Rampion 2 Wind Farm

Category 6: Environmental Statement

Volume 4, Appendix 12.4 Offshore and intertidal ornithology migratory collision risk modelling

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1. Introduction

1.1.1 This section outlines the proposed development and the need for collision risk modelling for migratory bird species to inform the environmental impact assessment.

1.2 Purpose of this report

1.2.1 This report has been produced for the purpose of describing the migratory Collision Risk Modelling (CRM) methodology and presenting the results, which forms part of the Environmental Impact Assessment (EIA) for the proposed Rampion 2 offshore wind farm. This report has been prepared in line with Natural England's guidance on best practice for Offshore Wind Marine Environmental Assessments (Parker et al., 2022).

1.3 Project background

1.3.1 Rampion Extension Development (RED; 'the Applicant') is proposing to develop the Rampion 2 Offshore Wind Farm ('Rampion 2'). Rampion 2 will be sited adjacent to the existing Rampion Offshore Wind Farm (OWF), located in the English Channel, 14km off the coast of Brighton and Hove and approximately 30km east of the Isle of Wight. For the purposes of clarification, in this document, the existing Rampion OWF is referred to as 'Rampion 1' hereon in to enable clear differentiation with Rampion 2. The existing Rampion 1 project was developed following award of Zone 6 in the United Kingdom Round 3 offshore wind development leasing round run by The Crown Estate (TCE) in 2009 and occupies 78km^2. Rampion 2 will comprise both offshore and onshore infrastructure including offshore wind turbine generators (WTGs) and associated foundations and inter-array cabling, offshore substations, offshore export cables within a defined cable corridor, a landfall site, and an onshore substation for connection to the electricity transmission network. The offshore element of Rampion 2 will be located within areas adjacent to the west and south east of the existing Rampion 1 project, together with a small link or 'bridge' area between the two areas for cabling.

1.3.2 APEM Ltd (hereafter APEM) was commissioned to undertake a study of offshore and intertidal ornithology that characterise the area that may be influenced by Rampion 2. A separate report (**Appendix 12.1: Offshore and intertidal ornithology baseline technical report, Volume 4** of the ES (Document Reference: 6.4.12.1)) provides the findings from offshore and intertidal ornithology data to determine the receptors that characterise the baseline and are of relevance to the assessment of potential impacts from Rampion 2. This technical appendix has been produced to support **Chapter 12: Offshore and intertidal ornithology, Volume 2** of the ES (Document Reference: 6.2.12).

1.4 Potential collision risk to migratory birds

1.4.1 As part of a proportional assessment, it is necessary to identify bird species at risk of potential impact from collisions with wind turbines. The level of risk to any bird species from collisions with wind turbines is typically estimated by way of CRM. Species which are not likely to be at risk from this potential impact can be screened out and excluded from more detailed modelling.

1.4.2 Digital aerial surveys were conducted within the proposed array area for Rampion 2 to characterise avian species within its boundary. This survey method provides useful information regarding the likely abundance and distribution of key seabird species within each of the biological periods. However, it does present limitations. In particular, neither this survey method nor any of the existing generally applied survey methods for offshore ornithology baseline characterisation are guaranteed to provide robust estimates of bird numbers during the migration periods, particularly non-seabird species. This is due to some species moving through in short pulses, in poor weather or at night (when no surveys take place), or at high altitudes, which makes recording their numbers extremely difficult when using standard methods.

1.4.3 One solution to overcome this issue is to model migratory bird movements. APEM has developed the bespoke software model 'Migropath' to provide estimates of such movements. This builds on the work carried out by the British Trust for Ornithology (BTO) for the SOSS-05 project (Wright et al., 2012). Migropath can be employed to estimate the proportion of a given population, which is thought to pass through a site's footprint, assuming point-to-point migration (for example from the coastline of continental Europe to designated Special Protection Areas (SPAs) within the UK). Further details on this model are provided in **Section 3: Migropath modelling methodology (migratory non-seabirds).**

1.4.4 The use of Migropath cannot be applied to all species, typically those species which do not display point-to-point migration patterns are unsuitable to be modelled using this procedure (Alerstam, 1990). Many seabird species fall into this category (Wernham et al., 2002), as many seabirds are known to undertake longer migratory routes, for example following the coastline in preference to a more direct route over land. For those species which display this migratory behaviour, a 'broad front' pathway might better describe the movements of these species as they travel through the English Channel. Consequently, the risks to which this population is exposed relates to the proportion of the 'broad front' pathway crossing, in this instance, the location of the Rampion 2 array area. Within that 'broad front', birds might be distributed evenly, or they might have a distribution that is skewed, such as a bias towards the coast. Further details on this model are provided in **Section 4: 'Broad Front' modelling (migratory seabirds)**.

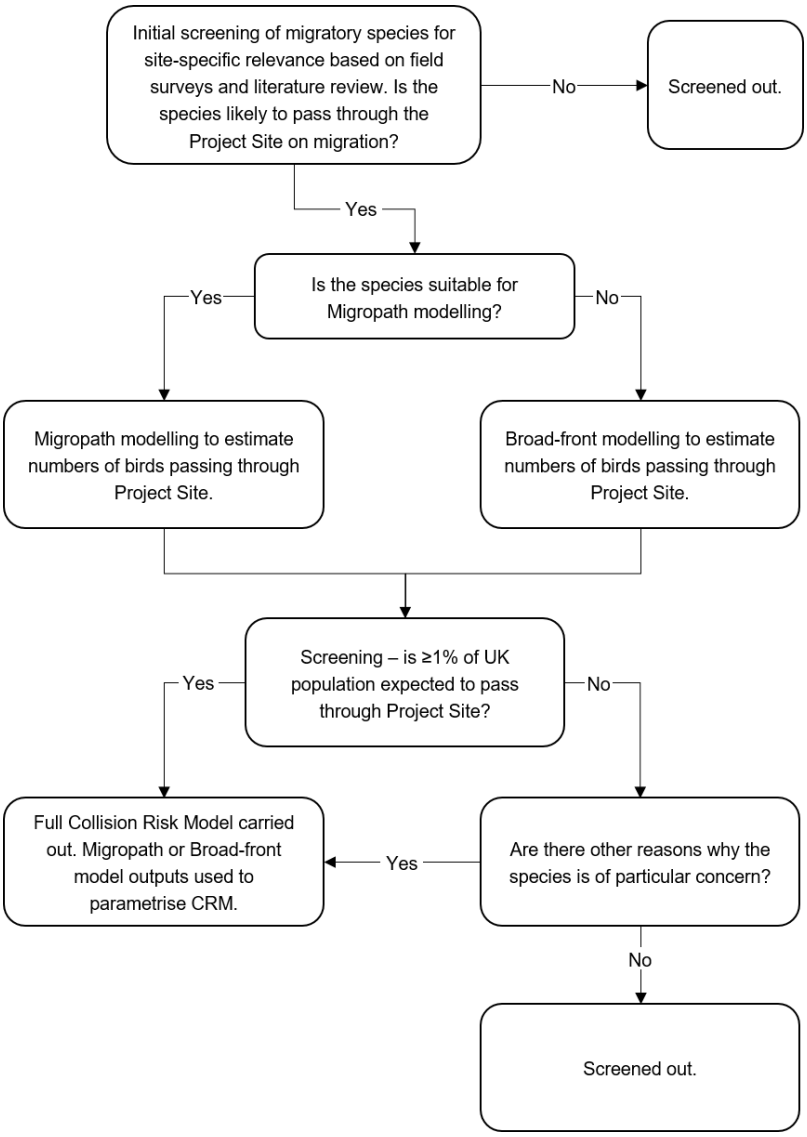
2. Methodology

2.1.1 This section describes the methodical approach for screening.

2.2 Screening methodology

2.2.1 A combination of data sources – field surveys, literature review, Migropath modelling, and migratory apportionment - have been used to determine which species are required to undergo further impact assessments for migratory collision risk. For those species which have been identified as candidates for further investigation, the results which were obtained through the initial data search have been used as inputs in the CRM. Particularly, the results which pertain to the timing and numbers of bird migrating through the area of interest. The standard threshold that is used to screen in migratory birds, is if 1% of the UK population is expected to pass through the site footprint each year, in this case the Rampion 2 array area. Alternatively, migratory species can be screened in if there is species-specific evidence of an elevated risk of a significant impact from collisions. Note that the focus of this report is to assess potential interaction of migratory species passing through the Rampion 2 array area and not for species present in the project area for longer periods (for example, breeding birds which may fly through the project area on regular foraging trips), which are considered separately in **Appendix 12.3: Offshore and intertidal ornithology collision risk modelling, Volume 4** of the ES (Document Reference: 6.4.12.3). This is summarised in the flow chart below (**Graphic 2-1**).

Graphic 2-1 Flowchart showing approach to screening and CRM for migratory bird species



2.3 Screening results

2.3.1 An initial screening exercise was completed to identify any migratory bird species that may pass through or nearby to the Rampion 2 array area. A review of Rampion 2, Rampion 1 aerial survey data and boat-based survey data, migration surveys, local bird reports and other ornithological literature helped identify the birds to take on to the next stage of modelling. The species screened in are presented in **Table 2-1**, and the full approach to assessment is detailed in the screening matrix presented in **Annex A**.

2.3.2 For the purposes of initial screening, the above sources of information were considered as well as expert judgement and experience of undertaking previous assessments of migratory birds for the purpose of assessing potential risk from collision with wind turbines. The objective was to screen out species which are unlikely to pass through the Rampion 2 array area in any meaningful numbers on migration.

Table 2-1 Migratory Birds Screened for Rampion 2 and modelling approach

Migropath modelling		
‘European’ White-fronted goose	Marsh harrier	Knot
‘Dark-bellied’ Brent goose	Hen harrier	Dunlin
Shelduck	Osprey	Ruff
Wigeon	Oystercatcher	Snipe
Gadwall	Avocet	Black-tailed godwit
Teal	Stone-curlew	Bar-tailed godwit
Pintail	Ringed plover	Whimbrel
Shoveler	Golden plover	Redshank
Pochard	Grey plover	Turnstone
Red-breasted merganser	Lapwing	Nightjar
Little egret	Sanderling	
‘Broad front’ modelling		
Arctic skua	Little tern	Arctic tern
Mediterranean gull	Roseate tern	Sandwich tern

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3. Migropath modelling methodology (migratory non-seabirds)

3.1.1 This section provides details of the Migropath modelling approach taken for migratory non-seabird species considered.

3.2 Migropath modelling approach

3.2.1 The non-breeding waterbird populations of UK SPAs (UK National Site Network) are regularly surveyed annually by the Wetland Bird Survey (Frost et al. 2020). Occasional surveys of non-breeding SPA features have been carried out, for example the inshore 2000/01 and 2001/02 Joint Nature Conservation Committee (JNCC) Winter Seaduck Survey (Dean et al. 2003). Each SPA has its original designation figures. There is therefore information on the numbers of birds over-wintering or breeding on these sites. From ringing/tagging data, as well as other literature, there is also information on the likely origin of some or all of these populations, including transboundary migrations (Wernham et al., 2002). A general migration route or zone can therefore be defined for a given population of birds. Furthermore, data from continental sites (e.g. staging posts, observatories) can be used to further refine the likely fronts, as well as provide information on temporal components of migration (e.g. daily passage rate and duration of migration events).

3.2.2 It is therefore possible to estimate the numbers of birds associated with one SPA, with a defined group of SPAs, or with a regional suite of SPAs that will encounter one or more wind farms by defining appropriate migratory corridors.

3.2.3 The approach is a relatively uncomplicated method to answer a pressing set of questions. In order to develop more complex models simulating bird movement, additional environmental variables such as weather and photoperiod, and biological factors such as flight speed, energy budget, flocking behaviour and manoeuvrability will need to be considered. APEM has been involved in similar simulations for fish passage at tidal barrage locations (Willis and Teague 2014), using hydrodynamic and behavioural modelling, but at present, no such models exist for UK birds.

3.3 Migropath modelling assumption

3.3.1 Migropath has been developed alongside BTO's SOSS-05 project (Wright et al. 2012) and therefore is limited to the species considered in that project, specifically species that are either designated features of UK SPAs ('SPA species'), or other rare or vulnerable species listed in Annex **I** of the EU Birds Directive ('Annex I species') that regularly migrate across UK waters. Annex 1 species that only occasionally migrate across UK waters are excluded.

