

# MORGAN OFFSHORE WIND PROJECT GENERATION ASSETS

## Preliminary Environmental Information Report

Volume 4, annex 10.4: Offshore ornithology migratory non-seabird collision risk assessment



April 2023  
FINAL

Image of an offshore wind farm

<b>Document status</b>					
<b>Version</b>	<b>Purpose of document</b>	<b>Authored by</b>	<b>Reviewed by</b>	<b>Approved by</b>	<b>Review date</b>
Rev01	Draft for Client review	RPS	bpEnBW		13/10/2022
Rev02	Addressing client comments	RPS	bpEnBW		15/11/2022
Rev03	Final	RPS	bpEnBW	bpEnBW	01/12/2022

The report has been prepared for the exclusive use and benefit of our client and solely for the purpose for which it is provided. Unless otherwise agreed in writing by RPS Group Plc, any of its subsidiaries, or a related entity (collectively 'RPS') no part of this report should be reproduced, distributed or communicated to any third party. RPS does not accept any liability if this report is used for an alternative purpose from which it is intended, nor to any third party in respect of this report. The report does not account for any changes relating to the subject matter of the report, or any legislative or regulatory changes that have occurred since the report was produced and that may affect the report.

The report has been prepared using the information provided to RPS by its client, or others on behalf of its client. To the fullest extent permitted by law, RPS shall not be liable for any loss or damage suffered by the client arising from fraud, misrepresentation, withholding of information material relevant to the report or required by RPS, or other default relating to such information, whether on the client's part or that of the other information sources, unless such fraud, misrepresentation, withholding or such other default is evident to RPS without further enquiry. It is expressly stated that no independent verification of any documents or information supplied by the client or others on behalf of the client has been made. The report shall be used for general information only.

<b>Prepared by:</b>	<b>Prepared for:</b>
<b>RPS</b>	<b>Morgan Offshore Wind Ltd.</b>

## Contents

<b>1</b>	<b>MIGRATORY NON-SEABIRD COLLISION RISK MODELLING TECHNICAL REPORT</b>	<b>1</b>
1.1	Introduction	1
1.2	Study area	1
1.3	Methodology	3
1.3.1	Overview	3
1.3.2	Selecting connectivity lines with Morgan Array Area in SOSSMAT	3
1.3.3	Population size and population correction factor	4
1.3.4	Collision risk modelling and avoidance rates	5
1.4	Results	7
1.4.1	Migratory non-seabird species	7
1.4.2	Numbers of collisions predicted using a range of avoidance rates	8
1.5	References	9

## Tables

Table 1.1:	Migration routes selected and corresponding SOSSMAT code	3
Table 1.2:	International name, scientific name, population size, and geographic population selected in the SOSSMAT tool	4
Table 1.3:	The Morgan Array Area configuration and turbines parameters	5
Table 1.4:	Species and population parameters used in the Band (2012) single transit collision risk model. Species are ranked according to their taxonomic order	6
Table 1.5:	Number of each species and percentage % of the population crossing the Morgan Array Area per annum. Species are ranked according to their taxonomic order	7
Table 1.6:	Migrant non-seabird annual collision risk for the Morgan Array Area using a range of avoidance rates. Species are ranked according to their taxonomic order	8

## Figures

Figure 1.1:	Morgan Offshore Ornithology Array Area study area, and the Morgan Array Area used for collision risk modelling	2
Figure 1.2:	Coastal zones defined for the SOSSMAT. The thirty different coastal zones defined for the purpose of the migration assessment are labelled and shown in different colours in the figure above (Source: Wright <i>et al.</i> , 2012)	3

## Glossary

Term	Meaning
Air Gap	The gap between the mean sea level and the lowest point of a turbine rotor blade.
Avoidance	Probability that a bird takes successful evasive action to avoid collision with a turbine.
Collision risk	Risk of a bird lethally colliding with a wind turbine within a wind farm.
Collision risk model	A model that calculates collision risk for a species within a wind farm based on a set of turbines and bird species specific parameters. Collision risk models can be run deterministically or stochastically.
Large Array Correction	Adjustment to the probability of bird collision to account for the depletion of bird density in later rows of a wind farm with a large array of turbines.
Lowest Astronomical Tide	The lowest level of the sea surface with respect to the land.
Maximum Design Scenario	The wind farm design scenario that is considered the worst case from the perspective of collision risk.
Mean Sea Level	The average level of the sea surface with respect to the land.
Ornithology	Ornithology is a branch of zoology that concerns the study of birds.
Parameter	Parameters are the input elements of a model that together affect the output of a model. In collision risk models, examples of parameters are the number of wind turbines and the length of the bird. All input parameters are described in Table 1.3 and Table 1.4.

## Acronyms

Term	Meaning
BTO	British Trust for Ornithology
CRM	Collision Risk Model
EIA	Environmental Impact Assessment
GIS	Geographical Information System
LAT	Lowest Astronomical Tide
MDS	Maximum Design Scenario
MSL	Mean Sea Level
PEIR	Preliminary Environmental Information Report
RPM	Rotations Per Minute
SOSSMAT	Strategic Ornithological Support Services Migration Assessment Tool
SPA	Special Protection Area

## Units

Unit	Description
MW	Megawatt
km	Kilometres
m	Metres
m/s	Metres per second
cm	Centimetres



# 1 Migratory non-seabird collision risk modelling technical report

## 1.1 Introduction

1.1.1.1 This technical report covers the potential impacts as a result of collision risk from the Morgan Offshore Wind Project Generation Assets, hereafter referred to as the Morgan Generation Assets, on migratory non-seabird species.

