn movements and spring movements respectively. For all species, September was chosen a typical month to represent autumn movements and April was chosen as a typical month to represent spring movements. In the Band (2012) CRM, these months are populated with the interacting populations from **Table 5**.

### 2.2.6 COLLISION RISK MODELLING

2.2.6.1 To quantify collision risk, collision risk modelling has been undertaken using the Band (2012) CRM. Band (2012) uses information derived from population estimation, bird behaviour, biological parameters, and project specific turbine information to calculate monthly collision risk values.

2.2.6.2 The wind farm and turbine parameters used for migratory seabird collision risk modelling are the same as those used for migratory waterbirds (see **Table 1**). The width of the migratory corridor is set to 7.5 km where the width of the migratory corridor out from shore is >10 km, or 4 km if the width of the migratory corridor out from shore is <10 km (see paragraph 2.2.4.4).

2.2.6.3 The species-specific parameters used in the Band (2012) CRM for migratory seabirds are presented in **Table 2-6**. The biometrics for all species (body length and wingspan) were taken from Robinson (2005) or WWT Consulting and MacArthur Green (2014). The percentage at collision risk height (PCH) was taken from Johnston *et al*. (2014) for Arctic skua, Arctic tern, common tern, great skua, little gull, and Sandwich tern, as these were the only migratory seabird species available in that source. For all other species listed in **Table 6**, PCH was taken from WWT Consulting and MacArthur Green (2014). These PCH values were calculated based on a 20 m airgap at mean sea level (MSL), and therefore represent a precautionary overestimate, as the Offshore Project has a higher airgap of 30 m at MSL. Flight speed values were sourced from Alerstam (2007), Hedenström and Åkesson (2016), WWT Consulting and MacArthur Green (2014), or Pennycuick (1987), depending on the species.

Table 6: Species input parameters used in collision risk modelling for migratory seabirds

| Species | Bird length | Wingspan | Flight types | Upwind % | PCH | PCH reference | Bird speed | Bird speed reference |
|---|---|---|---|---|---|---|---|---|
| Little Gull | 0.26 | 0.78 | Flapping | 50 | 7.7 | Johnston *et al.* (2014) | 11.59 | WWT Consulting and MacArthur Green 2014 |
| Sandwich Tern | 0.38 | 1.05 | Flapping | 50 | 2.7 | Johnston *et al.* (2014) | 12.6 | Hedenström and Akesson 2016 |
| Little Tern | 0.23 | 0.52 | Flapping | 50 | 5 | WWT Consulting and MacArthur Green 2014 | 9.8 | Hedenström and Akesson 2016 |
| Common Tern | 0.33 | 0.88 | Flapping | 50 | 2.9 | Johnston *et al.* (2014) | 10.8 | Hedenström and Akesson 2016 |
| Arctic Tern | 0.34 | 0.80 | Flapping | 50 | 1.3 | Johnston et *al.* (2014) | 10.9 | Alerstam 2007 |
| Great Skua | 0.56 | 1.36 | Flapping | 50 | 2.2 | Johnston *et al.* (2014) | 14.9 | Pennycuick 1987 |
| Pomarine Skua | 0.51 | 1.38 | Flapping | 50 | 5 | WWT Consulting and MacArthur Green 2014 | 15.2 | WWT Consulting and MacArthur Green 2014 |
| Arctic Skua | 0.44 | 1.18 | Flapping | 50 | 0.7 | Johnston *et al.* (2014) | 13.8 | Alerstam 2007 |
| Long-tailed Skua | 0.53 | 1.17 | Flapping | 50 | 5 | WWT Consulting and MacArthur Green 2014 | 13.6 | WWT Consulting and MacArthur Green 2014 |
| European Storm Petrel | 0.16 | 0.38 | Flapping | 50 | 1 | WWT Consulting and MacArthur Green 2014 | 12.0 | WWT Consulting and MacArthur Green 2014 |
| Leach's Petrel | 0.22 | 0.46 | Flapping | 50 | 1 | WWT Consulting and MacArthur Green 2014 | 12.0 | WWT Consulting and MacArthur Green 2014 |

2.2.6.4 In addition, flight height data from Johnston *et al.* (2014) has been used to inform Option 2 of the Band (2012) CRM for Arctic skua, Arctic tern, common tern, great skua, little gull, and Sandwich tern. Option 1 utilises PCH information which has been obtained from the relevant source, as indicated within **Table 6**. Option 3 and Option 4 were not run, because Statutory Nature Conservation Bodies (SNCBs) no longer advocate for the extended model (JNCC *et al.*, 2024).

### 2.2.7 AVOIDANCE RATES

2.2.7.1 Species-specific avoidance rates are not available for the migratory seabird species considered. For skuas, little gull and terns, the avoidance rates recommended in JNCC *et al.* (2024) have been applied. For tern species and great skua, an avoidance rate of 99.02% has been applied, which is the "all gulls and terns" rate from Oszanlav-Harris *et al*. (2023), as recommended in current SNCB guidance (JNCC *et al*., 2024). The "all gull" rate from Oszanlav-Harris *et al*. (2023) of 99.23% has been used for little gull, Arctic skua, long-tailed skua, and pomarine skua, reflecting JNCC *et al.* (2024) guidance that this rate is appropriate for these species.

2.2.7.2 For the remaining species, JNCC *et al.* (2024) does not make a specific recommendation. The Marine Scotland strategic report on collision risk for migrating birds (WWT Consulting and MacArthur Green, 2014) recommends a 98% avoidance rate as a suitable default for all species assessed.

2.2.7.3 In addition, to account for uncertainty, alongside these recommended rates, collision risk estimates have also been calculated using a range of avoidance rates: no avoidance, 95%, 98%, and 99.5%.

# 3 RESULTS

## 3.1 MIGRATORY WATERBIRDS

3.1.1.1 The results of the mCRM tool are provided in **Table 7**. Species for which the annual collision estimate exceeds one bird are shown in bold. Species for which the annual collision estimate is zero are shown in italics.