3.3.2 Migropath inevitably makes several assumptions. Chief amongst these is the assumption that migration is in a straight line between the SPA of interest and a

given point (or defined area) outside the UK. Birds migrating between breeding / wintering grounds outside the UK and UK SPAs that do not pass through the Rampion 2 array area are not considered to be at collision risk from Rampion 2, based on the assumption of straight-line migration. Such no-risk (no risk from Rampion 2) movements can be factored in to estimated proportions of birds arriving on/departing from SPAs but not encountering the Rampion 2 array area.

3.3.3 Another key assumption is that all migration of a particular species to a particular suite of SPAs can be defined within a set corridor. This corridor should aim to realistically represent the area across which birds must move.

3.3.4 Migropath does not take into account any macro-avoidance behaviour of birds (i.e. birds may alter their route to avoid the array area). It therefore represents the number of birds expected to pass through the Rampion 2 array area in the absence of any turbines. This ensures avoidance is not double-counted, as the CRM model includes an avoidance factor. The potential for macro-avoidance to impact migratory birds by increasing the length of their migration and energy expenditure (barrier effect) is considered in **Chapter 12: Offshore and intertidal ornithology, Volume 2** of the ES (Document Reference: 6.2.12).

3.3.5 Migropath does not consider flight height, and as a precautionary assumption where the migratory route intersects the Rampion 2 array area, it is assumed that this leads to a potential for collisions to occur. The proportion of birds at potential collision height is included as an input into the CRM model (**Section 7: Collision risk modelling for migratory birds**).

3.4 Migropath modelling technical methodology

3.4.1 The centroid of each SPA was calculated using the geometry function within ESRI® ArcMapTM 9.2 or QGIS 3.10. The coastlines of Continental Europe and Iceland were split into 1km segments, and each segment labelled with a unique ID. Using the ET Geowizard or MMQGIS Hub Lines tool, each segment along the European coast was joined to the centre of each SPA, with each line classified as either passing within or out from the Rampion 2 array area.

3.4.2 A list of SPAs that each of the species is associated with was collated (JNCC, no date; Stroud et al., 2001). This information, along with the migratory pathways, was then fed into the statistical software ‘R’ (R Core Team 2021).

3.4.3 Shapefiles produced as part of the SOSS_05 project (Wright et al., 2012) were used to determine which parts of the European or Icelandic coastline migrants of each species are expected to use. Where species have known staging sites in Europe, the locations of these were also extracted from the shapefiles.

3.4.4 Within R, all possible flight paths for each species determined in the previous step were then considered – i.e. all flight paths between the portion the European or Icelandic coast identified for each species and SPAs associated with each species. The proportion of birds following each individual flight path was allocated randomly across those flight paths. For species which are known to stage or moult in known staging sites, an extra step was carried out to ensure that the proportion of birds departing from the staging area equalled the proportion of the population known to use the staging area. For birds staging in the Wadden sea, this proportion was extracted from Laursen et al. (2010).

3.4.5 Note that the model is not directional and can be run separately for autumn and spring migrations, allowing these to be parameterised differently if appropriate. For example, the proportion of birds using staging areas may differ between migration periods.

3.4.6 For some species, distinct races, sub-species, or populations were modelled separately, where there is evidence that migratory patterns differ between them.

3.4.7 The proportion of birds modelled to pass through the Rampion 2 array area in one year was then calculated. The model re-runs the random allocation of flight paths 200 times in order to estimate the confidence surrounding this result.

3.4.8 Where the proportion of birds passing through the Rampion 2 array area exceeded the threshold of 1% of the UK population, this was then converted to absolute numbers of birds to feed into CRM. Estimates of the flyway population were obtained from the SOSS-05 project (Wright et al., 2012) while estimates for the UK population were from Woodward et al. (2020). For species with distinct races, sub-species, or populations modelled separately in Migropath, the 1% threshold was based on the summed collision risk for that species, and the CRM was carried out using this summed estimate.

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4. ‘Broad Front’ modelling (migratory seabirds)

4.1.1 This section provides details of the Broad Front modelling approach taken for migratory seabird species considered.

4.2 Approach

4.2.1 This method is based on a basic calculation utilising species-specific information on population estimates and migration behaviour derived from desk-based study, with the results presented in **Section 6**. The method used to calculate ‘broad front’ migration follows a stepwise methodology outlined below:

- identify the population of birds undertaking the ‘broad front’ migration;
- identify the width of the ‘broad front’ based on the migratory pathway or corridor that is being used;
- calculate the proportion of the ‘broad front’ occupied by the Rampion 2 array area perpendicular to the direction of flight;
- where possible, identify if there is any skewed distribution of birds within the ‘broad front’ such as a preference to fly along the coast; and
- calculate the numbers of birds flying across the array area based on the proportion of the ‘broad front’ occupied by the array area factoring in any skewed migratory distribution.

4.2.2 To ensure the estimates are precautionary, the maximum ‘broad front’ corridor is assumed to extend from the UK coast to the French coast based on the Rampion 2 location. This represents the width intersecting the array area perpendicular to birds migrating in an East/West flight pattern and was measured as being 132km. The width of the array area within that corridor is calculated to be 12.5km based on the maximum design scenario. This is the widest point across the array area and when presuming an even distribution of birds migrating within the ‘broad front’ represents the worst-case scenario for collision risk.

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5. Results of Migropath modelling (migratory non-seabirds)

5.1.1 This section provides the outputs derived from the Migropath modelling procedure run for all migratory non-seabird species considered to pass through the Rampion 2 Array Area.

5.1.2 The total number of bird species determined to be screened in for Migropath modelling was 32 species. The majority were waterfowl and wader species but marsh and hen harrier, and nightjar were also included in the analysis. Most were included due to the importance of the populations which migrate to the UK for the non-breeding seasons; however, for species which also breed in the UK, the migratory breeding population was also included in the model.

5.1.3 The mean proportion of the UK population expected to pass through the Rampion 2 array area and the number of birds this equates to is presented in **Table 5-1**. The upper and lower confidence limits are presented in **Annex B**.

5.1.4 Where the UK population is uncertain, the range of outputs has been presented in **Table 5-1**.

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Table 5-1 Results from Migropath modelling to estimate the number of birds of each species passing through the Rampion 2 array area on migration (and the proportion of the migratory population it represents). Species screened out are shown in italics

Species/ Population	UK Population	Migration Season	Number of birds passing through the Rampion 2 array area each migration (mean; see Appendix A for details)	Percentage of migratory population passing through the Rampion 2 array area each migration (mean; see Appendix A for details)	Percentage of UK population passing through Rampion 2 array area annually (mean)
White-fronted goose (*albifrons*; wintering)	2,400	Spring/Autumn	139	5.77%	5.77%
Brent goose (bernicla; wintering)	*91,000*	*Spring/Autumn*	*1*	*0.00%*	*0.00%*
Shelduck (wintering)	*61,000*	*Spring/Autumn*	*3*	*0.01%*	*0.01%*
Wigeon (wintering)	440,000	Spring/Autumn	18,136	4.12%	4.12%
Gadwall (wintering)	25,000	Spring/Autumn	1,835	6.90%	6.90%
Teal (wintering)	210,000	Spring/Autumn	8,026	3.82%	3.82%
Pintail (wintering)	29,000	Spring/Autumn	954	3.29%	3.29%

Species/ Population	UK Population	Migration Season	Number of birds passing through the Rampion 2 array area each migration (mean; see Appendix A for details)	Percentage of migratory population passing through the Rampion 2 array area each migration (mean; see Appendix A for details)	Percentage of UK population passing through Rampion 2 array area annually (mean)
Shoveler (wintering)	18,000	Spring/Autumn	958	5.32%	5.32%
Pochard (wintering)	38,000	Spring/Autumn	2,682	7.06%	7.06%
Red-breasted merganser (wintering)	*8,400*	*Spring/Autumn*	*0*	*0.00%*	*0.00%*
Little egret	4,500	Spring/Autumn	381	8.47%	8.47%
Marsh harrier	201	Spring/Autumn	40	19.81%	19.81%
Hen harrier (wintering)	750	Spring/Autumn	20	5.26%	2.63%
Osprey (migratory breeding)	*296*	*Spring/Autumn*	*0*	*0.00%*	*0.00%*
Oystercatcher (migratory breeding)	226,000	Spring/Autumn	11,489	10.17%	5.08%

Species/ Population	UK Population	Migration Season	Number of birds passing through the Rampion 2 array area each migration (mean; see Appendix A for details)	Percentage of migratory population passing through the Rampion 2 array area each migration (mean; see Appendix A for details)	Percentage of UK population passing through Rampion 2 array area annually (mean)
Oystercatcher (wintering)	320,000	Spring/Autumn	31	0.02%	0.02%
Avocet (migratory breeding)	877	Spring/Autumn	189	21.54%	21.54%
Avocet (wintering)	7,500	Spring/Autumn	9	0.12%	0.12%
Stone-curlew (migratory breeding)	*694*	*Spring/Autumn*	*0*	*0.00%*	*0.00%*
Ringed plover (migratory breeding)	10,876	Spring/Autumn	1,835	16.87%	16.87%
Ringed plover (wintering)	34,000	Spring/Autumn	1,714	5.04%	5.04%
Golden plover (migratory breeding)	45,200	Spring/Autumn	3,296	7.29%	7.29%

Species/ Population	UK Population	Migration Season	Number of birds passing through the Rampion 2 array area each migration (mean; see Appendix A for details)	Percentage of migratory population passing through the Rampion 2 array area each migration (mean; see Appendix A for details)	Percentage of UK population passing through Rampion 2 array area annually (mean)
Golden plover (wintering)	400,000	Spring/Autumn	0	0.00%	0.00%
Grey plover (wintering)	43,000	Spring/Autumn	1,157	2.69%	2.69%
Lapwing (wintering)	620,000	Spring/Autumn	27,722	4.47%	4.47%
Knot (wintering)	320,000	Spring/Autumn	9,289	2.90%	2.90%
Sanderling (wintering)	16,000	Spring/Autumn	366	2.29%	2.29%
Dunlin (migratory breeding)	18,300 – 19,800	Spring/Autumn	340 – 368	1.86%	1.86%
Ruff	800	Spring/Autumn	36	4.49%	4.49%
Snipe (wintering)	1,000,000	Spring/Autumn	63,277	6.33%	6.33%
Black-tailed godwit (*islandica*; wintering)	43,000	Spring/Autumn	3,297	8.37%	8.37%

Species/ Population	UK Population	Migration Season	Number of birds passing through the Rampion 2 array area each migration (mean; see Appendix A for details)	Percentage of migratory population passing through the Rampion 2 array area each migration (mean; see Appendix A for details)	Percentage of UK population passing through Rampion 2 array area annually (mean)
Bar-tailed godwit (wintering)	38,000	Spring/Autumn	415	1.09%	1.09%
Whimbrel (passage)	3,840	Spring/Autumn	71	1.86%	1.86%
Redshank (migratory breeding)	77,600	Spring/Autumn	1,889	2.43%	2.43%
Redshank (wintering)	120,000	Spring/Autumn	4,691	3.91%	3.91%
Turnstone (wintering)	48,000	Spring/Autumn	1,592	3.32%	3.32%
Nightjar (migratory breeding)	4,600	Spring/Autumn	392	8.52%	8.52%

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6. Results of 'Broad Front' modelling

6.1.1 This section provides the outputs derived from the Broad Front modelling procedure run for all migratory seabird species considered to pass through the Rampion 2 Array Area.

6.2 Species screened in

6.2.1 The total number of bird species determined to be required to be screened in for 'broad front' modelling was six seabirds (see **Table 2-1)**. These were: Arctic skua, Mediterranean gull, little tern, roseate tern, Arctic tern and Sandwich tern. To determine the number of migratory seabirds that are considered within the 'broad front' modelling process, a full literature review was undertaken for each species. A summary of these literature reviews that form the basis of the evidence for each species and how these populations are apportioned for CRM are presented in the following sections.

Arctic skua

6.2.2 The Arctic skua has a circumpolar and largely Arctic breeding range. The UK is at the extreme southern limit of the species breeding distribution and this population has declined significantly in recent years (Furness 2015). Mitchell et al. (2004) estimate the northeast Atlantic population at between 15,000 – 35,000 pairs and tens to hundreds of thousands of pairs on the Arctic tundra bordering the North Atlantic. Although a monotypic species, Arctic skua exhibits two colour phases, with proportions of each varying clinally. Dark phases predominate at colonies at the southern edge of the breeding range and the majority of high Arctic breeders are pale phase birds (Furness 2015).