1.1.1.2 During the operations and maintenance phase of the Morgan Generation Assets, the turning rotors of the wind turbines may present a risk of collision for birds that cross the Morgan Array Area during their migration. Stationary structures, such as offshore substation platforms, the wind turbine tower, nacelle or when rotors are not operating, are not expected to result in a material risk of collision. When a collision occurs between the turning rotor blade and the bird, it is assumed to result in direct mortality of the bird, which potentially could result in population level impacts.

1.1.1.3 This migratory non-seabird collision risk modelling technical report provides numbers of predicted collisions of migratory non-seabird species (excluding 'true seabirds', gulls, cormorants and divers) based on the species/populations identified to be at risk of crossing the Morgan Array Area. The results of collision risk modelling for seabirds are provided in volume 4, annex 10.3: Offshore ornithology non-migratory seabird collision risk assessment technical report of the Preliminary Environmental Information Report (PEIR).

## 1.2 Study area

1.2.1.1 The Morgan Array Area is located approximately 22.3km southeast of the Isle of Man in the east Irish Sea and 36.2km from the northwest coast of England (Figure 1.1). The Morgan Array Area covers 322.21km<sup>2</sup>.

1.2.1.2 Collision risk is an impact associated with the operation of wind turbines and their associated offshore structures. In the assessment of the collision risk to migratory non-seabird species, the number of collisions is therefore predicted across the Morgan Array Area only.

MORGAN OFFSHORE WIND PROJECT GENERATION ASSETS

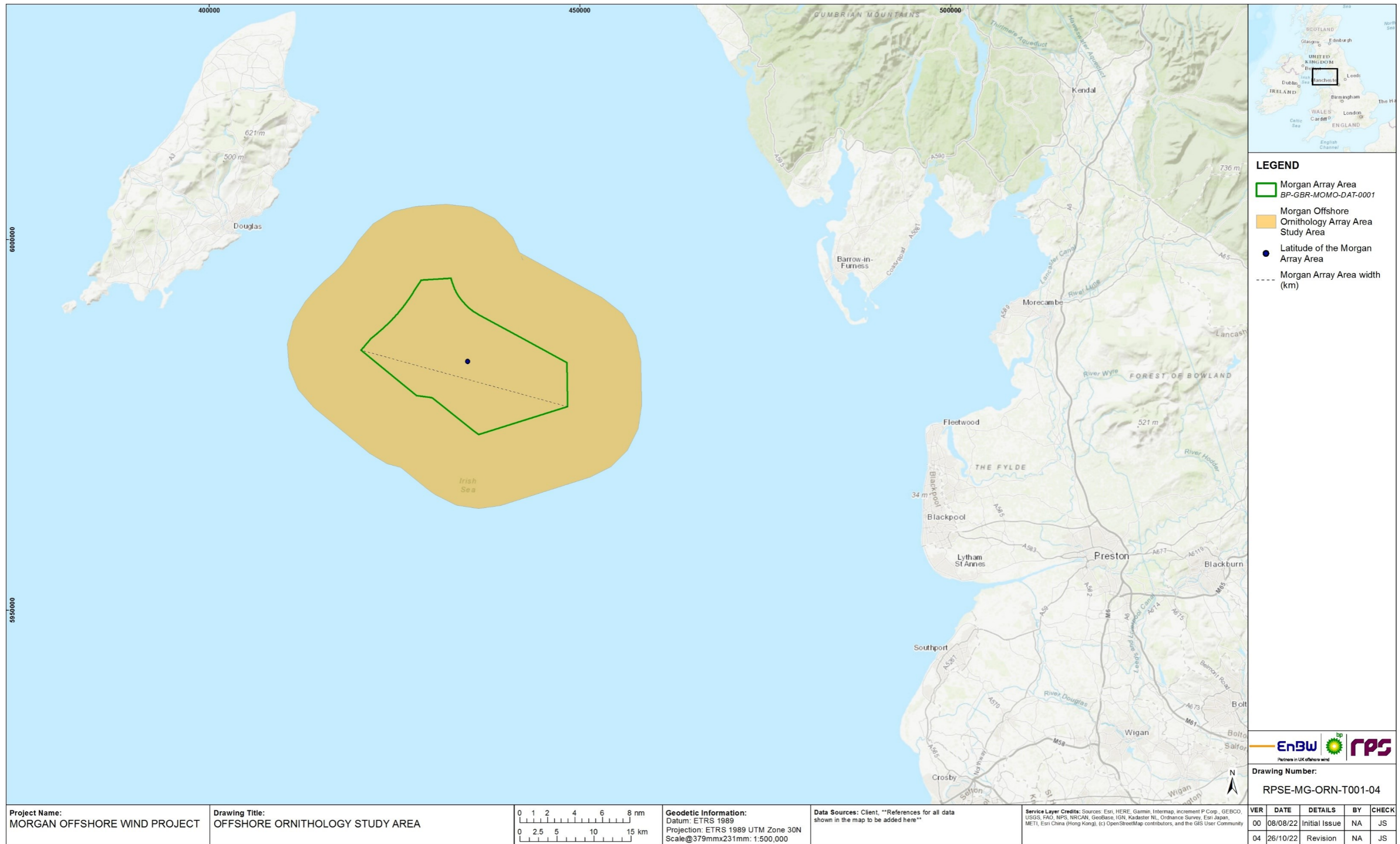


Figure 1.1: Morgan Offshore Ornithology Array Area study area, and the Morgan Array Area used for collision risk modelling.