3.1.1.2 For all species, it was assumed that there were 2 migration periods per year (i.e. spring and autumn) through the area (spring falls within the pre-breeding months set out in **Annex 14.4.1, Volume 2c**, and autumn falls within the post-breeding months set out in **Annex 14.4.1, Volume 2c**). Avoidance rates and populations utilised within modelling were obtained from Woodward *et al.* (2023).

3.1.1.3 Of the 69 migratory waterbird species considered, the majority had zero or negligible collision estimates. Only 1 species, wigeon, had an expected annual collision total exceeding one bird per year.

Table 7: Results of mCRM

| **Species** | **Population using UK Waters** | **Avoidance rate** | **Population passing through Turbine Area per migration (mean ± SD)** | **Annual collision estimate (mean ± SD)** |
|---|---|---|---|---|
| **Accipitridae** | | | | |
| Hen Harrier | 2,176 | 0.9957 ± 0.00006 | 0 ± 0 | 0 ± 0 |
| Honey Buzzard | 137 | 0.9957 ± 0.00006 | 0 ± 0 | 0 ± 0 |
| Marsh Harrier | 2,576 | 0.9957 ± 0.00006 | 0 ± 0 | 0 ± 0 |
| Montagu’s Harrier | 19 | 0.9957 ± 0.00006 | 0 ± 0 | 0 ± 0 |
| White-tailed Eagle | 148 | 0.9872 ± 0.00192 | 0 ± 0 | 0 ± 0 |
| **Anatidae** | | | | |
| Bean Goose | 97,000 | 0.9998 ± 0.00001 | 0 ± 0 | 0 ± 0 |
| Bewick’s Swan | 4,382 | 0.9885 ± 0.00091 | 0 ± 0 | 0 ± 0 |
| Canadian Light-Bellied Brent Goose | 40,000 | 0.9998 ± 0.00001 | 414 ± 89 | 0.002 ± 0 |
| Common Scoter | 135,180 | 0.9851 ± 0.00088 | 1,182 ± 307 | 0.661 ± 0.13 |
| Dark-bellied Brent Goose | 99,170 | 0.9998 ± 0.00001 | 0 ± 0 | 0 ± 0 |
| Eider | 133,400 | 0.9851 ± 0.00088 | 0 ± 0 | 0 ± 0 |
| European White-fronted Goose | 12,000 | 0.9998 ± 0.00001 | 0 ± 0 | 0 ± 0 |
| Gadwall | 30,940 | 0.9851 ± 0.00088 | 0 ± 0 | 0 ± 0 |
| Goldeneye | 30,000 | 0.9851 ± 0.00088 | 0 ± 0 | 0 ± 0 |

| Species | Population using UK Waters | Avoidance rate | Population passing through Turbine Area per migration (mean ± SD) | Annual collision estimate (mean ± SD) |
|---|---|---|---|---|
| Goosander | 17,420 | 0.9851 ± 0.00088 | 0 ± 0 | 0 ± 0 |
| Greenland Barnacle Goose | 81,000 | 0.9998 ± 0.00001 | 3,025 ± 376 | 0.027 ± 0.003 |
| Greenland White-fronted Goose | 21,500 | 0.9998 ± 0.00001 | 570 ± 82 | 0.006 ± 0.004 |
| Icelandic Greylag Goose | 68,400 | 0.9998 ± 0.00001 | 2,823 ± 297 | 0.02 ± 0.011 |
| Long-tailed Duck | 12,800 | 0.9851 ± 0.00088 | 0 ± 0 | 0 ± 0 |
| Mallard | 823,600 | 0.9851 ± 0.00088 | 0 ± 0 | 0 ± 0 |
| Pink-footed Goose | 510,000 | 0.9999 ± 0.0002 | 30,414 ± 2,830 | 0.068 ± 0.099 |
| Pintail | 20,942 | 0.9851 ± 0.00088 | 157 ± 46 | 0.093 ± 0.02 |
| Pochard | 28,500 | 0.9851 ± 0.00088 | 0 ± 0 | 0 ± 0 |
| Red-breasted Merganser | 15,840 | 0.9851 ± 0.00088 | 165 ± 38 | 0.094 ± 0.017 |
| Scaup | 7,000 | 0.9851 ± 0.00088 | 74 ± 19 | 0.042 ± 0.008 |
| Shelduck | 77,500 | 0.9851 ± 0.00088 | 650 ± 145 | 0.319 ± 0.053 |
| Shoveler | 22,960 | 0.9851 ± 0.00088 | 0 ± 0 | 0 ± 0 |
| Svalbard Barnacle Goose | 43,500 | 0.999 ± 0.0001 | 0 ± 0 | 0 ± 0 |
| Svalbard Light-bellied Brent Goose | 13,400 | 0.999 ± 0.0001 | 0 ± 0 | 0 ± 0 |
| Teal | 435,500 | 0.9851 ± 0.00088 | 0 ± 0 | 0 ± 0 |
| Tufted Duck | 155,000 | 0.9851 ± 0.00088 | 1,381 ± 314 | 0.757 ± 0.13 |
| Velvet Scoter | 3,465 | 0.9851 ± 0.00088 | 0 ± 0 | 0 ± 0 |
| Whooper Swan | 39,990 | 0.9874 ± 0.00138 | 470 ± 89 | 0.206 ± 0.049 |
| **Wigeon** | **544,000** | **0.9851 ± 0.00088** | **4,929 ± 1,210** | **2.901 ± 0.542** |
| **Ardeidae** | | | | |
| Bittern | 714 | 0.9928 ± 0.00092 | 0 ± 0 | 0 ± 0 |
| **Burhinidae** | | | | |
| Stone Curlew | 880 | 0.9996 ± 0.00002 | 0 ± 0 | 0 ± 0 |
| **Caprimulgidae** | | | | |
| Nightjar | 7,700 | 0.9954 ± 0.00002 | 0 ± 0 | 0 ± 0 |
| **Charadriidae** | | | | |
| Dotterel | 390 | 0.9996 ± 0.00002 | 0 ± 0 | 0 ± 0 |
| Golden Plover | 3,429,100 | 0.9996 ± 0.00002 | 20,095 ± 5,601 | 0.289 ± 0.057 |
| Grey Plover | 124,000 | 0.9996 ± 0.00002 | 0 ± 0 | 0 ± 0 |
| Lapwing | 3,942,500 | 0.9996 ± 0.00002 | 0 ± 0 | 0 ± 0 |
| Ringed Plover | 241,920 | 0.9996 ± 0.00002 | 2,556 ± 591 | 0.034 ± 0.006 |
| **Falconidae** | | | | |
| Merlin | 8,256 | 0.9891 ± 0.00033 | 82 ± 19 | 0.04 ± 0.03 |