6.2.3 Arctic skua is a long-distance, trans-equatorial migrant. Autumn migration may start as early as July but most juveniles and adults at UK breeding sites depart colonies in early August (Furness 2015). Birds from populations further north pass through UK waters mainly in August-September. Post-breeding migration typically follows the coast, with birds from North Sea colonies migrating south either through the North Sea and English Channel or in western waters, mostly along the west coast of Ireland with a small number travelling through the Irish Sea (Furness 2015). Autumn migration may continue into October but is completed by late October (Pennington et al., 2004). No Arctic skuas overwinter in UK waters.

6.2.4 Return migration from southern hemisphere wintering sites begins in late-March and tends to be more rapid. Arctic skuas reach UK waters by early April, peaking in April-May (Wernham et al., 2002). In contrast to autumn migration, most birds travel north up the west coast of Britain and Ireland rather than through the North Sea (Forrester et al., 2007). Large numbers may pass the west coast of Scotland, but these often travel far from land (Furness 2015). Scottish adult Arctic Skuas arrive back at breeding sites in late April and May but Arctic breeding birds may not occupy breeding sites until June (Wernham et al. 2002).

6.2.5 In the UK, Arctic skua is confined to north Scotland, with Orkney and Shetland hosting the majority of the UK breeding population. The UK North Sea and Channel Biologically Defined Minimum Population Scales (BDMPS) is defined by Furness (2015) as 5,287 for the autumn migration period (August to October) and 1,227 for the spring migration period (April to May). The understanding of Arctic skua movements and routes are relatively poor, especially with regards to overseas population due to limited ring recoveries and tracking studies.

6.2.6 During the 24 months of site-specific aerial digital surveys conducted for Rampion 2 (detailed in **Appendix 12.1: Offshore and intertidal ornithology baseline technical report, Volume 4** of the ES (Document Reference: 6.4.12.1)), no Arctic skuas were recorded within the Rampion 2 array area plus 4km buffer. However, Arctic skua was recorded in boast-based surveys for Rampion 1.

Mediterranean gull

6.2.7 Although scarce visitors to most of UK and Ireland, Mediterranean gulls are an increasingly familiar sight across southern and eastern England, as well as some locations further north, owing to a steady increase in the northwest European breeding population since the 1960s (Wernham et al., 2002). Globally, this species has a Palearctic breeding range with the main populations centred on the Ukrainian Black Sea coast. Following rapid range expansions, the breeding range now spreads discontinuously across the northeast Atlantic, North Sea, Black Sea and Caspian Sea coasts (Wernham et al., 2002). The first documented breeding attempt in Britain occurred in 1968, and by Seabird 2000 (Mitchell et al., 2004) 100 pairs breed in Britain. Increasing dramatically to 2,373–2,400 pairs in 2018 (Eaton and Holling 2020).

6.2.8 Movements of Mediterranean gulls can be difficult to interpret due in part to the range expansion but also as individuals may breed at widely separated locations in successive years. Ring-recoveries from birds ringed in Ukraine during the late 1940s and early 1950s suggest migrations away from Black Sea colonies begins in July, with birds reaching the Adriatic and eastern Libya in August and September, and the central Mediterranean by October. Some continue to the west Mediterranean and through the strait of Gibraltar into the east Atlantic, wintering along the coasts of Iberian and south to northwest Africa. A proportion also reach northern France and the Baltic, whereas some remain at the northeast coasts of the Black Sea (Wernham et al., 2002; Mayaud 1954). Mediterranean gull movements are predominantly coastal, although some follow major river valleys, particularly the Danube, across eastern Europe. Individuals breeding at Black Sea colonies may also travel overland across Turkey (Wernham et al., 2002).

6.2.9 There is limited data available for Mediterranean gulls in UK and Ireland due to a paucity of ringing projects from the UK. Co-ordinated colour-ringing across Europe since the late 1980s has, however, provided some details of the origins of birds within the UK (Wernham et al., 2002). Results from colour-ringing suggest the Hungarian population travel overland via the Danube and the Rhine to wintering quarters along the Atlantic coast, including the UK. Colour-ring re-sightings have identified the Netherlands, Germany, France and the former Yugoslavia as other origins of Mediterranean gulls present in UK and Ireland (Wernham et al., 2002).

6.2.10 Observations in Britain and Ireland show a notable arrival from July into early August and continuing through to September and October Mediterranean gulls are present throughout the winter with sites in southwest England used to a greater degree than at other times of year (Wernham et al., 2002). Individual wintering sites within the UK show regular turnover of birds through late winter and early spring, confirmed by re-sightings of colour-ringed individuals (Wernham et al., 2002).

6.2.11 Return migration towards North Sea breeding sites can begin as early as late January but more typically from February onwards, with adults arriving back on breeding grounds by late March and early April. Young birds also move eastward in spring, but these movements are much later in first-years compared to second-year birds and adults (Wernham et al., 2002). Mediterranean gulls moving back to Black Sea breeding colonies from the western Mediterranean do so from early March to late May, with many immatures remaining in the Mediterranean during the summer months (Wernham et al., 2002).

6.2.12 All seabirds assessed here, including Mediterranean gull migrate on and east-west axis through the English Channel and therefore Rampion 2. However, it is possible that birds breeding on the south coast of England may additionally travel on a north-south axis between their breeding colony and the open waters of the English Channel. However, as the largest UK breeding colony, Langstone Harbour, is west of the Rampion 2 array area, it is expected any north-south route from this location will not result in passage through Rampion 2, and indeed such birds will not have any passage through Rampion 2 if they migrate directly between the breeding colony and the Atlantic (and then on to wintering grounds). Furthermore, Mediterranean gulls from breeding colonies east of Rampion 2, along with UK wintering birds, are still expected to travel east-west through the English Channel as the 'broad front' approach assumes. Therefore, carrying out the assessment using the east-west axis for the broad front approach is reasonable and even precautionary considering the largest breeding colony is west of Rampion 2 and therefore unlikely to have significant connectivity during migration.

6.2.13 As Mediterranean gulls are not included in Furness (2015), the total migratory population with potential connectivity to Rampion 2 has been calculated as the sum of the breeding population of 2,400 pairs (Eaton et al., 2020) and the wintering population of 4,000 individuals (Woodward et al., 2020), to give a total of 8,800 individuals.

6.2.14 Mediterranean gulls were recorded in all seven months (September to March) of the site-specific intertidal surveys conducted for Rampion 2 (detailed in **Appendix 12.1: Offshore and intertidal ornithology baseline technical report, Volume 4** of the ES (Document Reference: 6.4.12.1)), with a peak count of 149 individuals in September 2020. During the 24 months of site-specific aerial digital surveys (detailed in **Appendix 12.1: Offshore and intertidal ornithology baseline technical report, Volume 4** of the ES (Document Reference: 6.4.12.1)), no Mediterranean gulls were recorded within the Rampion 2 array area. However, Mediterranean gull was recorded within the 4km buffer in one survey: February 2021, with an estimated peak abundance of eight individuals.

Little tern

6.2.15 The little tern has a wide breeding range that includes the Palearctic, Afrotropic and Australasian regions. Nominate *S. albifrons* breeds in the UK and Ireland and eastward across most of Europe (largest numbers in southern countries), central Asia, northern India and North Africa. Further races occur in central Africa, Australia and East Asia (Wernham et al., 2002). Across its range, little tern breeds on the coast and at inland waterways. However, in the UK and Ireland the species is strictly coastal. Its total population size is between 70,000-100,000 pairs with around 17,000-22,000 pairs breeding in Europe (Wernham et al., 2002; Mitchell et al., 2004). Little terns are highly migratory across their northern range with most western European breeding birds migrating to winter in near-shore areas off the west coast of Africa (Furness 2015; Wernham et al., 2002).

6.2.16 Post-breeding migration can be rather rapid, with ring recoveries from southern Europe as early as August (Wernham et al., 2002). Gatherings of little terns in the Netherlands in August suggests birds from a wide geographical area may stage here during autumn migration (Wernham et al., 2002). Birds ringed at Scottish colonies have been recovered in Denmark, in comparison to English birds which have mostly been recovered in the Netherlands, suggesting Scottish little terns may cross the North Sea eastward from Scotland rather than moving south (Wernham et al., 2002; Furness 2015). Spring migration begins in March in southern Europe with the first little terns arriving in the UK in April. The majority of birds are back at breeding locations by May (Furness 2015).

6.2.17 It is not well known if birds breeding elsewhere pass through UK waters on migration. Presumably at least Irish breeding little terns (210 pairs in Seabird 2000; Mitchell et al., 2004) must pass through UK waters during migration between Ireland and West Africa (Furness 2015). Moreover, while large numbers are known to breed in Fennoscandia, the Baltic states, Germany and the Netherlands (Mitchell et al., 2004) there is no evidence of these populations crossing the North Sea into UK waters. In contrast, ring recovery data suggests these populations migrate through continental Europe (Furness 2015; Wernham et al., 2002). An assessment of little tern migration undertaken by WWT and MacArthur Green (2014) concluded that the majority of little tern migration is likely to track coastlines in a narrow band of 0 to 10 km from shore. The BDMPS for little tern in the UK North Sea and Channel is defined by Furness (2015) as 3,524 for both spring and autumn migration seasons (mid-April to May and late July to early September).

6.2.18 During the 24 months of site-specific aerial digital surveys conducted for Rampion 2 (detailed in **Appendix 12.1: Offshore and intertidal ornithology baseline technical report, Volume 4** of the ES (Document Reference: 6.4.12.1)), no little terns were recorded within the Rampion 2 array area. However, little terns were recorded within the 4km buffer in one survey: June 2020, with an estimated peak abundance of 25 individuals.

Roseate tern

6.2.19 Roseate tern has a cosmopolitan distribution, breeding in tropical, sub-tropical and temperate regions around the world. There are five subspecies worldwide, but only nominate *S. dougallii* occurs in UK water. The nominate race breeds across the

north Atlantic coast of Europe and North America, travelling south to wintering grounds in west Africa and the Caribbean respectively. Mitchell et al. (2004) estimates the European population as between 1,900-2,400 pairs. Seabird 2000 recorded 734 in Ireland and 56 pairs in the UK, the majority of which breed on the Northumberland coast (Mitchel et al., 2004).

6.2.20 Roseate tern is a scarce species in the UK and their migration has not been studied in detail. It is, however, certain that UK breeding birds must pass through UK waters on migration. There is no evidence to suggest roseate terns migrate overland like common and Arctic terns do, so there is unlikely to be notable interchange between birds from the North Sea and western waters (Furness 2015). Roseate terns at UK colonies fledge chicks in July and post-breeding dispersal begins in August, with colonies deserted by late August (Wernham et al., 2002). During this time, birds congregate at suitable foraging sites and chicks remain dependent on adults for feeding. Autumn migration occurs mainly in August-October but peaks in August-September. However, some birds (presumably failed breeders) arrive on the wintering grounds by July (Wernham et al., 2002). Almost all first-year birds remain on the wintering grounds for their first summer, but a small number may visit breeding colonies briefly in July. Most, but not all, second-year birds attend breeding sites in late June and July to prospect nest sites (Wernham et al., 2002; Furness 2015).

6.2.21 Adults depart west African wintering grounds in March-April, spring migration peaks in May and is completed by early June (Wernham et al., 2002). Numbers observed on spring migration are very much smaller than those seen in autumn. This a common pattern for most seabird species but is very distinct in roseate tern. The causes of this are not understood (Furness 2015). Spring migration is more rapid than autumn migration which may explain this trend.

6.2.22 No roseate terns ringed at colonies outside of the UK and Ireland have been recorded in UK waters (Furness 2015). However, despite a preference to return to natal colonies, first-breeders are likely to recruit to any colony in northwest Europe. Clearly representing a meta-population with extensive gene flow. In comparison, there are very few records of chicks from northwest Europe visiting colonies in the Azores or North America, suggesting these colonies are somewhat discrete.

6.2.23 The BDMPS for roseate tern in the East coast and Channel is defined by Furness (2015) as 251 for both spring and autumn migration seasons (late-April to May and late July to early September). During 24 months of site-specific aerial digital surveys conducted for Rampion 2, no roseate terns were recorded in the Rampion 2 array area plus 4km buffer.