### 1.3 Methodology

#### 1.3.1 Overview

1.3.1.1 The Strategic Ornithological Support Services Migration Assessment Tool (SOSSMAT) was used to assess the population size of migratory non-seabird species designated as features of the UK Special Protection Area (SPA) network that may cross the Morgan Array Area. Instructions are given in Wright *et al.* (2012). The resulting number of birds estimated to cross the Morgan Array Area was inputted into the Band (2012) single transit collision risk model.

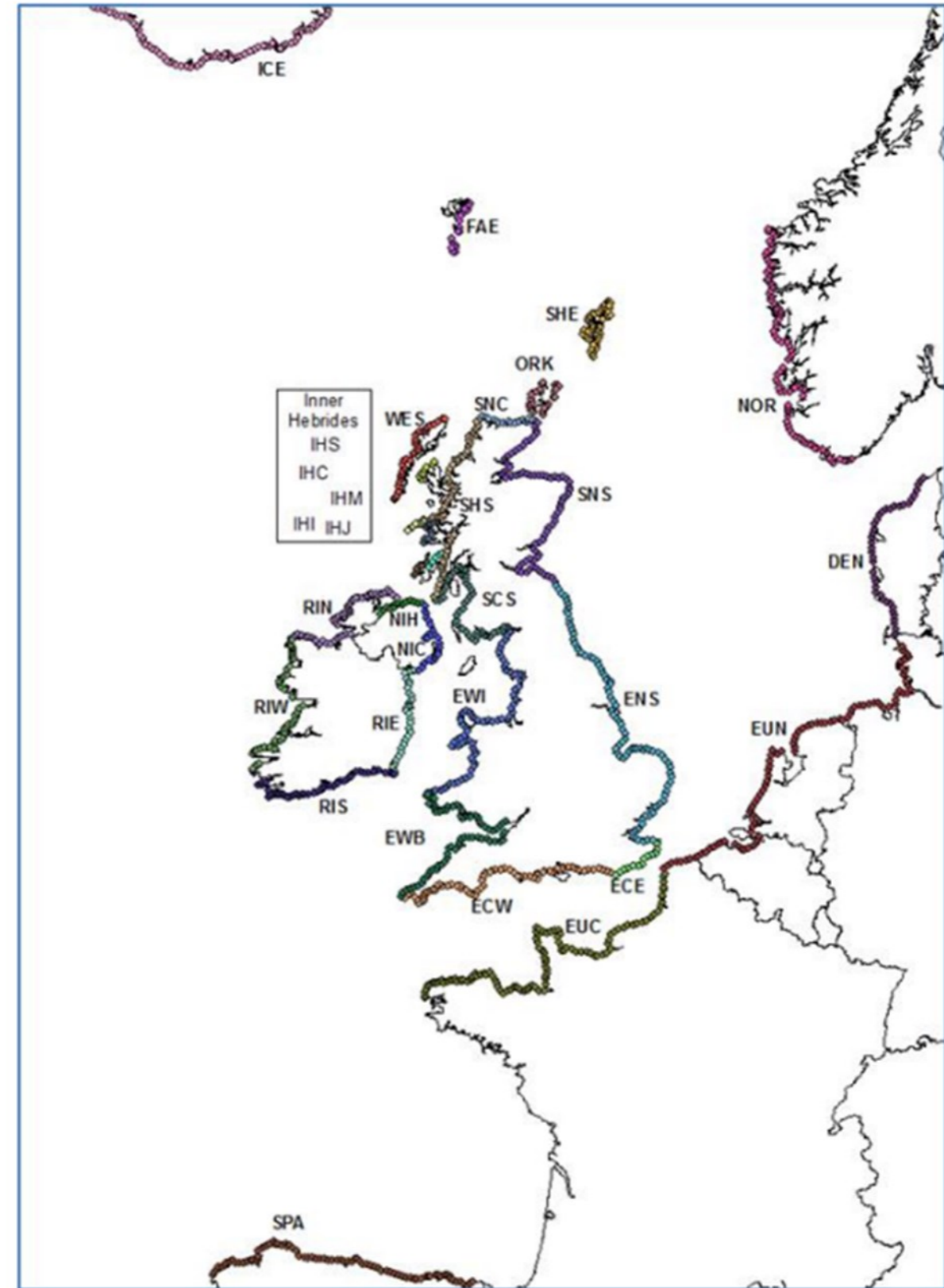
#### 1.3.2 Selecting connectivity lines with Morgan Array Area in SOSSMAT

1.3.2.1 First, the SOSSMAT Geographical Information System (GIS) tool was used to select crossing lines of migration (as identified by Wright *et al.*, 2012) that intersected with the Morgan Array Area. According to the sections of the coastline defined in the SOSSMAT tool (Figure 1.2) and the position of the Morgan Array Area, a number of migration routes were selected that included a start or end point bordering the Irish Sea in England and Wales. The routes selected are shown in Table 1.1. These routes followed the broad migrating patterns known to occur across the British Isles and are described below:

- Birds from Iceland, Canada and Greenland moving through and overwintering in Ireland
- Birds from the Arctic and sub-Arctic (further to the east) moving through the British Isles and over-wintering in Ireland
- Birds from the Arctic and sub-Arctic moving through Ireland to winter further south (e.g. Spain).