| Species | Population using UK Waters | Avoidance rate | Population passing through Turbine Area per migration (mean ± SD) | Annual collision estimate (mean ± SD) |
|---|---|---|---|---|
| **Gaviidae** | | | | |
| Black-throated Diver | 1,882 | 0.9954 ± 0.00002 | 0 ± 0 | 0 ± 0 |
| Great Northern Diver | 11,000 | 0.9954 ± 0.00002 | 133 ± 29 | 0.008 ± 0.001 |
| Red-throated Diver | 40,696 | 0.9954 ± 0.00002 | 455 ± 102 | 0.022 ± 0.004 |
| **Haematopodidae** | | | | |
| Oystercatcher | 620,389 | 0.9996 ± 0.00002 | 6,534 ± 1,414 | 0.112 ± 0.019 |
| **Pandionidae** | | | | |
| Osprey | 665 | 0.9957 ± 0.00006 | 0 ± 0 | 0 ± 0 |
| **Podicipedidae** | | | | |
| Great Crested Grebe | 1,380 | 0.9954 ± 0.00002 | 0 ± 0 | 0 ± 0 |
| Slavonian Grebe | 1,614 | 0.9954 ± 0.00002 | 13 ± 3 | 0.002 ± 0 |
| **Rallidae** | | | | |
| Corncrake | 169,600 | 0.9875 ± 0.00174 | 0 ± 0 | 0 ± 0 |
| Spotted Crake | 251 | 0.9875 ± 0.00174 | 0 ± 0 | 0 ± 0 |
| **Recurvirostridae** | | | | |
| Avocet | 13,090 | 0.9996 ± 0.00002 | 0 ± 0 | 0 ± 0 |
| **Scolopacidae** | | | | |
| Bar-tailed Godwit | 680,000 | 0.9996 ± 0.00002 | 0 ± 0 | 0 ± 0 |
| Black-tailed Godwit | 303,000 | 0.9996 ± 0.00002 | 0 ± 0 | 0 ± 0 |
| Curlew | 141,100 | 0.9996 ± 0.00002 | 0 ± 0 | 0 ± 0 |
| Dunlin | 2,025,776 | 0.9996 ± 0.00002 | 18,294 ± 4,914 | 0.242 ± 0.046 |
| Greenshank | 7,200 | 0.9996 ± 0.00002 | 0 ± 0 | 0 ± 0 |
| Knot | 360,000 | 0.9996 ± 0.00002 | 3,433 ± 803 | 0.045 ± 0.007 |
| Purple Sandpiper | 33,520 | 0.9996 ± 0.00002 | 402 ± 91 | 0.006 ± 0.001 |
| Red-necked Phalarope | 20 | 0.9996 ± 0.00002 | 2 ± 1 | 0 ± 0 |
| Redshank | 420,000 | 0.9996 ± 0.00002 | 3,411 ± 861 | 0.038 ± 0.006 |
| Ruff | 3,100 | 0.9996 ± 0.00002 | 0 ± 0 | 0 ± 0 |
| Sanderling | 200,000 | 0.9996 ± 0.00002 | 2,138 ± 526 | 0.026 ± 0.004 |
| Snipe | 2,331,000 | 0.9996 ± 0.00002 | 22,297 ± 4,939 | 0.469 ± 0.061 |
| Turnstone | 260,000 | 0.9996 ± 0.00002 | 2,186 ± 559 | 0.035 ± 0.018 |
| Whimbrel | 624,000 | 0.9996 ± 0.00002 | 6,166 ± 1,321 | 0.098 ± 0.016 |
| Wood Sandpiper | 54 | 0.9996 ± 0.00002 | 0 ± 0 | 0 ± 0 |
| **Strigidae** | | | | |
| Short-eared Owl | 14,880 | 0.9957 ± 0.00006 | 6 ± 7 | 0.002 ± 0.001 |

## 3.2 MIGRATORY SEABIRDS

3.2.1.1 **Table 8** presents the collision risk estimates for each migratory seabird species with connectivity to the Turbine Area for a range of avoidance rates. Results highlighted in bold are the assumed migratory collision risk estimate based on SNCB guidance (JNCC *et al.*, 2024).

3.2.1.2 Of the 11 migratory seabird species considered, the majority had negligible collision estimates. Only 2 species, common tern and Arctic tern, had an expected annual collision total exceeding 1 bird per year when following the preferred avoidance rates of the SNCB guidance (JNCC *et al.*, 2024).