Arctic tern

6.2.24 Britain is at the southern edge of the breeding range of the Arctic tern, and colonies are concentrated in the north of England and Scotland with its stronghold in Orkney and Shetland (Wright et al., 2012; Wernham et al., 2002). At the end of the breeding season, the main post-breeding movement of adult birds is southwards. Movements through Britain and Ireland are thought to occur further offshore than other British tern species (Furness 2015; Wernham et al., 2002). The migration continues southwards along the coast of western and southern Africa to wintering sites around the Antarctic (Wright et al., 2012). The return passage

begins in March, with birds heading for European colonies heading northwards through the eastern Atlantic, with a similar route to that undertaken in autumn taken in spring (Wernham et al., 2002). In Britain, overland northward movements of Arctic terns are indicated by observations of hundreds or even thousands of birds during some spring months at reservoirs in central England. These observations may be the result of poor flying conditions at sea or at high altitudes over land (Kramer 1995).

6.2.25 An assessment of Arctic tern migration undertaken by WWT and MacArthur Green (2014) concluded that the majority of UK Arctic terns migrate within 20km from the UK coastline based on observations from coastal watches and offshore surveys.

6.2.26 The BDMPS for Arctic terns is defined by Furness (2015) as 163,930 for both the spring and autumn migration seasons in UK North Sea and Channel (late April to May and July to early September). Arctic tern in most UK SPA colonies are monitored frequently. There has been a considerable decline in numbers from UK SPAs; if the same decline is apparent in non-SPA colonies, then the estimated number quoted could be smaller. Understanding of Arctic tern movements is relatively poor, due to limited ring recoveries in the UK and no studies conducted using geolocators with birds connected to UK waters.

6.2.27 During the 24 months of site-specific aerial digital surveys conducted for Rampion 2 (detailed in **Appendix 12.1: Offshore and intertidal ornithology baseline technical report, Volume 4** of the ES (Document Reference: 6.4.12.1)), no Arctic terns were recorded to species level within the Rampion 2 array area. However, Arctic and/or common tern were recorded in two surveys: September 2019 and May 2020, with an estimated peak abundance of 19 individuals.

Sandwich tern

6.2.28 The Sandwich tern has a circumpolar distribution and can be found breeding in most of Europe, Asia and North America except to the extreme north and south, with a total population at least 100,000 pairs, consisting of approximately 40,000 pairs in Europe and 45,000 pairs in North America, an estimated 40,000 pairs in the Caspian Sea (based on counts in 1995) and between 75,000 and 80,000 pairs in the former USSR (del Hoyo et al. 1992-2013).

6.2.29 Sandwich terns are a strictly coastal and a mainly warm-water species (del Hoyo et al., 1992-2013). After the breeding season, birds move north and south to favourable feeding grounds, dispersing around the coasts of Britain and Ireland and across the North Sea to the Netherlands and Denmark in late-June, July and August before southward migration begins in mid-September to wintering grounds (Wernham et al., 2002; del Hoyo et al., 1992-2013).

6.2.30 Return migration occurs between March and May and is more direct than in autumn, it is believed that birds from the west of the UK and Ireland do not enter the Channel on southward migration due to lack of recoveries (Wernham et al., 2002).

6.2.31 In the UK and Ireland, sandwich terns are primarily concentrated in three main areas: Northeast Scotland, Northumberland, and Norfolk, these locations alone make up over 60% of the UK and Ireland breeding population (Wernham et al.,

2002). On the North Sea coasts of the UK, the main colonies of Sandwich terns are located at the Ythan Estuary (NE Scotland), Farne and Coquet Islands (Northumberland), Blakeney Point and Scolt Head Island (North Norfolk coast) (Furness 2015). The UK North Sea and Channel BDMPS for Sandwich terns is defined by Furness (2015) as 38,051 individuals for both migration seasons (July to September and March to May). Understanding of Sandwich tern movements is relatively poor, due to limited ring recoveries in the UK and no studies conducted using geolocators.

6.2.32 Sandwich tern is listed in Stienen et al. (2007) as an inshore species that is most abundant within 20km from the shoreline. An assessment of Sandwich tern migration undertaken by WWT and MacArthur Green (2013) concluded that the majority of UK Sandwich terns migrate within 10km from the UK coastline based on observations from coastal watches and offshore surveys.

6.2.33 During the 24 months of site-specific aerial digital surveys conducted for Rampion 2 (detailed in **Appendix 12.1: Offshore and intertidal ornithology baseline technical report, Volume 4** of the ES (Document Reference: 6.4.12.1)), sandwich tern was recorded within the Rampion 2 array area in two surveys: August 2019 and May 2020, with an estimated peak abundance of nine individuals.

6.3 Summary of 'Broad Front' modelling assumptions

6.3.1 The Rampion 2 array area is located 14km offshore at its nearest point form the south-east coast of England. For the little tern, Arctic and Sandwich tern species, a migratory corridor of 20km was used as identified in the literature searches in **Section 6.2**: . It should be noted that this is highly precautionary for little tern and Sandwich tern, both of which primarily migrate up to 10km from the coast (WWT and MacArthur Green 2014). For Arctic skua, Mediterranean gull and roseate tern, the literature search did not identify that a predisposition for following the coast when on migration, it was therefore assumed the migratory corridor spans the entire width of the English Channel, taken to be 132km measured through Rampion 2.

6.3.2 The total populations with potential connectivity to Rampion 2 are presented in **Table 6-1**. Due to the migration routes of seabirds described in **Section 6.2**: **Species screened in**, the populations with potential for connectivity with Rampion 2 on migration were derived from Furness (2015) defined BDMPS for the North Sea and Channel. However, for Mediterranean gull, which is not assessed in Furness (2015), populations with potential migration connectivity with Rampion 2 included the total UK breeding population from Eaton et al. (2020), as 90% of the breeding population is concentrated on the south coast of England. On a precautionary basis, this was combined with the UK wintering population estimated in Woodward et al. (2020) as detailed above. From these total populations, the estimated numbers of birds predicted to pass through the Rampion 2 array area on migration are presented in **Table 6-2**.

Table 6-1 Total number of migratory seabirds with potential connectivity to Rampion 2 during spring and autumn migration

Species	Spring Migration	Autumn Migration
Arctic skua	1,227	6,427
Mediterranean gull	8,800	8,800
Little tern	3,524	3,524
Roseate tern	251	251
Arctic tern	163,930	163,930
Sandwich tern	38,051	38,051

Table 6-2 Estimated number of migratory seabirds predicted to pass through the Rampion 2 array area in spring and autumn

Species	Spring Migration	Autumn Migration
Arctic skua	116	609
Mediterranean gull	833	833
Little tern	1,057	1,057
Roseate tern	24	24
Arctic tern	49,179	49,179
Sandwich tern	11,415	11,415

7. Collision risk modelling for migratory birds

7.1 CRM methodology

7.1.1 There is potential risk to migratory birds from OWFs through collision with wind turbines and associated infrastructure. The risk to migratory birds can occur when passing through the area on seasonal migrations. The potential collision risk can be estimated using CRM.

7.1.2 CRM was carried out using the Band (2012) model. The Band (2012) model is still the most recent and only available model that can be used to estimate collision risk for migratory species, where the density of birds cannot be reliably estimated from site-specific surveys.

7.2 CRM input parameters

7.2.1 The CRM input parameters for each species run through the Band (2012) model are presented in **Table 7-1**. Species biometrics for all species were obtained from Robinson (2005).

7.2.2 Flight speeds for species were derived from Alterstam et al. (2007), where possible. Flight speeds given in Alterstam et al. (2007) are generally regarded as suitable for this purpose. For species not included in Alterstam et al. (2007), alternative published species-specific flight speeds were used if available, detailed in **Table 7-1**. If no species-specific flight speeds were available, flight speeds for the most similar co-generic species included in Alterstam et al. (2007) were substituted, as detailed in **Table 7-1**. Nocturnal activity scores were obtained from (King et al., 2009).

7.2.3 The Large Array Correction factor was applied, using the longest line through the array area as the width (37km).

7.2.4 The “width of migration corridor” value used within the Band model for calculating migrant flux density was calculated as the width of the Rampion 2 array area perpendicular to the direction of migration, which was measured as 12.5km.

Table 7-1 Species biometrics used in the migratory CRM of the proposed Rampion 2 for all species selected

Species	Body Length (m)	Wingspan (m)	Flight Speed (ms^{-1})	Nocturnal Activity	Flight Type
'European' White-fronted goose	0.72	1.48	16.1	5	Flapping
Wigeon	0.48	0.80	20.6	5	Flapping
Gadwall	0.51	0.90	19.6	5	Flapping
Teal	0.36	0.61	19.7	5	Flapping
Pintail	0.58	0.88	20.6	5	Flapping
Shoveler	0.48	0.77	20.6	5	Flapping
Pochard	0.46	0.77	23.6	3	Flapping
Little egret	0.60	0.92	8.71	1	Flapping
Marsh harrier	0.52	1.22	10.1	2	Flapping
Hen harrier	0.48	1.10	9.1	2	Flapping
Oystercatcher	0.42	0.83	13.0	5	Flapping
Avocet	0.44	0.78	12.3	5	Flapping
Ringed plover	0.19	0.52	19.5	5	Flapping
Golden plover	0.28	0.72	13.7[2]	5	Flapping
Grey plover	0.28	0.77	17.9	5	Flapping
Lapwing	0.30	0.84	11.9	5	Flapping
Knot	0.24	0.59	20.1	5	Flapping
Sanderling	0.20	0.42	21.4[3]	5	Flapping
Dunlin	0.18	0.40	15.3	5	Flapping
Ruff	0.25	0.53	13.6	5	Flapping
Snipe	0.26	0.46	17.1	5	Flapping
Black-tailed godwit	0.42	0.76	18.3[4]	5	Flapping

Species	Body Length (m)	Wingspan (m)	Flight Speed (ms^{-1})	Nocturnal Activity	Flight Type
Bar-tailed godwit	0.38	0.75	18.3	5	Flapping
Whimbrel	0.41	0.82	16.3	5	Flapping
Redshank	0.28	0.62	12.3[5]	5	Flapping
Turnstone	0.23	0.54	14.9	5[6]	Flapping
Nightjar	0.27	0.60	8.7[7]	5	Flapping
Arctic skua	0.44	1.18	13.8	1	Flapping
Mediterranean gull	0.37	0.96	11.9[8]	2[8]	Flapping
Little tern	0.23	0.52	10.0[9]	1	Flapping
Roseate tern	0.36	0.76	10.0[9]	1	Flapping
Arctic tern	0.34	0.80	10.9	1	Flapping
Sandwich tern	0.38	1.00	10.0	1	Flapping

[1] Used *Egretta thula* value
[2] Used *Pluvialis dominica* value
[3] Howell et al. (2020)
[4] Used *Limosa lapponica* value
[5] Used *Tringa nebularia* value
[6] Used *Calidris spp*. value (*C. alpina*, *C. alba and C. canutus* all have nocturnal activity rating of 5)
[7] Norevik et al. (2021)
[8] Used *Chroicocephalus ridibundus* value
[9] Cook et al. (2014)

Avoidance rates

7.2.5 A bird's ability to avoid colliding with a wind turbine's rotating blades is a critical factor in predicting mortality rates. This ability will vary between species and is a measure of how sensitive each species is to those turbines and the wind farm in its entirety.

7.2.6 CRM following the standard Band model (Band 2012) was carried out using the following range of avoidance rates, 95%, 98%, 99%, and 99.5% for all species. For species where no specific avoidance rate has been calculated, Cook et al. (2014) recommend using an avoidance rate of 98% for evaluation of collision risk.

Proportion at Potential Collision Height

7.2.7 Band Option 1 (BO1) and/or Band Option 2 (BO2) have been used to carry out all of the CRM. BO1 uses a fixed proportion at Potential Collision Height (PCH). For

all species considered in this report, the proportions of birds at PCH from literature sources have been used as the sample sizes from site-based survey data were too low these species (**Table 7-2**). For BO1, for Arctic skua, Arctic tern and Sandwich tern, proportion at PCH values were taken from Cook et al. (2012), which assessed the flight height data from 32 OWFs. For the remaining species, the generic species group values put forward by Wright et al. (2012) were selected in the absence of any species-specific proportion at PCH data. BO2 uses flight height distribution data and turbine parameters (air gap and rotor radius) to calculate the proportion of birds at PCH. BO2 is therefore reliant on availability of flight height distribution data. For Arctic skua, Arctic and Sandwich tern BO2 CRM was run using the maximum likelihood values in the Johnson et al. (2014) flight height spreadsheets, which supplemented the SOSS-02 project (Cook et al. 2012).