**Table 1.1: Migration routes selected and corresponding SOSSMAT code.**

SOSSMAT Code	Start Migration	End Migration
EWBEWI	England and Wales Bristol Channel	England and Wales Irish Sea
EWBNIC	England and Wales Bristol Channel	Northern Ireland Celtic Seas coast
EWBSCS	England and Wales Bristol Channel	Scottish mainland Celtic Seas coast
EWINIC	England and Wales Irish Sea	Northern Ireland Celtic Seas coast
EWISCS	England and Wales Irish Sea	Scottish mainland Celtic Seas coast
RIEEWI	Republic of Ireland - Celtic Seas eastern coast	England and Wales Irish Sea
SPAEWI	Spanish north coast	England and Wales Irish Sea
SPASCS	Spanish north coast	Scottish mainland Celtic Seas coast



**Figure 1.2: Coastal zones defined for the SOSSMAT. The thirty different coastal zones defined for the purpose of the migration assessment are labelled and shown in different colours in the figure above (Source: Wright *et al.*, 2012).**

### 1.3.3 Population size and population correction factor

1.3.3.1 The percentage of lines crossing the Morgan Array Area was derived for each species known to migrate along the route selected in SOSSMAT. For this assessment, 'true seabirds', all gull species, cormorant and diver species were excluded. In the SOSSMAT worksheets, the number of birds crossing the Morgan Array Area was calculated by adding parameters such as population size and population correction factor (% of the population using the relevant sea crossing). Population size estimates are given by Wright *et al.* (2012) and include international population size (Wetlands International, 2012; Birdlife International, 2004), British Population size (Musgrove *et al.*, 2011; Baker *et al.*, 2006) and Irish population size (Crowe *et al.*, 2008).

1.3.3.2 As a precautionary approach, the assumptions in Wright *et al.* (2012) were followed where the scale and magnitude of the migration were unknown. Therefore, in some instances, the entire international population or estimation given by Wright *et al.* (2012) was used. Generally, it was assumed that 100% of the population identified used the migratory route selected except for a few species (Table 1.2). While the assumptions by Wright *et al.* (2012) were followed for Eurasian oystercatcher *Haematopus ostralegus*, some assumptions were made for long-tailed duck *Clangula hyemalis*, merlin *Falco columbarius*, Western osprey *Pandion haliaetus* and Eurasian bittern *Botaurus stellaris* given the lack of evidence and guidance for these species in the SOSSMAT document.

**Table 1.2: International name, scientific name, population size, and geographic population selected in the SOSSMAT tool.**

International name	Scientific name	Population size	Population correction factor (percent of population estimated to be using relevant sea-crossings)	Population origin
Tundra swan (Bewick's swan)	<i>Cygnus columbianus bewickii</i>	380	100	Ireland
Whooper swan	<i>Cygnus cygnus</i>	12,730	100	Ireland
Greenland white-fronted goose	<i>Anser albifrons flavirostris</i>	11,340	100	Ireland
Light-bellied brent goose (Canadian population)	<i>Branta bernicla hrota</i>	40,000	100	International
Common shelduck	<i>Tadorna tadorna</i>	14,610	100	Ireland
Eurasian wigeon	<i>Mareca penelope</i>	82,370	100	Ireland
Gadwall	<i>Mareca strepera</i>	630	100	Ireland
Eurasian teal	<i>Anas crecca</i>	45,010	100	Ireland
Mallard	<i>Anas platyrhynchos</i>	38,250	100	Ireland
Northern pintail	<i>Anas acuta</i>	1,235	100	Ireland

International name	Scientific name	Population size	Population correction factor (percent of population estimated to be using relevant sea-crossings)	Population origin
Northern shoveler	<i>Spatula clypeata</i>	2,545	100	Ireland
Common pochard	<i>Aythya ferina</i>	37,780	100	Ireland
Tufted duck	<i>Aythya fuligula</i>	36,610	100	Ireland
Greater scaup	<i>Aythya marila</i>	4,430	100	Ireland
Long-tailed duck	<i>Clangula hyemalis</i>	11,000	50	Great Britain
Common scoter	<i>Melanitta nigra</i>	23,190	100	Ireland
Common goldeneye	<i>Bucephala clangula</i>	9,665	100	Ireland
Red-breasted merganser	<i>Mergus serrator</i>	3,390	100	Ireland
Eurasian bittern	<i>Botaurus stellaris</i>	1,200	25	Great Britain
Great crested grebe	<i>Podiceps cristatus</i>	5,385	100	Ireland
Horned grebe (Slavonian grebe)	<i>Podiceps auritus</i>	1,100	100	Great Britain
Hen harrier	<i>Circus cyaneus</i>	100	100	Estimation
Western osprey	<i>Pandion haliaetus</i>	296	50	Great Britain
Merlin	<i>Falco columbarius</i>	49,000	50	International
Corncrake	<i>Crex crex</i>	1,178	100	United Kingdom
Eurasian oystercatcher (breeding)	<i>Haematopus ostralegus</i>	113,000	50	Great Britain
Eurasian oystercatcher (non-breeding)	<i>Haematopus ostralegus</i>	67,720	100	Ireland
Common ringed plover (breeding)	<i>Charadrius hiaticula</i>	5,438	100	Great Britain
Common ringed plover (non-breeding)	<i>Charadrius hiaticula</i>	73,000	100	International
Eurasian dotterel	<i>Charadrius morinellus</i>	1,500	50	Great Britain
European golden plover (breeding)	<i>Pluvialis apricaria</i>	400,000	100	Ireland
European golden plover (non-breeding)	<i>Pluvialis apricaria</i>	166,700	100	Ireland
Grey plover	<i>Pluvialis squatarola</i>	6,315	100	Ireland
Northern lapwing	<i>Vanellus vanellus</i>	207,700	100	Ireland
Red knot	<i>Calidris canutus</i>	18,970	100	Ireland