Table 8: Collision risk estimates for migratory seabird species

| Species | Model Option | Annual collision risk estimates (Avoidance rate (%)) | | | | | |
|---|---|---|---|---|---|---|---|
| | | No avoidance | 95 | 98 | 99.02 | 99.23 | 99.5 |
| Little Gull | 1 | 4.02 | 0.20 | 0.08 | NA | **0.03** | 0.02 |
| | 2 | 2.94 | 0.15 | 0.06 | | **0.02** | 0.01 |
| Sandwich Tern | 1 | 20.43 | 1.02 | 0.41 | **0.20** | NA | 0.10 |
| | 2 | 13.75 | 0.69 | 0.28 | **0.13** | | 0.07 |
| Little Tern | 1 | 4.63 | 0.23 | 0.09 | **0.05** | NA | 0.02 |
| Common Tern | 1 | 125.71 | 6.29 | 2.51 | **1.23** | NA | 0.63 |
| | 2 | 85.17 | 4.26 | 1.70 | **0.83** | | 0.43 |
| Arctic Tern | 1 | 173.40 | 8.67 | 3.47 | **1.70** | NA | 0.87 |
| | 2 | 47.61 | 2.38 | 0.95 | **0.47** | | 0.24 |
| Arctic Skua | 1 | 1.34 | 0.07 | 0.03 | NA | **0.01** | 0 |
| | 2 | 0.80 | 0.02 | 0.01 | | **0.01** | 0 |
| Great Skua | 1 | 9.15 | 0.46 | 0.18 | **0.09** | | 0.05 |
| | 2 | 5.79 | 0.29 | 0.12 | **0.06** | | 0.03 |
| Pomarine Skua | 1 | 2.43 | 0.12 | 0.05 | NA | **0.02** | 0.01 |
| Long-tailed Skua | 1 | 0.66 | 0.03 | 0.01 | | **0.01** | 0.00 |
| European Storm Petrel | 1 | 12.62 | 0.63 | **0.25** | NA | NA | 0.06 |
| Leach's Petrel | 1 | 33.44 | 1.67 | **0.67** | NA | NA | 0.17 |

# 4 GLOSSARY OF TERMS AND ABBREVIATIONS

4.1.1.1 A list of key terms and acronyms used in this appendix are provided in **Table 9** and **Table 10**.

Table 9 Acronyms and abbreviations

| Term | Definition |
|---|---|
| BDMPS | Biologically Defined Minimum Population Scale |
| CRM | Collision Risk Modelling |
| DAS | Digital Aerial Survey |
| EIAR | Environmental Impact Assessment Report |
| HAT | Highest Astronomical Tide |
| mCRM | Migratory Collision Risk Modelling |
| MHWS | Mean High Water Springs |
| MSL | Mean Sea Level |
| OCAS | Offshore Cable Area of Search |
| OSP | Offshore Substation Platform |
| OWF | Offshore Wind Farm |
| PCH | Potential Collision Height |
| SD | Standard Deviation |
| SNCB | Statutory Nature Conservation Body |
| SPA | Special Protection Area |
| UK | United Kingdom |
| VOR | Valued Ornithological Receptor |
| WTG | Wind Turbine Generators |
| WWT | Wildfowl and Wetlands Trust |

Table 10 Glossary

| Term | Meaning |
|---|---|
| the Applicant | Spiorad na Mara Limited (the Project owner) |
| Array Area | The offshore area within which the offshore wind turbine generators (WTGs), associated foundations, Offshore Cables, and Offshore Substation Platform (OSP) (if required), will be located. This area encompasses the Turbine Area that will contain all above water surface infrastructure (WTGs/OSP) and an additional area within which further below water infrastructure (foundations and cables) may also be located. |
| Offshore Project | The components of the Spiorad na Mara offshore wind farm (the Project) located seaward of Mean High Water Springs (MHWS). |
| Tidal Offset | The difference in height between mean sea level and highest astronomical tide. |
| Turbine Area | A reduced area within the Array Area where above water surface infrastructure would be located i.e. wind turbine generators |

| Term | Meaning |
|---|---|
| | (WTG) and Offshore Substation Platform (OSP) (if required). This area has been developed and refined through stakeholder engagement and environmental assessment. |

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# ANNEX 14.4.1 – SPECIES-SPECIFIC INPUTS FOR MIGRATORY WATERBIRDS

**Table 11 Species-specific inputs for migratory waterbirds. Values are derived from Woodward *et al.*, (2023) or HiDef (2022)**

| Species (sub-population) | Biogeographic population/sub-population size | Proportion of biogeographic population/sub-population | Total population/sub-population | Species total population migrating in UK | Flight type | Body Length (m) (mean ± SD) | Wingspan (m) (mean ± SD) | Flight Speed (m/s) (mean ± SD) | Avoidance (mean ± SD) | Proportion at PCH | Pre-breeding migration | Post-breeding migration | Other migration (NA = not applicable) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Avocet | 110,000 | 19.9% | 13,090 | N/A | Flapping | 0.44 ± 0.01 | 0.78 ± 0.01 | 13 ± 2.5 | 0.9996 ± 0.00002 | 100% | Mar - Apr | Jul - Nov | NA |
| Bar-tailed Godwit (wintering) | 180,000 | 100.00% | 180,000 | 680,000 | Flapping | 0.38 ± 0.02 | 0.75 ± 0.02 | 18.3 ± 2.1 | 0.9996 ± 0.00002 | 100% | Mar - Apr | Jul - Oct | NA |
| Bar-tailed Godwit (passage) | 500,000 | 100.00% | 500,000 | | | | | | | | | | NA |
| Bean Goose | 97,000 | 1.00% | 970 | NA | Flapping | 0.75 ± 0.06 | 1.58 ± 0.06 | 15.8 ± 1.3 | 0.9998 ± 0.00001 | 100% | Jan - Feb | Sep - Dec | NA |
| Bewick's Swan | 20,100 | 21.8% | 4,382 | NA | Flapping | 1.21 ± 0.04 | 1.96 ± 0.04 | 24 ± 7.6 | 0.9885 ± 0.00091 | 50% | Feb - Mar | Oct - Dec | NA |

| Species (sub-population) | Biogeographic population/sub-population size | Proportion of biogeographic population/sub-population | Total population/sub-population | Species total population migrating in UK | Flight type | Body Length (m) (mean ± SD) | Wingspan (m) (mean ± SD) | Flight Speed (m/s) (mean ± SD) | Avoidance (mean ± SD) | Proportion at PCH | Pre-breeding migration | Post-breeding migration | Other migration (NA = not applicable) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bittern | 8,200 | 8.7% | 714 | NA | Flapping | 0.75 ± 0.02 | 1.3 ± 0.02 | 8.8 ± 2 | 0.9928 ± 0.00092 | 100% | Jan - May | Jun – Oct | NA |
| Black-tailed Godwit | 303,000 | 100% | 303,000 | NA | Flapping | 0.42 ± 0.02 | 0.76 ± 0.02 | 18.1 ± 6 | 0.9996 ± 0.00002 | 100% | Mar - May | Jun – Oct | NA |
| Black-throated Diver | 590,000 | 0.20% | 1,180 | 1,882 | Flapping | 0.66 ± 0.02 | 1.2 ± 0.02 | 19.3 ± 2.1 | 0.9954 ± 0.00002 | 25% | Mar - May | Aug - Nov | NA |
| Black-throated Diver | 175,600 | 0.40% | 702 | | | | | | | | | | NA |
| Canadian Light-bellied Brent Goose | 40,000 | 100% | 40,000 | NA | Flapping | 0.58 ± 0.02 | 1.15 ± 0.02 | 17.9 ± 6.1 | 0.9998 ± 0.00001 | 50% | Mar - May | Aug - Oct | NA |