Table 7-2 Proportion at Potential Collision Height (PCH) for all migratory species used for BO1 CRM

Species	Proportion at PCH (%)
‘European White-fronted goose	30.0
Wigeon	15.0
Gadwall	15.0
Teal	15.0
Pintail	15.0
Shoveler	15.0
Pochard	15.0
Little egret	50.0
Marsh harrier	50.0
Hen harrier	50.0
Oystercatcher	25.0
Avocet	25.0
Ringed plover	25.0
Golden plover	25.0
Grey plover	25.0
Lapwing	25.0
Knot	25.0

Species	Proportion at PCH (%)
Sanderling	25.0
Dunlin	25.0
Ruff	25.0
Snipe	25.0
Black-tailed godwit	25.0
Bar-tailed godwit	25.0
Redshank	25.0
Whimbrel	25.0
Turnstone	25.0
Nightjar	50.0
Arctic skua	3.8
Mediterranean gull	8.0[1]
Little tern	7.0
Roseate tern	7.0
Arctic tern	2.8
Sandwich tern	3.6

[1] Used *Chroicocephalus ridibundus* value

Turbine parameters

7.2.8 Input parameters for the wind turbine specifications used within the CRM are presented in **Section 2.2** of **Appendix 12.3: Offshore and intertidal ornithology collision risk modelling, Volume 4** of the ES (Document Reference: 6.4.12.3).

7.3 CRM results

7.3.1 Species for which less than 1% of the UK population are expected to pass through the Rampion 2 array area were screened out, and the Band (2012) CRM was run for remaining species. The species screened out were 'dark-bellied' brent goose, shelduck, red-breasted merganser, osprey, oystercatcher (wintering only), avocet (wintering only), stone-curlew and golden plover (wintering only).

7.3.2 The annual total number of collisions for each species, using the most appropriate avoidance rates for each species and based on the mean population size and mean results from Migropath and 'broad front' modelling, are presented in

Table 7-3. Results are presented using both Band Option 1 (BO1) and Band Option 2 (BO2), where possible.

Table 7-3 Summary of annual collision risk for species screened in.

Species	Avoidance Rate	Annual Collision Rate BO1	Annual Collision Rate BO2
European White-fronted goose	95.0%	0.11	N/A
	98.0%	0.04	N/A
	99.0%	0.02	N/A
	99.5%	0.01	N/A
Wigeon	95.0%	6.30	N/A
	98.0%	2.52	N/A
	99.0%	1.26	N/A
	99.5%	0.63	N/A
Gadwall	95.0%	0.65	N/A
	98.0%	0.26	N/A
	99.0%	0.13	N/A
	99.5%	0.06	N/A
Teal	95.0%	2.70	N/A
	98.0%	1.08	N/A
	99.0%	0.54	N/A
	99.5%	0.27	N/A
Pintail	95.0%	0.34	N/A
	98.0%	0.14	N/A
	99.0%	0.07	N/A
	99.5%	0.03	N/A
Shoveler	95.0%	0.33	N/A
	98.0%	0.13	N/A

Species	Avoidance Rate	Annual Collision Rate BO1	Annual Collision Rate BO2
	99.0%	0.07	N/A
	99.5%	0.03	N/A
Pochard	95.0%	0.92	N/A
	98.0%	0.37	N/A
	99.0%	0.18	N/A
	99.5%	0.09	N/A
Little egret	95.0%	0.53	N/A
	98.0%	0.21	N/A
	99.0%	0.11	N/A
	99.5%	0.05	N/A
Marsh harrier	95.0%	0.05	N/A
	98.0%	0.02	N/A
	99.0%	0.01	N/A
	99.5%	0.01	N/A
Hen harrier	95.0%	0.03	N/A
	98.0%	0.01	N/A
	99.0%	0.01	N/A
	99.5%	0.00	N/A
Oystercatcher	95.0%	6.91	N/A
	98.0%	2.77	N/A
	99.0%	1.38	N/A
	99.5%	0.69	N/A
Avocet	95.0%	0.12	N/A
	98.0%	0.05	N/A

Species	Avoidance Rate	Annual Collision Rate BO1	Annual Collision Rate BO2
	99.0%	0.02	N/A
	99.5%	0.01	N/A
Ringed plover	95.0%	0.12	N/A
	98.0%	0.05	N/A
	99.0%	0.02	N/A
	99.5%	0.01	N/A
Golden plover	95.0%	2.24	N/A
	98.0%	0.89	N/A
	99.0%	0.45	N/A
	99.5%	0.22	N/A
Grey plover	95.0%	0.65	N/A
	98.0%	0.26	N/A
	99.0%	0.13	N/A
	99.5%	0.07	N/A
Lapwing	95.0%	16.21	N/A
	98.0%	6.48	N/A
	99.0%	3.24	N/A
	99.5%	1.62	N/A
Knot	95.0%	5.10	N/A
	98.0%	2.04	N/A
	99.0%	1.02	N/A
	99.5%	0.51	N/A
Sanderling	95.0%	0.20	N/A
	98.0%	0.08	N/A

Species	Avoidance Rate	Annual Collision Rate BO1	Annual Collision Rate BO2
	99.0%	0.04	N/A
	99.5%	0.02	N/A
Dunlin	95.0%	0.18 – 0.20	N/A
	98.0%	0.07 – 0.08	N/A
	99.0%	0.04	N/A
	99.5%	0.02	N/A
Ruff	95.0%	0.02	N/A
	98.0%	0.01	N/A
	99.0%	0.00	N/A
	99.5%	0.00	N/A
Snipe	95.0%	34.68	N/A
	98.0%	13.88	N/A
	99.0%	6.94	N/A
	99.5%	3.47	N/A
Black-tailed godwit	95.0%	2.07	N/A
	98.0%	0.83	N/A
	99.0%	0.41	N/A
	99.5%	0.21	N/A
Bar-tailed godwit	95.0%	0.24	N/A
	98.0%	0.09	N/A
	99.0%	0.05	N/A
	99.5%	0.02	N/A
Redshank	95.0%	3.76	N/A
	98.0%	1.50	N/A

Species	Avoidance Rate	Annual Collision Rate BO1	Annual Collision Rate BO2
	99.0%	0.75	N/A
	99.5%	0.38	N/A
Whimbrel	95.0%	0.04	N/A
	98.0%	0.02	N/A
	99.0%	0.01	N/A
	99.5%	0.00	N/A
Turnstone	95.0%	0.88	N/A
	98.0%	0.35	N/A
	99.0%	0.18	N/A
	99.5%	0.09	N/A
Nightjar	95.0%	0.23	N/A
	98.0%	0.09	N/A
	99.0%	0.05	N/A
	99.5%	0.02	N/A
Arctic skua	95.0%	0.10	0.03
	98.0%	0.04	0.01
	99.0%	0.02	0.01
	99.5%	0.01	0.00
Mediterranean gull	95.0%	0.47	N/A
	98.0%	0.19	N/A
	99.0%	0.09	N/A
	99.5%	0.05	N/A
Little tern	95.0%	0.50	N/A
	98.0%	0.20	N/A

Species	Avoidance Rate	Annual Collision Rate BO1	Annual Collision Rate BO2
	99.0%	0.10	N/A
	99.5%	0.05	N/A
Roseate tern	95.0%	0.01	N/A
	98.0%	0.00	N/A
	99.0%	0.00	N/A
	99.5%	0.00	N/A
Arctic tern	95.0%	9.73	5.89
	98.0%	3.89	2.36
	99.0%	1.95	1.18
	99.5%	0.97	0.59
Sandwich tern	95.0%	3.01	2.87
	98.0%	1.21	1.15
	99.0%	0.60	0.57
	99.5%	0.30	0.29

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8. Glossary of terms and abbreviations

Table 8-1 Glossary of terms and abbreviations

Term (acronym)	Definition
CRM	Collision Risk Modelling
Development Consent Order (DCO)	An order made under the Planning Act 2008 granting development consent for one or more Nationally Significant Infrastructure Projects (NSIP).
EIA	Environmental Impact Assessment
ES	Environmental Statement
km	Kilometres
OWF	Offshore Wind Farm
PCH	Potential Collision Height
RED	Rampion Extension Development Limited (the Applicant)
TCE	The Crown Estate
SPA	Special Protected Area
WTG	Wind Turbine Generators

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Annex A
Screening Matrix

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Key
Main flight path not over site
Assessed in Baseline/EIA
Not selected for modelling
Species selected for modelling
Insufficient data available

No.	Species / Sub-Species	Scientific Name	Flight Path through array area		Observations from surveys		Literature Review		Species of CRM Concern (SOSS		Perceived Risk from Collision		SOSS 02 Flight Heights		Qualifiying Feature with potential connectivity to SPA				Screened in?	Comments
			Main	Partial	Rampion 1	Rampion 2	Wernham, C., Toms, M., Marchant, J., Clark, J., Siriwardena, G. and Baillie, S. (2002). The Migration Atlas: Movements of the Birds of Britain and Ireland. T & AD Poyser.	Rampion 1 ES (CRM magnitude of effect)	Spring	Autumn	Langston, R.H.W. (2010) Offshore wind farms and birds: Round 3 zones, extensions to Round 1 & Round 2 sites & Scottish Territorial Waters. RSPB Research Report No. 39.	Furness, B. & Wade, H. (2012) Vulnerability of Scottish Seabirds to Offshore Wind Turbines. Report for Marine Scotland, The Scottish Government.	Percentage of Birds flying at Potential Collision Height (PCH)	Confidence Level attached to PCH	Chichester and Langstone Harbours SPA / RAMSAR	Portsmouth Harbour SPA / RAMSAR	Solent and Southampton Water SPA / RAMSAR	Pagham Harbour SPA / RAMSAR		
1	Bewick's Swan	*Cygnus columbianus bewickii*	No	No	No	No	None	n/a	n/a	n/a	high	n/a							No	Bewick's swan is not a qualifiying feature of any SPA with potential connectivity to Rampion 2. This species was not recorded in boat or aerial survey for Rampion 1 or 2 and as the migration shadow does not cross over Rampion 2. Therefore this species is at no risk.
2	Whooper Swan	*Cygnus cygnus*	No	No	No	No	Mod	n/a	low/mod	mod	high	n/a							No	Not selected for modelling as migration path is not over site.
3	Bean Goose	*Anser fabalis*	No	No	No	No	None	n/a	n/a	n/a	mod	n/a							No	Not selected for modelling as migration path is not over site.
4	Pink-footed Goose	*Anser brachyrhynchus*	No	No	No	No	Low	n/a	low	low/mod	mod	n/a							No	Not selected for modelling as migration path is not over site.
5	European White-fronted Goose	*Anser albifrons albifrons*	Yes	No	No	No	None	n/a	low	low	mod	n/a							Yes	Britain is at the western edge of *albifrons* wintering range with the majority of the population concentrating in Severn Estuary, Kent and East Anglia. Most birds migrate across the southern North Sea. But as the migration zone also includes the eastern English Channel this species is screened in on a precautionary basis.
6	Greenland White-fronted Goose	*Anser albifrons flavirostris*	No	No	No	No	Low	n/a	n/a	n/a	n/a	n/a							No	Not selected for modelling as migration path is not over site.
7	Icelandic Greylag Goose	*Anser anser*	No	No	No	No	None	n/a	low	low	n/a	n/a							No	Not selected for modelling as migration path is not over site.
8	Greenland Barnacle Goose	*Branta leucopsis*	No	No	No	No	None	n/a	n/a	n/a	n/a	n/a							No	Not selected for modelling as migration path is not over site.
9	Svalbard Barnacle Goose	*Branta leucopsis*	No	No	No	No	None	n/a	low	low	n/a	n/a							No	Not selected for modelling as migration path is not over site.
10	Dark-bellied Brent Goose	*Branta bernicla bernicla*	Yes	No	Yes	Yes	None	None	low	low/mod	mod	n/a			Yes	Yes	Yes	Yes	Yes	British wintering birds account for almost half of the entire flyway population. This subspecies is a qualifying feature of four SPAs/RAMSARs with potential connectivity to Rampion 2. Recorded in boat and aerial surveys for Rampion I and aerial surveys for Rampion 2.
11	Canadian Light-bellied Brent Goose	*Branta bernicla hrota*	No	No	No	No	Low	n/a	n/a	n/a	n/a	n/a							No	Not selected for modelling as migration path is not over site.
12	Svalbard Light-bellied Brent Goose	*Branta bernicla hrota*	No	No	No	No	None	n/a	n/a	n/a	mod	n/a							No	Not selected for modelling as migration path is not over site.
13	Shelduck	*Tadorna tadorna*	Yes	No	No	Yes	Low	n/a	low	low	n/a	n/a			Yes				Yes	The majority of shelduck migrate across the North Sea. This species is a qualifying feature of Chinchester and Langstone Harbours SPA/RAMSAR. Recorded in aerial surveys for Rampion 2.
14	Wigeon	*Anas penelope*	Yes	No	No	No	Low	n/a	low	low	n/a	n/a			Yes				Yes	Qualifying feature of Chinchester and Langstone Harbours SPA/RAMSAR. Details of migratory movements are poorly understood; however, there is widespread movement within and between UK and continental Europe. The highest concentrations of migrating birds are expected to be in the North Sea. However, on a precautionary basis, this species has been screened in.