International name	Scientific name	Population size	Population correction factor (percent of population estimated to be using relevant sea-crossings)	Population origin
Sanderling	<i>Calidris alba</i>	6,680	100	Ireland
Purple sandpiper	<i>Calidris maritima</i>	3,300	100	Ireland
Dunlin (sub-species <i>schinzii</i> and <i>arctica</i> )	<i>Calidris alpina schinzii</i> & <i>C.a.arctica</i>	1,000,500	100	International
Dunlin (sub-species <i>alpina</i> )	<i>Calidris alpina alpina</i>	88,480	100	International
Ruff	<i>Philomachus pugnax</i>	1,600	100	Great Britain
Common snipe	<i>Gallinago gallinago</i>	100,000,000	100	Estimation
Black-tailed godwit (Icelandic race)	<i>Limosa limosa islandica</i>	13,880	100	Ireland
Bar-tailed godwit	<i>Limosa lapponica</i>	16,280	100	Ireland
Whimbrel	<i>Numenius phaeopus</i>	3,840	100	Great Britain
Eurasian curlew (breeding)	<i>Numenius arquata</i>	107,000	100	Great Britain
Eurasian curlew (non-breeding)	<i>Numenius arquata</i>	54,650	100	Ireland
Common greenshank	<i>Tringa nebularia</i>	1,265	100	Ireland
Wood sandpiper	<i>Tringa glareola</i>	16	100	Great Britain
Common redshank (breeding)	<i>Tringa totanus britannica</i>	38,800	100	United Kingdom/Great Britain
Common redshank (Icelandic race - non-breeding)	<i>Tringa totanus robusta</i>	400,000	100	Iceland and Faeroes
Ruddy turnstone	<i>Arenaria interpres</i>	11,810	100	Ireland
Short-eared owl	<i>Asio flammeus</i>	7,000	100	Great Britain

### 1.3.4 Collision risk modelling and avoidance rates

1.3.4.1 As recommended in the SOSSMAT guidance, the Band (2012) single transit collision risk model was used. Input parameters for the wind turbine specifications used within the CRM are shown in Table 1.3. These values are based on the Maximum Design Scenario (MDS) parameter values for the worst-case collision risk. Species/populations input parameters are shown in Table 1.4. While species biometrics (length and wingspan) were taken from the BTO BirdFacts resource (Robinson, 2005), flight speeds were taken from Alerstam *et al.* (2007) for most species. For some species (Table 1.3), there were no estimations in Alerstam *et al.*

(2007). As such, the same assumptions were followed as those used by Marine Scotland (2014) in their document *Strategic assessment of collision risk of Scottish offshore wind farms to migrating birds*. In this document, flight speed of species for which insufficient evidence existed were derived from species of similar genus and flight characteristics (e.g. European golden plover *Pluvialis apricaria* and American golden plover *Pluvialis dominica*).

1.3.4.2 The CRMs used the proportion flying at rotor height given for species group (e.g. wildfowl, wader etc.) from Wright *et al.* (2012). The at risk-population resulted from the calculations in the SOSSMAT worksheet.

**Table 1.3: The Morgan Array Area configuration and turbines parameters.**

<sup>1</sup> In the absence of data in Alerstam *et al.* (2007), the flight speed was from a bird species of a similar genus/group and with similar biometrics (i.e. wingspan and length).

Parameter <sup>a</sup>	Parameter value	Source/Reference
Max. number of turbines	107	Volume 2, chapter 10: Offshore ornithology of the PEIR
Number of rotor blades per turbine	3	Volume 2, chapter 10: Offshore ornithology of the PEIR.
Max. chord width (m)	6.8	Volume 2, chapter 10: Offshore ornithology of the PEIR.
Average blade pitch (degrees)	10	Volume 2, chapter 10: Offshore ornithology of the PEIR.
Max. rotor radius (m)	125	Volume 2, chapter 10: Offshore ornithology of the PEIR.
Average rotation speed (rpm)	6.4	Volume 2, chapter 10: Offshore ornithology of the PEIR.
Tidal offset (m) (MSL)	+/- 4	Volume 2, chapter 10: Offshore ornithology of the PEIR.
Lower blade tip height above Lowest Astronomical Tide LAT (m)	34	Volume 2, chapter 10: Offshore ornithology of the PEIR.
Air gap (MSL) (m)	30	Air gap relative to Mean Sea Level (MSL) allowing for -4m tidal offset between LAT and MSL
Morgan Array Area width (km)	28.79	Calculated in RStudio
Latitude	54.00	Calculated in RStudio
Large array correction	YES	Standard procedure