| Species (sub-population) | Biogeographic population/sub-population size | Proportion of biogeographic population/sub-population | Total population/sub-population | Species total population migrating in UK | Flight type | Body Length (m) (mean ± SD) | Wingspan (m) (mean ± SD) | Flight Speed (m/s) (mean ± SD) | Avoidance (mean ± SD) | Proportion at PCH | Pre-breeding migration | Post-breeding migration | Other migration (NA = not applicable) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Common scoter | 751,000 | 18.00% | 135,180 | NA | Flapping | 0.49 ± 0.03 | 0.84 ± 0.03 | 22.1 ± 4.0 | 0.9851 ± 0.00088 | 100% | Apr - May | Jun - Oct | NA |
| Corncrake | 2,120,000 | 0.08% | 169,600 | NA | Flapping | 0.28 ± 0.02 | 0.50 ± 0.02 | 13.0 ± 2.0 | 0.9875 ± 0.00174 | 100% | Apr - May | Jul - Aug | NA |
| Curlew | 830,000 | 17.00% | 141,100 | NA | Flapping | 0.55 ± 0.02 | 0.90 ± 0.02 | 15.4 ± 3.3 | 0.9996 ± 0.00002 | 100% | Mar - May | Jun - Oct | NA |
| Dark-bellied Brent Goose | 211,000 | 47% | 99,170 | NA | Flapping | 0.58 ± 0.02 | 1.15 ± 0.02 | 17.9 ± 6.1 | 0.9998 ± 0.00001 | 50% | Feb - May | Sep - Nov | NA |
| Dotterel | 65,000 | 0.60% | 390 | NA | Flapping | 0.21 ± 0.01 | 0.60 ± 0.01 | 16.5 ± 1.8 | 0.9996 ± 0.00002 | 100% | Mar - Jun | Aug - Nov | NA |
| Dunlin (*schinzii*, wintering) | 32,000 | 100.00% | 32,000 | 2,025,776 | Flapping | 0.18 ± 0.01 | 0.40 ± 0.01 | 15.3 ± 1.9 | 0.9996 ± 0.00002 | 100% | Mar - May | Jun - Oct | NA |

| Species (sub-population) | Biogeographic population/sub-population size | Proportion of biogeographic population/sub-population | Total population/sub-population | Species total population migrating in UK | Flight type | Body Length (m) (mean ± SD) | Wingspan (m) (mean ± SD) | Flight Speed (m/s) (mean ± SD) | Avoidance (mean ± SD) | Proportion at PCH | Pre-breeding migration | Post-breeding migration | Other migration (NA = not applicable) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dunlin (*schinzii*, passage) | 830,000 | 87.60% | 727,080 | | | | | | | | | | NA |
| Dunlin (*arctica*, passage) | 46,000 | 87.60% | 40,296 | | | | | | | | | | NA |
| Dunlin (*alpina*, wintering) | 1,400,000 | 87.60% | 1,226,400 | | | | | | | | | | NA |
| Eider | 920,000 | 14.50% | 133,400 | NA | Flapping | 0.60 ± 0.03 | 0.94 ± 0.03 | 17.3 ± 2.4 | 0.9851 ± 0.00088 | 25% | Mar - Apr | Oct - Nov | NA |
| European White-fronted Goose | 1,200,000 | 10% | 12,000 | NA | Flapping | 0.72 ± 0.06 | 1.48 ± 0.06 | 19 ± 2 | 0.9998 ± 0.00001 | 100% | Mar-May | Nov - Feb | NA |
| Gadwall | 140,000 | 22.1% | 30,940 | NA | Flapping | 0.51 ± 0.02 | 0.9 ± 0.02 | 19.6 ± 2 | 0.9851 ± 0.00088 | 100% | Mar - July | July - Nov | NA |

| Species (sub-population) | Biogeographic population/sub-population size | Proportion of biogeographic population/sub-population | Total population/sub-population | Species total population migrating in UK | Flight type | Body Length (m) (mean ± SD) | Wingspan (m) (mean ± SD) | Flight Speed (m/s) (mean ± SD) | Avoidance (mean ± SD) | Proportion at PCH | Pre-breeding migration | Post-breeding migration | Other migration (NA = not applicable) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Golden Plover (wintering) | 3,470,000 | 95.00% | 3,296,500 | 3,429,100 | Flapping | 0.28 ± 0.01 | 0.72 ± 0.01 | 16.5 ± 1.8 | 0.9996 ± 0.00002 | 100% | Feb - May | Jul - Oct | NA |
| Golden Plover (breeding) | 170,000 | 78.00% | 132,600 | | | | | | | | | | NA |
| Goldeneye | 1,500,000 | 2.00% | 30,000 | NA | Flapping | 0.46 ± 0.01 | 0.72 ± 0.01 | 20.3 ± 3.8 | 0.9851 ± 0.00088 | 100% | Feb - May | Aug - Dec | NA |
| Goosander | 260,000 | 6.70% | 17,420 | NA | Flapping | 0.62 ± 0.03 | 0.90 ± 0.03 | 19.7 ± 1.1 | 0.9851 ± 0.00088 | 100% | Mar - May | Jun - Sep | NA |
| Great Crested Grebe | 690,000 | 0.20% | 1,380 | NA | Flapping | 0.48 ± 0.02 | 0.88 ± 0.02 | 21.1 ± 1.6 | 0.9954 ± 0.00002 | 100% | Mar - Jun | Jul - Nov | Feb - Mar |
| Great Northern Diver | 11,000 | 100% | 11,000 | NA | Flapping | 0.8 ± 0.02 | 1.37 ± 0.02 | 19.5 ± 1.6 | 0.9954 ± 0.00002 | 25% | Dec - Jun | Aug - Nov | NA |