15	Gadwall	*Anas strepera*	**Yes**	No	No	No	Low	n/a	low	low	n/a	n/a							**Yes**	Details of migratory movements are poorly understood; however, there is widespread movement within and between the UK and continental Europe. The highest concentrations of migrating birds are expected to be around the south east UK. Screened in on a precautionary basis.
16	Teal	*Anas crecca*	**Yes**	No	No	No	Low	n/a	low	low	n/a	n/a			**Yes**		**Yes**		**Yes**	Details of migratory movements are poorly understood, however there is widespread movements between the UK and continental Europe. Approximately 15% are estimated to fly at collision risk height (Wright et al. 2012). Teal is a qualifying feature of Chichester and Langstone Harbours SPA/RAMSAR and Solent and Southampton Water SPA/RAMSAR.
17	Mallard	Anas platyrhynchos	**Yes**	No	No	No	Low	n/a	low	low	n/a	n/a							No	Mallard is largely sedentary in the UK but there is evidence of movements to the continent but is perceived to be be at low risk of collision during migration.
18	Pintail	*Anas acuta*	**Yes**	No	No	No	Low	n/a	low	low	n/a	n/a			**Yes**				**Yes**	There is widespread movements within and between UK, Scandinavia and continental Europe, with some birds also moving from Iceland. However, specific details of migration movements are poorly understood, but it is believed most movement is via the southern North Sea and English Channel. Pintail are highly localised winter visitors and significant concentrations occur in a small number of sites. Approximately 15% are estimated to fly at collision risk height (Wright et al. 2012). Screened in on a precautionary basis.
19	Shoveler	*Anas clypeata*	**Yes**	No	No	No	Low	n/a	low	low	n/a	n/a			**Yes**				**Yes**	There is widespread movements between the UK and continental Europe. Most move across the North Sea, however, a large proportion of these birds continue south to France and southern Europe, probably crossing the English Channel.
20	Pochard	*Aythya ferina*	**Yes**	No	No	No	Low	n/a	low	low	n/a	n/a							**Yes**	Details of migratory movements are not well known but the majority of wintering birds probably cross the central and southern North Sea with smaller numbers crossing the English Channel. Screened in on a precautionary basis.
21	Tufted Duck	*Aythya fuligula*	No	**Yes**	No	No	Low	n/a	low	low	n/a	n/a							No	Details of migratory movements are not well known, however, there is widespread movements between the UK, Ireland, Iceland, Scandinavia, continental Europe. Only small numbers cross the English Channel.
22	Scaup	*Aythya marila*	No	No	No	No	Low	n/a	low	low	low	mod							No	Not selected for modelling as migration path is not over site.
23	Eider	*Somateria mollissima*	No	**Yes**	No	No	Low	n/a	low	low	low	mod	11.54	v low					No	Most UK breeding birds are fairly sedentary. There is some evidence of movemet around the UK. Wintering birds crossing from the continent are concentrated on the east coast, especially around Scotland.
24	Long-tailed Duck	*Clangula hyemalis*	No	**Yes**	No	No	n/a	n/a	low	low	low	low							No	Most migration is between Scandinavia and Scotland. However, a small numbers travel further around the UK and Ireland. Unlikely to migrate through Rampion 2 in significant numbers.

25	Common Scoter	*Melanitta nigra*	**Yes**	No	**Yes**	No	n/a	None	low	low	low	low	0.04	v high					No	Migration routes are poorly understood, but significant numbers of birds migrate between key wintering sites around the UK and breeding grounds elsewhere in northern Europe and Iceland. Common scoter were screened out of collision risk modelling due to low sensitivity.
26	Velvet Scoter	*Melanitta fusca*	**Yes**	No	No	No	n/a	n/a	low	low	low	low							No	Scarce species in UK waters. Most numerous in NE Scotland.
27	Goldeneye	*Bucephala clangula*	**Yes**	No	No	No	Low	n/a	low	low	low	low							No	Migration routes across UK waters and the precise timing of migration are not well understood. Most winter in northern England, Scotland and Northern Ireland.
28	Smew	*Mergus albellus*	No	No	No	No	n/a	n/a	low	low	n/a	n/a							No	Scarce species in the UK. No migratory shadow available as migration routes are poorly understood.
29	Red-breasted Merganser	*Mergus serrator*	No	**Yes**	**Yes**	No	n/a	n/a	low	low	low	n/a			**Yes**	**Yes**			**Yes**	Details of migration routes are not well understood; however there is an influx of birds in winter from Iceland and probably central Europe. Red-breasted merganser is a qualifying feature of SPAs with potential connectivity to Rampion 2.
30	Goosander	*Mergus merganser*	**Yes**	No	No	No	Low	n/a	low	low	n/a	n/a							No	Those that winter in Britain are thought to be largely derived from the Bristish breeding population but some may migrate in from the neear continent, epsecially to southeast England during cold weather. However, this species is considered low risk to collision.
31	Red-throated Diver	*Gavia stellata*	**Yes**	No	**Yes**	**Yes**	Mod	n/a	n/a	n/a	low	mod							No	Migratory routes are poorly understood, however, there is a general movement south following the breeding season with UK breeding birds not moving as far as populations from Iceland and northern Europe. Screened out of collision risk modelling due to low sensitivity.
32	Black-throated Diver	*Gavia arctica*	No	No	No	No	n/a	n/a	n/a	n/a	n/a	mod/high	0.61	mod					No	Not selected for modelling as migration path is not over site.
33	Fulmar	*Fulmarus glacialis*	**Yes**	No	**Yes**	**Yes**	Low	n/a	low	low	low	n/a							No	Wide ranging on migration. Some birds travel large distances out into the Atlantic while others remain around the coast of UK and Ireland. Fulmar were screened out of collision risk modelling due to low sensitivity.
34	Manx Shearwater	*Puffinus puffinus*	**Yes**	No	**Yes**	**Yes**	Low	n/a	n/a	n/a	low	low	0.00	mod					No	Wide ranging. Main migratory movement is south-west across the Atlantic as far as the Brazilian coast. Manx shearwater were screened out of collision risk modelling due to low sensitivity.
35	Storm Petrel	*Hydrobates pelagicus*	**Yes**	No	**Yes**	No	Low	n/a	n/a	n/a	low	low							No	Details of migration routes are not well understood but this species could travel through the eastern English Channel. Recorded during Rampion 1 surveys but considered of low risk to collision.
36	Leach's Petrel	*Oceanodroma leucorhoa*	**Yes**	No	No	No	Low	n/a	n/a	n/a	low	low							No	Migration routes are not well understood. But it is believed most migration occurs down the west coast of the UK and Ireland. Species considered low risk to collision.

37	Gannet	*Morus bassanus*	Yes	No	Yes	Yes	Mod	Medium	mod/high	mod/high	mod	high							No	Specific details of migratory routes are not well understood; however it is likely that birds do use the English Channel when migrating between breeding grounds in Britain and Northern Europe and wintering grounds to the south. It is assumed that gannet densities during migratory seasons are well represented by site-specific survey data and therefore no separate migratory assessment is required. The potential effect from collision risk to gannet is considered in detail in the main assessment.
38	Cormorant	*Phalacrocorax carbo*	Yes	No	Yes	Yes	Low	n/a	n/a	n/a	mod	low/mod	0.03	v low					No	Most UK breeding birds are largely sedentary; however, some disperse south to wintering sites long the French, Portugese and northern Spanish coasts. There is also some movement of contiental breeding birds to the UK during winter. Cormorant was recorded in surveys of Rampion 1 and 2 but is considered low risk to collision.
39	Shag	*Phalacrocorax aristotelis*	Yes	No	No	No	Low	n/a	n/a	n/a	low	mod	1.45	mod					No	Some Shags disperse widely outside the breeding season but many remain within 50-100 km of breeding colonies throughout the year. This species is considered low risk of collision.
40	Bittern	*Botaurus stellaris*	Yes	No	No	No	n/a	n/a	n/a	n/a	n/a	n/a							No	The UK breeding population is largley sedentary; however, in the non-breeding season the UK populations is often supplemented by birds from continetal Europe but the details of these movements are poorly understood. Available evidence suggests UK breeding bitterns are unlikely to come into contact with offshore windfarms.
41	Little Egret	*Egretta garzetta*	Yes	No	No	No	n/a	n/a	n/a	n/a	n/a	n/a							Yes	UK numbers are boosted by influxes from the continent during winter. However, these movements are not well understood but it is likely most arrive to the UK from France. On a precautionary basis this species is screened in.
42	Great Crested Grebe	*Podiceps cristatus*	Yes	No	No	No	Low	n/a	n/a	n/a	n/a	low							No	There is widespread movement of great crested grebes around UK and Ireland, with some arriving from continental Europe but these movements are poorly understood.
43	Slavonian Grebe	*Podiceps auritus*	Yes	No	No	No	n/a	n/a	n/a	n/a	low	mod							No	Details of migratory movements are poorly understood; however, birds moving from Holarctic breeding grounds to overwinter in Britain, Ireland and Europe may use any of the waters around the UK.
44	Honey-buzzard	*Pernis apivorus*	Yes	No	No	No	n/a	n/a	n/a	n/a	n/a	n/a							No	Honey Buzzard is a long-distance migrant, travelling to breeding sites in southern England from tropical Africa. Only a small proportion of the international population occurs in the UK.
45	White-tailed Eagle	*Haliaeetus albicilla*	No	No	No	No	n/a	n/a	n/a	n/a	n/a	high							No	Not selected for modelling as migration path is not over site.
46	Marsh Harrier	*Circus aeruginosus*	Yes	No	No	No	None	n/a	n/a	n/a	n/a	n/a							Yes	Marsh harrier in the UK is a partial migrant, with some individuals remaining in the UK over winter and others migrating to southern Europe and sub-Saharan Africa, but these routes are not well understood. On a precautionary basis this species is screened in.

47	Hen Harrier	*Circus cyaneus*	**Yes**	No	No	No	Low	n/a	n/a	n/a	n/a	n/a							**Yes**	Of the UK-breeding population, approximately half of first-year birds and 25% of older birds are believed to migrate outside of the UK. The majortiy of which head south into France and the Iberian Penisula, crossing the English Channel between Devon and Brittany. The UK non-breeding population is supplemented by birds from Scandinavia and continental Europe, but the numbers involved are uncertain. Screened in on a precautionary basis.
48	Montagu's Harrier	*Circus pygargus*	**Yes**	No	No	No	None	n/a	n/a	n/a	n/a	n/a							No	Montagu's harrier is a long-distance migrant, travelling to breeding sites in Europe from sub-Saharan Africa. The UK is at the northwest limit of the species range with only a fraction of the international population breeding.
49	Osprey	*Pandion haliaetus*	**Yes**	No	No	No	Low	n/a	n/a	n/a	n/a	n/a							**Yes**	Ospreys migrate between breeding sites in the UK and wintering grounds in western Africa. Following a route via Spain, France and crossing the English Channel. Screened in on a precautionary basis.
50	Merlin	*Falco columbarius*	**Yes**	No	No	No	Low	n/a	n/a	n/a	n/a	n/a							No	The majority of the UK population is relatively sedentary; however, there is evidence that in winter a small number of additional birds arrive from Iceland. The details of migratory routes followed by these birds is poorly understood but it seems unlikely many cross the Engish Channel.
51	Spotted Crake	*Porzana porzana*	**Yes**	No	No	No	None	n/a	n/a	n/a	n/a	n/a							No	Very little is known about spotted crake migration routes. However, most move south towards African wintering grounds. A fraction of the international population is made up of UK breeding birds.
52	Corncrake	*Crex crex*	**Yes**	No	No	No	n/a	n/a	low	low	high	n/a							No	The UK-breeding population is largely restricted to islands on the west coast of Scotland. Migration takes place between those breeding grounds and wintering grounds in sub-Saharan Africa. The migratory routes are poorly understood, however, Corncrakes are known to migrate at very high altitudes, meaning they are at very low risk of collision.
53	Coot	*Fulica atra*	**Yes**	No	**Yes**	No	None	None	n/a	n/a	n/a	n/a							No	UK Coots are largely sedentary; however, there is some evidence of movements into the UK from the Baltic, North Sea and North French coasts. But knowledge of these movements is limited.
54	Oystercatcher	*Haematopus ostralegus*	**Yes**	No	No	No	Mod	n/a	n/a	n/a	n/a	n/a							**Yes**	There is widespread movement within and between UK, Ireland, Iceland, Scandinavia and continental Europe; however the specifics of these movements are not well understood. Oystercatcher is not a qualifying feature of SPAs with potentail connectivity to Rampion 2. Screened in based on its widespread migratory movements.
55	Avocet	*Recurvirostra avosetta*	**Yes**	No	No	No	None	n/a	n/a	n/a	n/a	n/a							**Yes**	Avocets in the UK are concentrated on the south and east coasts of England throughout the year. Some UK birds migrate south to sites in France, Iberia and North Africa, and in winter, birds arrive from the Low Countries into the UK. However, the precise details of these movements are not known. Screened in on a precautionary basis.