MORGAN OFFSHORE WIND PROJECT GENERATION ASSETS

**Table 1.4: Species and population parameters used in the Band (2012) single transit collision risk model. Species are ranked according to their taxonomic order.**

International name	Length (m)	Wingspan (m)	Flight speed (ms <sup>-1</sup> )	Proportion at rotor height (%)	Number crossing Morgan Array Area per annum
Tundra swan (Bewick's swan)	1.210	1.960	18.50	50	19
Whooper swan	1.525	2.305	17.30	50	351
Greenland white-fronted goose	0.720	1.460	16.10	30	371
Light-bellied brent goose (Canadian population)	0.580	1.150	17.70	30	1,422
Common shelduck	0.670	1.330	15.40	15	466
Eurasian wigeon	0.480	0.800	20.60	15	2,628
Gadwall	0.510	0.900	18.50	15	22
Eurasian teal	0.360	0.610	19.70	15	1,436
Mallard	0.650	0.980	18.50	15	1,220
Northern pintail	0.580	0.880	20.60	15	39
Northern shoveler	0.480	0.770	18.50	15	85
Common pochard	0.460	0.770	23.60	15	1,264
Tufted duck	0.440	0.700	21.10	15	1,168
Greater scaup	0.510	0.840	21.30	15	149
Long-tailed duck	0.440	0.760	20.30	15	175
Common scoter	0.490	0.840	22.10	1	740
Common goldeneye	0.460	0.720	20.30	15	308
Red-breasted merganser	0.550	0.780	19.70	15	109
Eurasian bittern	0.750	1.300	8.80	50	35
Great crested grebe	0.480	0.880	18.60	10	208
Horned grebe (Slavonian grebe)	0.450	0.860	18.60	10	35
Hen harrier	0.480	1.100	9.10	50	4
Western osprey	0.560	1.580	13.30	50	5
Merlin	0.280	0.560	10.10	50	782
Corncrake	0.280	0.500	10.00	50	40

International name	Length (m)	Wingspan (m)	Flight speed (ms <sup>-1</sup> )	Proportion at rotor height (%)	Number crossing Morgan Array Area per annum
Eurasian oystercatcher (breeding)	0.420	0.830	13.00	25	1,805
Eurasian oystercatcher (non-breeding)	0.420	0.830	13.00	25	2,161
Common ringed plover (breeding)	0.190	0.520	19.50	25	174
Common ringed plover (non-breeding)	0.190	0.520	19.50	25	2,329
Eurasian dotterel	0.210	0.600	13.70	25	42
European golden plover (breeding)	0.280	0.720	13.70	25	12,763
European golden plover (non-breeding)	0.280	0.720	13.70	25	5,319
Grey plover	0.280	0.770	17.90	25	201
Northern lapwing	0.300	0.840	11.90	25	6,627
Red knot	0.240	0.590	20.10	25	605
Sanderling	0.200	0.420	15.30	25	213
Purple sandpiper	0.210	0.440	15.30	25	93
Dunlin (sub-species <i>schinzii</i> and <i>arctica</i> )	0.180	0.400	15.30	25	31,923
Dunlin (sub-species <i>alpina</i> )	0.180	0.400	15.30	25	3,602
Ruff	0.250	0.530	17.40	25	84
Common snipe	0.270	0.470	17.10	25	31,908
Black-tailed godwit (Icelandic race)	0.420	0.760	18.30	25	443
Bar-tailed godwit	0.380	0.750	18.30	25	623
Whimbrel	0.410	0.820	16.30	25	123
Eurasian curlew (breeding)	0.550	0.900	16.30	25	3,415
Eurasian curlew (non-breeding)	0.550	0.900	16.30	25	1,744

International name	Length (m)	Wingspan (m)	Flight speed (ms <sup>-1</sup> )	Proportion at rotor height (%)	Number crossing Morgan Array Area per annum
Common greenshank	0.320	0.690	12.30	25	43
Wood sandpiper	0.200	0.560	9.60	25	1
Common redshank (breeding)	0.280	0.620	12.30	25	1,238
Common redshank (Icelandic race - non-breeding)	0.280	0.620	12.30	25	12,763
Ruddy turnstone	0.230	0.540	14.90	25	377
Short-eared owl	0.380	1.020	19.10	50	223

1.3.4.3 As birds may avoid the wind farm (through macro, meso or micro avoidance), an avoidance rate must be applied to the collision risk model theoretical predictions. As there is a paucity of species-specific avoidance rates, a range of avoidance rates (i.e. 95.00%, 98.00%, 99.00% and 99.50%) has been applied, as recommended by Band (2012).

## 1.4 Results

### 1.4.1 Migratory non-seabird species

1.4.1.1 The species presented in Table 1.4 were considered in the Band (2012) single transit collision risk model. Wader species, which predominately breed in the Arctic and sub-Arctic regions, were estimated to move through the Morgan Array Area in the highest numbers. Table 1.5 presents the number of birds crossing the site annually, considering the spring and autumn passage. For all species, it was assumed that there were two migration periods per year (i.e. spring and autumn) through the area.