| Species (sub-population) | Biogeographic population/sub-population size | Proportion of biogeographic population/sub-population | Total population/sub-population | Species total population migrating in UK | Flight type | Body Length (m) (mean ± SD) | Wingspan (m) (mean ± SD) | Flight Speed (m/s) (mean ± SD) | Avoidance (mean ± SD) | Proportion at PCH | Pre-breeding migration | Post-breeding migration | Other migration (NA = not applicable) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Greenland Barnacle Goose | 81,000 | 100% | 81,000 | NA | Flapping | 0.64 ± 0.04 | 1.38 ± 0.04 | 17.4 ± 1.08 | 0.9998 ± 0.00001 | 100% | Apr - May | Oct - Oct | NA |
| Greenland White-fronted Goose | 21,500 | 100% | 21,500 | NA | Flapping | 0.72 ± 0.06 | 1.48 ± 0.06 | 18.75 ± 7.19 | 0.9998 ± 0.00001 | 100% | Mar - Apr | Sep - Nov | NA |
| Greenshank | 360,000 | 2% | 7,200 | NA | Flapping | 0.32 ± 0.01 | 0.69 ± 0.01 | 12.3 ± 3.3 | 0.9996 ± 0.00002 | 100% | Mar - Jun | Aug - Nov | NA |
| Grey Plover | 200,000 | 62.00% | 124,000 | NA | Flapping | 0.28 ± 0.01 | 0.77 ± 0.01 | 16.5 ± 1.8 | 0.9996 ± 0.00002 | 100% | Mar - May | Jul - Sep | NA |
| Hen Harrier | 108,800 | 2% | 2,176 | NA | Flapping | 0.48 ± 0.02 | 1.1 ± 0.02 | 11.4 ± 1.1 | 0.9957 ± 0.00006 | 100% | Mar - May | Sep - Nov | NA |
| Honey Buzzard | 342,000 | 0.04% | 137 | NA | Flapping | 0.56 ± 0.02 | 1.42 ± 0.02 | 11.1 ± 2.3 | 0.9957 ± 0.00006 | 50% | Apr - May | Sep - Oct | NA |

| Species (sub-population) | Biogeographic population/sub-population size | Proportion of biogeographic population/sub-population | Total population/sub-population | Species total population migrating in UK | Flight type | Body Length (m) (mean ± SD) | Wingspan (m) (mean ± SD) | Flight Speed (m/s) (mean ± SD) | Avoidance (mean ± SD) | Proportion at PCH | Pre-breeding migration | Post-breeding migration | Other migration (NA = not applicable) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Icelandic Greylag Goose | 76,000 | 90% | 68,400 | NA | Flapping | 0.82 ±0.03 | 1.64 ± 0.03 | 12 ± 0.49 | 0.9998 ± 0.00001 | 50% | Mar - Apr | Oct - Nov | NA |
| Knot | 360,000 | 100.00% | 360,000 | NA | Flapping | 0.24 ± 0.01 | 0.59 ± 0.01 | 24.6 ± 3.3 | 0.9996 ± 0.00002 | 100% | Feb - May | Jun - Oct | NA |
| Lapwing | 9,500,000 | 41.50% | 3,942,500 | NA | Flapping | 0.30 ± 0.01 | 0.84 ± 0.01 | 12.8 ± 1.3 | 0.9996 ± 0.00002 | 100% | Jan - May | Oct - Nov | NA |
| Long-tailed Duck | 1,600,000 | 0.80% | 12,800 | NA | Flapping | 0.44 ± 0.01 | 0.76 ± 0.01 | 19.7 ± 1.7 | 0.9851 ± 0.00088 | 100% | Mar - May | Sep - Oct | NA |
| Mallard | 7,100,000 | 11.60% | 823,600 | NA | Flapping | 0.58 ± 0.02 | 0.90 ± 0.02 | 15.9 ± 2.0 | 0.9851 ± 0.00088 | 100% | Apr - Jun | Sep - Oct | Jan - Mar |
| Marsh Harrier | 368,000 | 0.7% | 2,576 | NA | Flapping | 0.52 ± 0.02 | 1.22 ± 0.02 | 13.2 ± 2.9 | 0.9957 ± 0.00006 | 50% | Mar - May | Aug - Nov | NA |
| Merlin | 103,200 | 8% | 8,256 | NA | Flapping | 0.28 ± 0.02 | 0.56 ± 0.02 | 12.7 ± 5.8 | 0.9891 ± 0.00033 | 100% | Mar - May | Aug - Nov | NA |

| Species (sub-population) | Biogeographic population/sub-population size | Proportion of biogeographic population/sub-population | Total population/sub-population | Species total population migrating in UK | Flight type | Body Length (m) (mean ± SD) | Wingspan (m) (mean ± SD) | Flight Speed (m/s) (mean ± SD) | Avoidance (mean ± SD) | Proportion at PCH | Pre-breeding migration | Post-breeding migration | Other migration (NA = not applicable) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Montagu's Harrier | 184,000 | 0.01% | 19 | NA | Flapping | 0.45 ± 0.02 | 1.12 ± 0.02 | 10.7 ± 2.2 | 0.9957 ± 0.00006 | 100% | Apr - Jun | Jul - Sep | NA |
| Nightjar | 1,100,000 | 0.70% | 7,700 | NA | Flapping | 0.27 ± 0.02 | 0.60 ± 0.02 | 9.7 ± 3.3 | 0.9954 ± 0.00002 | 100% | Apr - May | Aug - Sep | NA |
| Osprey | 24,600 | 2.7% | 665 | NA | Flapping | 0.56 ± 0.02 | 1.58 ± 0.02 | 10.6 ± 3.1 | 0.9957 ± 0.00006 | 50% | Mar - Apr | Aug - Oct | NA |
| Oystercatcher (breeding) | 843,512 | 31.00% | 261,489 | 620,389 | Flapping | 0.42 ± 0.02 | 0.83 ± 0.02 | 13.0 ± 2.5 | 0.9996 ± 0.00002 | 100% | Jan - Mar | Jul - Nov | NA |
| Oystercatcher (wintering) | 970,000 | 37.00% | 358,900 | | | | | | | | | | NA |
| Pink-footed Goose | 510,000 | 100.00% | 510,000 | NA | Flapping | 0.68 ± 0.06 | 1.52 ± 0.06 | 16.9 ± 0.2 | 0.9999 ± 0.0002 | 50% | Mar - Apr | Sep - Oct | NA |