56	Stone-curlew	*Burhinus oedicnemus*	**Yes**	No	No	No	None	n/a	n/a	n/a	n/a	n/a							**Yes**	All Stone-curlews that breed in the UK are migratory, moving south to the Mediterranean and West Afrcia. Three key populations are in southern and eastern England and the majority of these crossing the English Channel to France in autumn. However, there may be a more eastern route across the southern North Sea during spring migration. There is no indication of significant passage from breeding sites elsewhere in Europe into the UK. Screened in on a precautionary basis.
57	Ringed Plover	*Charadrius hiaticula*	**Yes**	No	No	No	Low	n/a	n/a	n/a	n/a	n/a			**Yes**		**Yes**		**Yes**	Most ringed plover that breed in the UK remain in the UK; however, some a likely to undertake small movements around the UK or into France. Moreover, large numbers of ringed plover pass through the UK from breeding sites in Arctic Canada, Greenland, Iceland and Scandinavia en-route to wintering sites in Spain and West Africa. Ringed plover is a qualifying feature of SPAs with potential connectivity to Rampion 2.
58	Dotterel	*Charadrius morinellus*	**Yes**	No	No	No	Low	n/a	n/a	n/a	n/a	n/a							No	The small UK breeding population migrates southwards to Morocco during the winter. However, details of the migratory routes taken are unknown.
59	Golden Plover	*Pluvialis apricaria*	**Yes**	No	No	No	Low / mod	n/a	n/a	n/a	n/a	n/a							**Yes**	Specific details of migratory routes are not well understood; however, three different populations migrate through Britain, so this species could migrate across almost any UK waters. Some British breeders stay in the UK for the winter but other may migrate southwards to France, Iberia and North Africa, therefore crossing the English Channel.
60	Grey Plover	*Pluvialis squatarola*	**Yes**	No	No	No	Low	n/a	n/a	n/a	n/a	n/a			**Yes**				**Yes**	Grey plovers occur as passage migrants and winter visitors, with all birds belived to orginate from Russian breeding grounds. Autumn arrivals cross the North Sea with a signifcant proportion continuing south to southwest Europe and northwest Africa, presumably crossing the English Channel. During the return migration passage birds arrving in the UK presuambly cross the English Channel again. Grey Plover is a qualifying feature of Chichester and Langstone Harbours SPA/RAMSAR.
61	Lapwing	*Vanellus vanellus*	**Yes**	No	No	No	Mod	n/a	n/a	n/a	n/a	n/a							**Yes**	British breeding lapwings mainly migrate to the west, crossing the Irish Sea or southwest across the English Channel. Though many British breeders remain clsoe to breeding sites in winter. During the non-breeding season, lapwing migrate to the UK from Northern Europe. With further movements south and west during periods of cold weather. Lapwing may corss parts of the English Channel on the return migration.

62	Knot	*Calidris canutus*	**Yes**	No	No	No	Low	n/a	n/a	n/a	n/a	n/a							**Yes**	Large numbers of knot overwinter in or pass through the UK on migration from breeding grounds in the high Arctic and via staging grounds in Iceland and Norway. The UK is internationally important both as a wintering site and as a staging site in spring and autumn, supporting more than 70% of the *islandica* population. Although the precise details of migration routes are poorly undertsood, there is evidence of extensive movement around all UK waters. The English Channel is likely to be crossed by many birds that winter in France or further south.
63	Sanderling	*Calidris alba*	**Yes**	No	No	No	Low	n/a	n/a	n/a	n/a	n/a			**Yes**				**Yes**	Large numbers of sanderling pass through UK waters on migration from high Arctic breeding grounds to wintering grounds further south in Europe and Africa, likely crossing the English Channel. The precise routes taken at not known but it is evident that movements are widspread around all UK waters. Sanderling is a qualifying feature of Chichester and Langstone Harbours SPA.
64	Purple Sandpiper	*Calidris maritima*	No	No	No	No	None	n/a	n/a	n/a	n/a	n/a							No	Not selected for modelling as migration path is not over site.
65	Dunlin (breeding and passage populations)	*Calidris alpina schinzii and arctica*	**Yes**	No	No	No	Low	n/a	n/a	n/a	n/a	n/a							**Yes**	Both the majority of UK-breeding population of dunlin and migratory birds from breeding grounds further north in Iceland/Greenland (schinzii and arctica races) migrate to wintering grounds in Africa. The precise details of migration routes is poorly understood, but it is evident that there is extensive movement of birds around all UK waters, including crossing the English Channel.
66	Dunlin (wintering population)	*Calidris alpina alpina*	**Yes**	No	No	No	Mod	n/a	n/a	n/a	n/a	n/a			**Yes**	**Yes**			No	Birds of the *alpina* race that overwinter in Britain and Ireland migrate from northern Scandinavia and Russia. With substantial numbers crossing the North Sea. Juvenile dunlin migrate on a broader front than adults arriving in the UK and Ireland via the North Sea and probably the far-eastern parts of the English Channel. Limited movement of winter dunlin in the English Channel screens this population out of further collision risk modelling. However, wintering dunlin are a qualifying feature of Chichester and Langstone Harbours SPA / RAMSAR and Portsmouth Harbour SPA.
67	Ruff	*Philomachus pugnax*	**Yes**	No	No	No	None	n/a	n/a	n/a	n/a	n/a						**Yes**	**Yes**	Small numbers of ruff overwinter or breed in UK; a larger number (although still a small proportion of the biogeographic population) pass through on migration between breeding sites in Scandinavia or Russia to wintering sites in sub-Saharan Africa, North Africa or further south in Europe. Migratory routes are poorly understood, but it is thought that the English Channel and North Sea are probably the main routes. Ruff is a qualifying feature of Pagham Harbour SPA.

68	Snipe	*Gallinago gallinago*	**Yes**	No	No	No	Low	n/a	n/a	n/a	n/a	n/a							**Yes**	While many British-breeding birds make only small movements to stay within Britain, others migrate across the English Channel to Europe or across the Irish Sea to Ireland. In addition, outside of the breeding season there is an influx of birds from Iceland, northern Europe and Scandinavia to the UK and Ireland, with some continuing on from Britain across the English Channel into continental Europe. Details of migratory routes are unknown but it is evident that there is extensive movement of birds around all UK waters.
69	Black-tailed Godwit (breeding population)	*Limosa limosa limosa*	**Yes**	No	No	No	None	n/a	n/a	n/a	n/a	n/a							No	The British breeding population of Black-tailed Godwits is very small and concentrated at the two main breeding sites. Continental-breeding birds may migrate across Britain on passage but the precise migration routes are not known.
70	Black-tailed Godwit (Icelandic)	*Limosa limosa islandica*	**Yes**	No	No	No	Low	n/a	n/a	n/a	n/a	n/a				**Yes**	**Yes**		**Yes**	The vast majority of the Icelandic population of Black-tailed Godwits either winters in or migrates across the UK and Ireland. Details of migratory routes are unknown but it is evident that there is extensive movement of birds around all UK waters, including the English Channel. Black-tailed godwit is a qualifying feature of the Solent and Southampton Water SPA/RAMSAR and Portsmouth Harbour SPA.
71	Bar-tailed Godwit	*Limosa lapponica*	**Yes**	No	**Yes**	No	Low	Low	n/a	n/a	n/a	n/a			**Yes**				**Yes**	Bar-tailed Godwits that spend the winter in the UK come from breeding populations in Scandinavia and Russia. Their migration routes take almost the entire Britain and Ireland population across the North Sea, with some continuing across the English Channel (low thousands) while others remain in Britain for the winter. Bar-tailed godwit was recorded during Rampion I boat-based surveys and is a qualifying feature of Chichester and Langstone Harbours SPA.
72	Whimbrel	*Numenius phaeopus*	**Yes**	No	No	No	Low	n/a	n/a	n/a	n/a	n/a							**Yes**	A small number of whimbrel breed in the Shetland Isles but far larger numbers occur on passage migration. These passage birds breed in Iceland, Scandinavia and Russia and winter in West Africa, thus their migration routes take them across most parts of UK waters, including the English Channel.
73	Curlew	*Numenius arquata*	No	**Yes**	No	No	Mod	None	n/a	n/a	n/a	n/a			**Yes**				No	Although most UK-breeding birds remain within the UK and Ireland, most do travel significant distances between breeding and wintering sites, and the population is supplemented by birds breeding in northern Europe. Large numbers of Curlew migrate across the North Sea and Irish Sea, with much smaller numbers crossing the English Channel. Curlew is a qualifying feature of Chichester and Langstone Harbours SPA.
74	Greenshank	*Tringa nebularia*	**Yes**	No	No	No	Low	n/a	n/a	n/a	n/a	n/a							No	In the UK breeding greenshank is confined to Scotland. The migratory routes of these birds are not known in detail, but it is believed they winter in Ireland, western Britain, southwest Europe or northwest Africa and therefore may use any UK waters on migration. However, the proportion of the international population using UK waters on migration is low.

75	Wood Sandpiper	*Tringa glareola*	Yes	No	No	No	n/a	n/a	n/a	n/a	n/a	n/a							No	A very small number of wood sandpipers breed in northern Scotland. These birds winter in West Africa and thus must migrate across UK waters. A small number of passage birds also use UK waters when migrating between wintering grounds and other Palearctic breeding grounds. It is highly unlikely that any significant numbers would cross the Rampion 2 array area.
76	Redshank	*Tringa totanus*	Yes	No	No	No	Mod	n/a	n/a	n/a	n/a	n/a			Yes				Yes	Details of migratory movements are uncertain, but the UK-breeding brittanica population the robusta population (breeding in Iceland and the Faroes) are found all around UK waters on migration. Totanus (breeding in northern Europe) migrate mostly along the east an south coasts of the UK. Redshank is a qualifying feature of the Chichester and Langstone Harbours SPA / RAMSAR.
77	Turnstone	*Arenaria interpres*	Yes	No	No	No	Mod	n/a	n/a	n/a	n/a	n/a			Yes				Yes	Birds from breeding populations in northern Greenland, Arctic Canada and Scandinavia migrate to the UK, with some overwintering in the UK and others continuing south to continental Europe, many of which probably migrating via the English Channel. However, details of specific routes or if turnstones migrate on a broad front are not clear. Turnstone is a qualifying feature of Chichester and Langstone Harbours SPA.
78	Red-necked Phalarope	*Phalaropus lobatus*	Yes	No	No	No	None	n/a	n/a	n/a	n/a	n/a							No	A very small number of birds breed in the UK, in northern Scotland. They winter pelagically in the Atlantic. It is thought that the majority migrate via the east coast of the UK, and although details are not know, this species may migate through the English Channel.
79	Arctic Skua	*Stercorarius parasiticus*	Yes	No	Yes	No	Low	n/a	low/mod	mod/high	mod	high	0.07	mod					Yes	Birds breeding in northern Scotland and elsewhere in northern Europe migrate south and west towards the Atlantic, where they winter off the coasts of Europe, Africa and South America. It is thought that the majority follow a route through the North Sea and English Channel. Screened in on a precautionary basis.
80	Great Skua	*Stercorarius skua*	Yes	No	Yes	No	Low	Low	low/mod	mod/high	mod	high	0.34	high					No	Birds breeding in northern Britain migrate to wintering sites off the coasts of southern Europe and northwest Africa. It is thought that birds breeding on the west coast of the UK are likely to use the Irish Sea, while those from colonies in the Orkney and Shetland Isles probably migrate via the North Sea. The species is unlikely to pass through Rampion 2 in significant numbers.
81	Kittiwake	*Rissa tridactyla*	Yes	No	Yes	Yes	Mod	Medium	n/a	n/a	n/a	high							No	Birds breeding in the UK migrate to pelagic wintering grounds in the Atlantic. They can migrate in all directions past all coasts of Britain and Ireland. It is assumed that kittiwake densities during migratory seasons are well represented by site-specific survey data and therefore no separate migratory assessment is required. The potential effect from collision risk to kittiwakes is considered in detail in the main assessment.