**Table 1.5: Number of each species and percentage % of the population crossing the Morgan Array Area per annum. Species are ranked according to their taxonomic order.**

International name	No. crossing Morgan Array Area per annum	Percentage of population crossing Morgan Array Area per annum
Tundra swan (Bewick's swan)	19	0.05
Whooper swan	351	0.03
Greenland white-fronted goose	371	0.03
Light-bellied brent goose (Canadian population)	1,422	0.04
Common shelduck	466	0.03

International name	No. crossing Morgan Array Area per annum	Percentage of population crossing Morgan Array Area per annum
Eurasian wigeon	2,628	0.03
Gadwall	22	0.04
Eurasian teal	1,436	0.03
Mallard	1,220	0.03
Northern pintail	39	0.03
Northern shoveler	85	0.03
Common pochard	1,264	0.03
Tufted duck	1,168	0.03
Greater scaup	149	0.03
Long-tailed duck	175	0.03
Common scoter	740	0.03
Common goldeneye	308	0.03
Red-breasted merganser	109	0.03
Eurasian bittern	35	0.06
Great crested grebe	208	0.04
Horned grebe (Slavonian grebe)	35	0.03
Hen harrier	4	0.04
Western osprey	5	0.03
Merlin	782	0.03
Corncrake	40	0.03
Eurasian oystercatcher (breeding)	1,805	0.03
Eurasian oystercatcher (non-breeding)	2,161	0.03
Common ringed plover (breeding)	174	0.03
Common ringed plover (non-breeding)	2,329	0.03
Eurasian dotterel	42	0.06
European golden plover (breeding)	12,763	0.03
European golden plover (non-breeding)	5,319	0.03
Grey plover	201	0.03
Northern lapwing	6,627	0.03
Red knot	605	0.03
Sanderling	213	0.03
Purple sandpiper	93	0.03



International name	No. crossing Morgan Array Area per annum	Percentage of population crossing Morgan Array Area per annum
Dunlin (sub-species <i>schinzii</i> and <i>arctica</i> )	31,923	0.03
Dunlin (sub-species <i>alpina</i> )	3,602	0.04
Ruff	84	0.05
Common snipe	31,908	0.03
Black-tailed godwit (Icelandic race)	443	0.03
Bar-tailed godwit	623	0.04
Whimbrel	123	0.03
Eurasian curlew (breeding)	3,415	0.03
Eurasian curlew (non-breeding)	1,744	0.03
Common greenshank	43	0.03
Wood sandpiper	1	0.04
Common redshank (breeding)	1,238	0.03
Common redshank (Icelandic race - non-breeding)	12,763	0.03
Ruddy turnstone	377	0.03
Short-eared owl	223	0.03

#### 1.4.2 Numbers of collisions predicted using a range of avoidance rates

1.4.2.1 Even assuming a highly precautionary avoidance rate of 95.00%, the numbers of collisions were low and predicted to be below one bird per annum for the majority of species considered (Table 1.6). The number of collisions however exceeded one bird per annum for European golden plover, Northern lapwing *Vanellus vanellus*, dunlin *Calidris alpina*, common snipe *Gallinago gallinago*, Eurasian curlew *Numenius arquata* and common redshank *Tringa totanus*.

1.4.2.2 Because of their breeding population size and migration routes through the Irish Sea, wader species were at the greatest risk of collision. Of the species/populations considered, dunlin and common snipe were predicted to be above five collisions per year, with up to eight collisions each (assuming a 95.00% avoidance rate).

1.4.2.3 Of the wildfowl species, the light-bellied brent goose (Canadian population) had the highest predicted number of collisions (0.52, assuming a 95.00% avoidance rate).

1.4.2.4 Other migrant species considered in the assessment were raptors, and this group included merlin, western osprey, short-eared owl *Asio flammeus* and hen harrier *Circus cyaneus*. For those species, there is insufficient information on migratory routes and population size. Therefore, a highly precautionary approach was taken when assuming population size and proportion of population moving through the Irish Sea. The numbers of collisions were predicted to be low (less than one bird per year

assuming a 95.00% avoidance rate). Unlike wader and wildfowl species, the number of raptors species breeding and wintering in Ireland and the United Kingdom is relatively low.

**Table 1.6: Migrant non-seabird annual collision risk for the Morgan Array Area using a range of avoidance rates. Species are ranked according to their taxonomic order.**

International name	No. of collision (no avoidance)	95.00%	98.00%	99.00%	99.50%
Tundra swan (Bewick's swan)	0.86	0.04	0.02	0.01	0.00
Whooper swan	6.62	0.33	0.13	0.07	0.03
Greenland white-fronted goose	2.96	0.15	0.06	0.03	0.01
Light-bellied brent goose (Canadian population)	10.45	0.52	0.21	0.10	0.05
Common shelduck	1.80	0.09	0.04	0.02	0.01
Eurasian wigeon	9.12	0.46	0.18	0.09	0.05
Gadwall	0.06	0.00	0.00	0.00	0.00
Eurasian teal	4.60	0.23	0.09	0.05	0.02
Mallard	4.59	0.23	0.09	0.05	0.02
Northern pintail	0.13	0.01	0.00	0.00	0.00
Northern shoveler	0.28	0.01	0.01	0.00	0.00
Common pochard	4.39	0.22	0.09	0.04	0.02
Tufted duck	3.96	0.20	0.08	0.04	0.02
Greater scaup	0.52	0.03	0.01	0.01	0.00
Long-tailed duck	0.59	0.03	0.01	0.01	0.00
Common scoter	0.16	0.01	0.00	0.00	0.00
Common goldeneye	1.06	0.05	0.02	0.01	0.01
Red-breasted merganser	0.39	0.02	0.01	0.00	0.00
Eurasian bittern	0.55	0.03	0.01	0.01	0.00
Great crested grebe	0.47	0.02	0.01	0.00	0.00
Horned grebe (Slavonian grebe)	0.09	0.00	0.00	0.00	0.00
Hen harrier	0.03	0.00	0.00	0.00	0.00
Western osprey	0.07	0.00	0.00	0.00	0.00
Merlin	6.89	0.34	0.14	0.07	0.03
Corncrake	0.36	0.02	0.01	0.00	0.00
Eurasian oystercatcher (breeding)	9.41	0.47	0.19	0.09	0.05
Eurasian oystercatcher (non-breeding)	11.27	0.56	0.23	0.11	0.06