| Species (sub-population) | Biogeographic population/sub-population size | Proportion of biogeographic population/sub-population | Total population/sub-population | Species total population migrating in UK | Flight type | Body Length (m) (mean ± SD) | Wingspan (m) (mean ± SD) | Flight Speed (m/s) (mean ± SD) | Avoidance (mean ± SD) | Proportion at PCH | Pre-breeding migration | Post-breeding migration | Other migration (NA = not applicable) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pintail | 74,000 | 28.30% | 20,942 | NA | Flapping | 0.58 ± 0.02 | 0.88 ± 0.02 | 21.9 ± 2.0 | 0.9851 ± 0.00088 | 100% | Mar - May | Aug - Nov | NA |
| Pochard | 150,000 | 19% | 28,500 | NA | Flapping | 0.46 ± 0.01 | 0.77 ± 0.01 | 23.6 ± 2 | 0.9851 ± 0.00088 | 100% | Mar - May | Aug - Nov | NA |
| Purple Sandpiper (N Europe) | 110,000 | 20.00% | 22,000 | 33,520 | Flapping | 0.21 ± 0.01 | 0.44 ± 0.01 | 15.3 ± 1.9 | 0.9996 ± 0.00002 | 100% | Mar - May | Jul - Nov | NA |
| Purple Sandpiper (Canada) | 12,000 | 96.00% | 11,520 | | | | | | | | | | NA |
| Red-breasted Merganser | 160,000 | 9.90% | 15,840 | NA | Flapping | 0.55 ± 0.01 | 0.78 ± 0.01 | 22.0 ± 2.9 | 0.9851 ± 0.00088 | 100% | Apr - Jul | Aug - Nov | NA |
| Red-necked Phalarope | 3,200,000 | 0.0006% | 20 | NA | Flapping | 0.18 ± 0.01 | 0.36 ± 0.01 | 10.2 ± 3.9 | 0.9996 ± 0.00002 | 100% | Apr - Jun | Jun - Oct | NA |

| Species (sub-population) | Biogeographic population/sub-population size | Proportion of biogeographic population/sub-population | Total population/sub-population | Species total population migrating in UK | Flight type | Body Length (m) (mean ± SD) | Wingspan (m) (mean ± SD) | Flight Speed (m/s) (mean ± SD) | Avoidance (mean ± SD) | Proportion at PCH | Pre-breeding migration | Post-breeding migration | Other migration (NA = not applicable) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Redshank | 420,000 | 100.00% | 420,000 | NA | Flapping | 0.28 ± 0.01 | 0.62 ± 0.01 | 15.3 ± 4.1 | 0.9996 ± 0.00002 | 100% | Mar - May | Jul - Sep | NA |
| Red-throated Diver (wintering) | 340,000 | 10.00% | 34,000 | 40,696 | Flapping | 0.61 ± 0.02 | 1.11 ± 0.02 | 18.6 ± 3.9 | 0.9954 ± 0.00002 | 25% | Feb - Jun | Jul - Sep | NA |
| Red-throated Diver (breeding) | 186,000 | 3.60% | 6,696 | | | | | | | | | | NA |
| Ringed Plover (breeding) | 68000 | 24.00% | 16,320 | 241,920 | Flapping | 0.19 ± 0.01 | 0.52 ± 0.01 | 16.0 ± 1.1 | 0.9996 ± 0.00002 | 100% | Mar - May | Aug - Oct | NA |
| Ringed Plover (passage) | 240,000 | 94.00% | 225,600 | | | | | | | | | | NA |
| Ruff | 6,200,000 | 0.05% | 3,100 | NA | Flapping | 0.25 ± 0.01 | 0.53 ± 0.01 | 16.9 ± 1.8 | 0.9996 ± 0.00002 | 100% | Mar - May | Jul - Nov | NA |

| Species (sub-population) | Biogeographic population/sub-population size | Proportion of biogeographic population/sub-population | Total population/sub-population | Species total population migrating in UK | Flight type | Body Length (m) (mean ± SD) | Wingspan (m) (mean ± SD) | Flight Speed (m/s) (mean ± SD) | Avoidance (mean ± SD) | Proportion at PCH | Pre-breeding migration | Post-breeding migration | Other migration (NA = not applicable) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sanderling | 200,000 | 100.00% | 200,000 | NA | Flapping | 0.20 ± 0.01 | 0.42 ± 0.01 | 21.4 ± 1.1 | 0.9996 ± 0.00002 | 100% | Apr - Jun | Jul - Oct | NA |
| Scaup | 280,000 | 2.50% | 7,000 | NA | Flapping | 0.46 ± 0.01 | 0.78 ± 0.01 | 21.1 ± 2.0 | 0.9851 ± 0.00088 | 100% | Feb - May | Sep - Nov | NA |
| Shelduck | 310,000 | 25.00% | 77,500 | NA | Flapping | 0.62 ± 0.02 | 1.12 ± 0.02 | 18.2 ± 4.3 | 0.9851 ± 0.00088 | 50% | Jan - Feb | Jun - Jul | Aug - Dec |
| Short-eared Owl | 372,000 | 4% | 14,880 | NA | Flapping | 0.38 ± 0.02 | 1.02 ± 0.02 | 9.7 ± 2 | 0.9957 ± 0.00006 | 100% | Mar - May | Jul - Oct | NA |
| Shoveler | 80,000 | 28.70% | 22,960 | NA | Flapping | 0.48 ± 0.02 | 0.77 ± 0.02 | 18.3 ± 2.0 | 0.9851 ± 0.00088 | 100% | Mar - Jun | Jul - Aug | Sep - Dec |
| Slavonian Grebe (breeding) | 5,300 | 1.00% | 53 | 1,614 | Flapping | 0.34 ± 0.02 | 0.62 ± 0.02 | 21.1 ± 1.6 | 0.9954 ± 0.00002 | 100% | Feb - Apr | Aug - Oct | NA |