82	Black-headed Gull	*Chroicocephalus ridibundus*	Yes	No	No	No	Low	n/a	low	low	n/a	high	2.01	v high					No	Most British breeding black-headed gulls may make small movements post-breeding but they mostly remain within Britian and Ireland. However, a small propotion of these movements may cross the English Channel to wintering sites in France or Iberia.
83	Mediterranean Gull	*Larus melanocephalus*	Yes	No	Yes	Yes	None	Low	n/a	n/a	mod	n/a					Yes		Yes	Mediterranean gulls are at the north-western limit of their breeding raneg in the UK. The wintering sites of British breeding Mediterranean gulls are poorly understood, but they are likely to winter around the English Channel and southern North Sea near the breeding sites. Breeding Mediterranean gull is a qualifying feature of the Solent and Southhampton Water SPA, therefore is screened in.
84	Common Gull	*Larus canus*	No	No	Yes	Yes	Low	None	low	low	n/a	high							No	Common Gulls breeding in Britain and Ireland are partial migrants, with some being fairly sedentary while others move in a south or south-westerly direction from breeding sites, but most remaining within Brtian and Ireland. The potential effect from collision risk to common gulls is considered in detail in the main assessment.
85	Lesser Black-backed Gull	*Larus fuscus*	Yes	No	Yes	Yes	Low	Medium	mod	mod	mod	high							No	Most UK-breeding birds migrate southwards to wintering sites on the coasts of Iberia and north-west Africa, and this includes movement through the Irish Sea. In addition, a large number of birds from other populations visit the UK during the non-breeding season, migrating from Iceland or, in larger numbers, across the North Sea from Scandinavia. It is assumed that lesser black-backed gull densities during migratory seasons are well represented by site-specific survey data and therefore no separate migratory assessment is required. The potential effect from collision risk to lesser black-backed gull is considered in detail in the main assessment.
86	Herring Gull	*Larus argentatus*	Yes	No	Yes	Yes	Low	Medium	mod	mod	mod	high							No	While most UK-breeding birds are fairly sedentary, some migrate including some movements between Britain and the near-continent. Potentially crossing the English Channel. It is assumed that herring gull densities during migratory seasons are well represented by site-specific survey data and therefore no separate migratory assessment is required. The potential effect from collision risk to herring gulls is considered in detail in the main assessment.
87	Great Black-backed Gull	*Larus marinus*	Yes	No	Yes	Yes	Low	Low	mod	mod	mod	high							No	While most UK-breeding birds are fairly sedentary, some migrate including some movement between Britan and continental Europe, potentially crossing the English Channel. It is assumed that great black-backed gull densities during migratory seasons are well represented by site-specific survey data and therefore no separate migratory assessment is required. The potential effect from collision risk to great black-backed gulls is considered in detail in the main assessment.

88	Little Tern	*Sternula albifrons*	Yes	No	No	No	Low	n/a	low/mod	low/mod	low	mod			Yes		Yes	Yes	Yes	All Little Terns that breed in the UK migrate to and from wintering sites off western Africa, probably via the western coasts of Europe. The details of migratory routes are poorly understood, but likely involve travelling through the English Channel. Breeding little tern is a qualifying feature of Chichester and Langstone Harbours SPA / RAMSAR, Solent and Southampton Water SPA and Pagham Harbour SPA.
89	Black Tern	*Childonias niger*	Yes	No	No	No	None	n/a	low/mod	low/mod	n/a	n/a							No	Black terns do not breed or winter in the UK but significant numbers occur in UK waters on passage migration. The routes taken and the numbers involved across UK waters are not well understood.
90	Sandwich Tern	*Sterna sandvicensis*	Yes	No	Yes	Yes	Low	None	low/mod	low/mod	mod	mod/high	0.48	mod	Yes		Yes		Yes	Both UK-breeding birds and birds which use UK waters on passage overwinter in West Africa. Details of migratory routes are uncertain, but birds are found all around UK waters. It is assumed that sandwich tern densities during migratory seasons are well represented by site-specific survey data. However, as specified by Natural England in their S42 reponses this species has been screened in for migratory collision risk assessment.
91	Common Tern	*Sterna hirundo*	Yes	No	Yes	Yes	Low	Low	low/mod	low/mod	mod	mod	0.54	low	Yes		Yes	Yes	No	Both UK-breeding birds and birds which use UK waters on passage overwinter in West Africa. Details of migratory routes are uncertain, but birds are found all around UK waters. It is assumed that common tern densities during migratory seasons are well represented by site-specific survey data and therefore no separate migratory assessment is required. The potential effect from collision risk to common tern is considered in detail in the main assessment.
92	Roseate Tern	*Sterna dougallii*	Yes	No	No	No	None	n/a	low/mod	low/mod	mod	mod					Yes		Yes	A small number of roseate terns breed in the UK, and those birds migrate southwards via the western coast of Europe to wintering sites on the west coast of Africa. Breeding roseate tern is a qualifying feature of the Solent and Southhampton Water SPA. Screened in on a precautionary basis.
93	Arctic Tern	*Sterna paradisaea*	Yes	No	Yes	Yes	Low	Low	low/mod	low/mod	mod	mod	0.14						Yes	Both UK-breeding birds and birds which use UK waters on passage migrate past the west of Africa to wintering sites around the Antarctic. Details of migratory routes are uncertain, but birds are found all around UK waters. Common/Arctic tern was recorded in the Rampion II array area so this species is screened in on a precautionary basis.
94	Guillemot	*Uria aalge*	Yes	No	Yes	Yes	Mod	None	low	low	low	mod							No	Birds disperse from breeding colonies and can be found throughout UK waters and further afield in the non-breeding season. Guillemot was screened out of collision risk modelling due to very low sensitivity.
95	Razorbill	*Alca torda*	Yes	No	Yes	Yes	Mod	n/a	low	low	low	mod							No	Razorbills that breed in the UK generally migrate in a southerly direction following the breeding season, to wintering sites along the Atlantic coasts of France, Iberia and Morocco or in the Mediterranean Sea. Most birds travel via the North Sea and probably the English Channel. Razorbills were screened out of collision risk modelling due to very low sensitivity.

96	Puffin	*Fratercula arctica*	Yes	No	Yes	Yes	Low	n/a	low	low	low	low							No	Birds disperse from breeding colonies and can be found throughout UK waters and further afield in the non-breeding season. Puffin was screened out of collision risk modelling due to very low sensitivity.
97	Short-eared Owl	*Asio flammeus*	Yes	No	No	No	None	n/a	n/a	n/a	n/a	n/a							No	Movement patterns are poorly understood; however there is evidence of this species crossing almost all parts of the UK's waters, including the English Channel. However, it is unlikely that significant numbers will pass throught the Rampion 2 array area.
98	Nightjar	*Caprimulgus europaeus*	Yes	No	No	No	None	n/a	n/a	n/a	n/a	n/a							No	Nightjars are summer visitors to the UK, with the entire population migrating into the UK from Africa in spring, and returning in autumn. It is likely that the majority of migration is concentrated in the English Channel and southern North Sea. Screened in on a precautionary basis.
99	Woodlark	*Lullula arborea*	Yes	No	No	No	n/a	n/a	n/a	n/a	n/a	n/a							No	Woodlark is a partial migrant and its migratory movements are not well understood, but it is thought those in the south UK are largely sedentary. There are records of Breckland-breeding birds from Kent, Devon and the Isles of Scilly in autumn, suggesting that birds may cross the Channel, however, the proportion involved in such movements are unknown.
100	Dartford Warbler	*Sylvia undata*	n/a	n/a	No	No	n/a	n/a	n/a	n/a	n/a	n/a							No	Dartford Warbler is a largely sedentary speices. However, there are some movements, most of which are within the UK. Although there is evidence suggesting inter-change with birds from France.
101	Aquatic Warbler	*Acrocephalus paludicola*	n/a	n/a	No	No	n/a	n/a	n/a	n/a	n/a	n/a							No	Very rare species in the UK. Unlikely to pass through the Rampion 2 array area.
102	Great Northern Diver		n/a	n/a	No	Yes	n/a	n/a	n/a	n/a	n/a	mod/high							No	No migration path
103	Long-tailed Skua		n/a	n/a	No	No	n/a	n/a	n/a	n/a	n/a	n/a							No	No migration path
104	Pomarine Skua		n/a	n/a	Yes	No	n/a	Medium	n/a	n/a	n/a	n/a							No	No migration path. Scarce passage migrant in UK waters. Unlikely to pass through the Rampion 2 array area in significant numbers.
105	Sabine's Gull		n/a	n/a	No	No	n/a	n/a	n/a	n/a	n/a	n/a							No	No migration path
106	Little Gull		n/a	n/a	Yes	Yes	n/a	None	low	low	n/a	n/a	2.14	mod					No	The potential effect from collision risk to little gulls is considered in detail in the main assessment.
107	Little auk		n/a	n/a	No	No	n/a	n/a	low	low	n/a	low	0.13	high					No	No migration path

Annex B
Migropath Confidence Limits

Species/Population	Number of birds passing through the Rampion 2 array area each migration (mean)	Number of birds passing through the Rampion 2 array area each migration (Lower 95% CL)	Number of birds passing through the Rampion 2 array area each migration (Upper 95% CL)
White-fronted goose (albifrons; wintering)	139	134	143
Brent goose (bernicla; wintering)	0.6	0.5	0.7
Shelduck (wintering)	3	2	4
Wigeon (wintering)	18,136	17,934	18,344
Gadwall (wintering)	1,835	1,802	1,866
Teal (wintering)	8,026	7,883	8,160
Pintail (wintering)	954	932	976
Shoveler (wintering)	958	941	975
Pochard (wintering)	2,682	2,610	2,752
Red-breasted merganser (wintering)	0	0	0
Little egret	381	363	401
Marsh harrier	40	39	41

Species/Population	Number of birds passing through the Rampion 2 array area each migration (mean)	Number of birds passing through the Rampion 2 array area each migration (Lower 95% CL)	Number of birds passing through the Rampion 2 array area each migration (Upper 95% CL)
Hen harrier (wintering)	20	19	20
Osprey (migratory breeding)	0	0	0
Oystercatcher (migratory breeding)	11,489	11,283	11,696
Oystercatcher (wintering)	31	22	41
Avocet (migratory breeding)	189	186	192
Avocet (wintering)	9	7	11
Stone-curlew (migratory breeding)	0	0	0
Ringed plover (migratory breeding)	1,835	1,794	1,878
Ringed plover (wintering)	1,714	1,684	1,736
Golden plover (migratory breeding)	3,296	3,168	3,423
Golden plover (wintering)	0	0	0
Grey plover (wintering)	1,157	1,142	1,172
Lapwing (wintering)	27,722	27,414	28,000

Species/Population	Number of birds passing through the Rampion 2 array area each migration (mean)	Number of birds passing through the Rampion 2 array area each migration (Lower 95% CL)	Number of birds passing through the Rampion 2 array area each migration (Upper 95% CL)
Knot (wintering)	9,289	9,160	9,410
Sanderling (wintering)	366	356	375
Dunlin (migratory breeding)	340 – 368	327 – 354	355 – 384
Ruff	36	35	37
Snipe (wintering)	63,277	60,265	66,768
Black-tailed godwit (islandica; wintering)	3,597	3,554	3,645
Bar-tailed godwit (wintering)	415	400	431
Whimbrel (passage)	71	65	77
Redshank (migratory breeding)	1,889	1,749	2,023
Redshank (wintering)	4,691	4,636	4,748
Turnstone (wintering)	1,592	1,559	1,623
Nightjar (migratory breeding)	392	384	399

Rampion 2
WIND FARM