International name	No. of collision (no avoidance)	95.00%	98.00%	99.00%	99.50%
Common ringed plover (breeding)	0.86	0.04	0.02	0.01	0.00
Common ringed plover (non-breeding)	11.40	0.57	0.23	0.11	0.06
Eurasian dotterel	0.19	0.01	0.00	0.00	0.00
European golden plover (breeding)	59.87	2.99	1.20	0.60	0.30
European golden plover (non-breeding)	24.95	1.25	0.50	0.25	0.12
Grey plover	1.04	0.05	0.02	0.01	0.01
Northern lapwing	30.91	1.55	0.62	0.31	0.15
Red knot	3.07	0.15	0.06	0.03	0.02
Sanderling	0.95	0.05	0.02	0.01	0.00
Purple sandpiper	0.42	0.02	0.01	0.00	0.00
Dunlin (sub-species <i>schinzii</i> and <i>arctica</i> )	139.69	6.98	2.79	1.40	0.70
Dunlin (sub-species <i>alpina</i> )	15.76	0.79	0.32	0.16	0.08
Ruff	0.40	0.02	0.01	0.00	0.00
Common snipe	155.29	7.76	3.11	1.55	0.78
Black-tailed godwit (Icelandic race)	2.45	0.12	0.05	0.02	0.01
Bar-tailed godwit	3.37	0.17	0.07	0.03	0.02
Whimbrel	0.65	0.03	0.01	0.01	0.00
Eurasian curlew (breeding)	20.07	1.00	0.40	0.20	0.10
Eurasian curlew (non-breeding)	10.25	0.51	0.20	0.10	0.05
Common greenshank	0.21	0.01	0.00	0.00	0.00
Wood sandpiper	0.00	0.00	0.00	0.00	0.00
Common redshank (breeding)	5.58	0.28	0.11	0.06	0.03
Common redshank (Icelandic race - non-breeding)	57.53	2.88	1.15	0.58	0.29
Ruddy turnstone	1.73	0.09	0.03	0.02	0.01
Short-eared owl	2.50	0.13	0.05	0.03	0.01

## 1.5 References

- Alerstam T, Rosén M, Bäckman J, Ericson PGP, Hellgren O. (2007) Flight speeds among bird species: Allometric and phylogenetic effects. *PLoS Biol* 5(8): e197. doi:10.1371/journal.pbio.0050197.
- Baker, H., Stroud, D.A., Aebischer, N.J., Cranswick, P.A., Gregory, R.D., McSorley, C.A., Noble, D.G. & Rehfisch, M.M. (2006) Population estimates of birds in Great Britain and the United Kingdom. *British Birds* 99: 25-44.
- Band, W. (2012) Using a collision risk model to assess bird collision risks for offshore windfarms. The Crown Estate Strategic Ornithological Support Services (SOSS) report SOSS-02. <http://www.bto.org/science/wetland-and-marine/soss/projects>. Original published Sept 2011, extended to deal with flight height distribution data March 2012.
- Birdlife International (2004) *Birds in Europe: population estimates, trends and conservation status*. Birdlife International, Cambridge, UK.
- Crowe, O., Austin, G.E., Colhoun, K., Cranswick, P.A., Kershaw, M. & Musgrove, A.J. (2008) Estimates and trends of waterbird numbers wintering in Ireland, 1994/95 to 2003/04. *Bird Study* 55: 66-77.
- Marine Scotland. (2014) *Scottish Marine and Freshwater Science Volume 5 Number 12: Strategic assessment of collision risk of Scottish offshore wind farms to migrating birds*. Available: <https://www.gov.scot/publications/scottish-marine-freshwater-science-volume-5-number-12-strategic-assessment/pages/7/>. Accessed August 2022.
- Musgrove, A.J., Austin, G.E., Hearn, R.D., Holt, C.A., Stroud, D.A. & Wotton, S.R. (2011) Over-winter population estimates of British waterbirds. *British Birds* 104: 364-397.
- Robinson, R.A. (2005) *BirdFacts: profiles of birds occurring in Britain & Ireland* (BTO Research Report 407). BTO, Thetford (<http://www.bto.org/birdfacts>).
- Wetlands International (2012) *Waterbird Population Estimates – Fifth Edition*. [wpe.wetlands.org](http://wpe.wetlands.org).
- Wright, L.J., Ross-Smith, V.H., Massimino, D., Dadam, D., Cook, A.S.C.P. and Burton, N.H.K. (2012) Assessing the risk of offshore wind farm development to migratory birds designated as features of UK Special Protection Areas (and other Annex I species). Strategic Ornithological Support Services. Project SOSS-05. BTO Research Report No. 592.