| Species (sub-population) | Biogeographic population/sub-population size | Proportion of biogeographic population/sub-population | Total population/sub-population | Species total population migrating in UK | Flight type | Body Length (m) (mean ± SD) | Wingspan (m) (mean ± SD) | Flight Speed (m/s) (mean ± SD) | Avoidance (mean ± SD) | Proportion at PCH | Pre-breeding migration | Post-breeding migration | Other migration (NA = not applicable) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Slavonian Grebe (wintering) | 36,300 | 4.30% | 1,561 | | | | | | | | | | NA |
| Snipe (faeroeensis) | 1,100,000 | 21.00% | 231,000 | 2,331,000 | Flapping | 0.26 ± 0.01 | 0.46 ± 0.01 | 17.1 ± 2.7 | 0.9996 ± 0.00002 | 100% | Mar - May | Aug - Oct | Oct - Dec |
| Snipe (gallinago) | 10,000,000 | 21.00% | 2,100,000 | | | | | | | | | | |
| Spotted Crake | 251,000 | 0.10% | 251 | NA | Flapping | 0.23 ± 0.02 | 0.40 ± 0.02 | 13.0 ± 2.0 | 0.9875 ± 0.00174 | 100% | May - Jun | Jul - Oct | NA |
| Stone Curlew | 176,000 | 0.5% | 880 | NA | Flapping | 0.42 ± 0.01 | 0.81 ± 0.01 | 13 ± 2.5 | 0.9996 ± 0.00002 | 100% | Mar - May | Aug - Sep | NA |
| Svalbard Barnacle Goose | 43,500 | 100.00% | 43,500 | NA | Flapping | 0.64 ± 0.04 | 1.38 ± 0.04 | 17.4 ± 1.1 | 0.999 ± 0.0001 | 100% | Mar - May | Sep - Oct | NA |

| Species (sub-population) | Biogeographic population/sub-population size | Proportion of biogeographic population/sub-population | Total population/sub-population | Species total population migrating in UK | Flight type | Body Length (m) (mean ± SD) | Wingspan (m) (mean ± SD) | Flight Speed (m/s) (mean ± SD) | Avoidance (mean ± SD) | Proportion at PCH | Pre-breeding migration | Post-breeding migration | Other migration (NA = not applicable) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Svalbard Light-bellied Brent Goose | 13,400 | 100.00% | 13,400 | NA | Flapping | 0.58 ± 0.02 | 1.15 ± 0.02 | 17.9 ± 6.1 | 0.999 ± 0.0001 | 50% | Mar - Mar | Aug - Oct | NA |
| Teal | 670,000 | 65% | 435,500 | NA | Flapping | 0.36 ± 0.015 | 0.61 ± 0.015 | 17.4 ± 1.6 | 0.9851 ± 0.00088 | 100% | Feb - May | Jul - Dec | NA |
| Tufted Duck | 1,000,000 | 15.50% | 155,000 | NA | Flapping | 0.44 ± 0.01 | 0.70 ± 0.01 | 21.1 ± 1.1 | 0.9851 ± 0.00088 | 100% | Apr - Jun | Sep - Oct | NA |
| Turnstone | 260,000 | 100.00% | 260,000 | NA | Flapping | 0.23 ± 0.01 | 0.54 ± 0.01 | 10.0 ± 3.3 | 0.9996 ± 0.00002 | 100% | Jan - Jun | Jul - Aug | NA |
| Velvet Scoter | 315,000 | 1.10% | 3,465 | NA | Flapping | 0.54 ± 0.03 | 0.94 ± 0.03 | 20.1 ± 4.7 | 0.9851 ± 0.00088 | 100% | Mar - May | Jun - Sep | NA |
| Whimbrel | 780,000 | 80.00% | 624,000 | NA | Flapping | 0.41 ± 0.02 | 0.82 ± 0.02 | 13.8 ± 0.4 | 0.9996 ± 0.00002 | 100% | Apr - Jun | Jun - Oct | NA |

| Species (sub-population) | Biogeographic population/sub-population size | Proportion of biogeographic population/sub-population | Total population/sub-population | Species total population migrating in UK | Flight type | Body Length (m) (mean ± SD) | Wingspan (m) (mean ± SD) | Flight Speed (m/s) (mean ± SD) | Avoidance (mean ± SD) | Proportion at PCH | Pre-breeding migration | Post-breeding migration | Other migration (NA = not applicable) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| White-tailed Eagle | 12,300 | 1.2% | 148 | NA | Flapping | 0.8 ± 0.02 | 2.2 ± 0.02 | 14.4 ± 1.04 | 0.9872 ± 0.00192 | 100% | Apr - May | Aug - Oct | NA |
| Whooper Swan | 43,000 | 93.00% | 39,990 | NA | Flapping | 1.52 ± 0.04 | 2.30 ± 0.04 | 17.5 ± 4.2 | 0.9874 ± 0.00138 | 50% | Feb - Apr | Sep - Nov | NA |
| Wigeon | 1,600,000 | 34.00% | 544,000 | NA | Flapping | 0.48 ± 0.02 | 0.80 ± 0.02 | 18.5 ± 2.0 | 0.9851 ± 0.00088 | 100% | Mar - Apr | Aug - Nov | NA |
| Wood Sandpiper | 1,800,000 | 0.003% | 54 | NA | Flapping | 0.20 ± 0.01 | 0.56 ± 0.01 | 9.6 ± 1.7 | 0.9996 ± 0.00002 | 100% | Apr - May | Jul - Sep | NA |