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Awel y Môr Migratory CRM Annex

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1. Introduction

1.1 Project background

APEM Ltd (hereafter APEM) was commissioned by Awel y Môr Offshore Wind Farm Limited (the Applicant) to undertake a study of offshore and intertidal ornithology that characterises the area that may be influenced by Awel y Môr (AyM). A separate report (**Volume 4, Annex 4.1: Offshore Ornithology Baseline Characterisation Report (application ref: 6.4.4.1)**) provides the findings from offshore ornithology data to determine the receptors that characterise the baseline and which are of relevance to the assessment of potential impacts from AyM. This technical annex has been produced to support **Volume 2, Chapter 4: Offshore Ornithology (application ref: 6.2.4)** and considers the potential risk to migratory birds that are not typically recorded in monthly surveys, which may interact with AyM, as requested in SNCB Section 42 responses in **Volume 2, Chapter 4: Offshore Ornithology (application ref: 6.2.4)**.

1.2 Potential collision risk to migratory birds

APEM has conducted site specific surveys of AyM and surrounding area via high resolution aerial digital surveys. While the results of these surveys provide information on the likely abundance and distribution of key seabird species for each biological period, they also have limitations. In particular, neither these surveys nor any other existing generally applied survey methods are guaranteed to provide reliable estimates of bird numbers during migration periods, particularly non-seabirds. This is due to the snapshot nature of baseline surveys which has the potential to miss 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 complex using standard methods.

One solution 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 used to estimate the proportion of a given population passing through a site's footprint, assuming point-to-point migration (for example from the coastline of continental Europe to designated SPAs within the UK).

The use of Migropath is not suitable for all species, in particular species which do not follow a point-to-point migration pattern (Alerstam, 1990). Many seabirds fall into this category (Wernham et al. 2002), with some seabirds known to take longer routes, for example following the coastline in preference to a more direct route over land. For such species, a 'broad front' pathway might better describe the movements that these birds are making within western waters. Consequently, the risks to which the population is exposed relates to the proportion of the 'broad front' pathway crossing, in this instance, the location of the AyM array area. Within that 'broad front', birds might be distributed evenly, or they might have distribution that is skewed, such as a bias towards the coast.

2. Species selection/Screening process

2.1 Screening methodology

A combination of data sources – field surveys, literature review, Migropath modelling, and migratory apportionment – have been used to screen migratory species for more detailed impact assessments for collision risk. Where species have been screened in, the results also quantify inputs for use in CRM, in particular the timing and numbers of birds migrating through the area of interest. The standard threshold for migratory birds used is that the species will be screened in if at least 1% of the UK population is expected to pass through the site footprint each year, in this case the AyM array area. Migratory species may also 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 AyM array area and not for species present in the project area for longer periods (for example, breeding birds which may fly through the project on regular foraging trips), which are considered separately in **Volume 4, Annex 4.3: Offshore Ornithology Collision Risk Modelling (application ref: 6.4.4.3)**. This is summarised in the flowchart below (**Figure 1**).

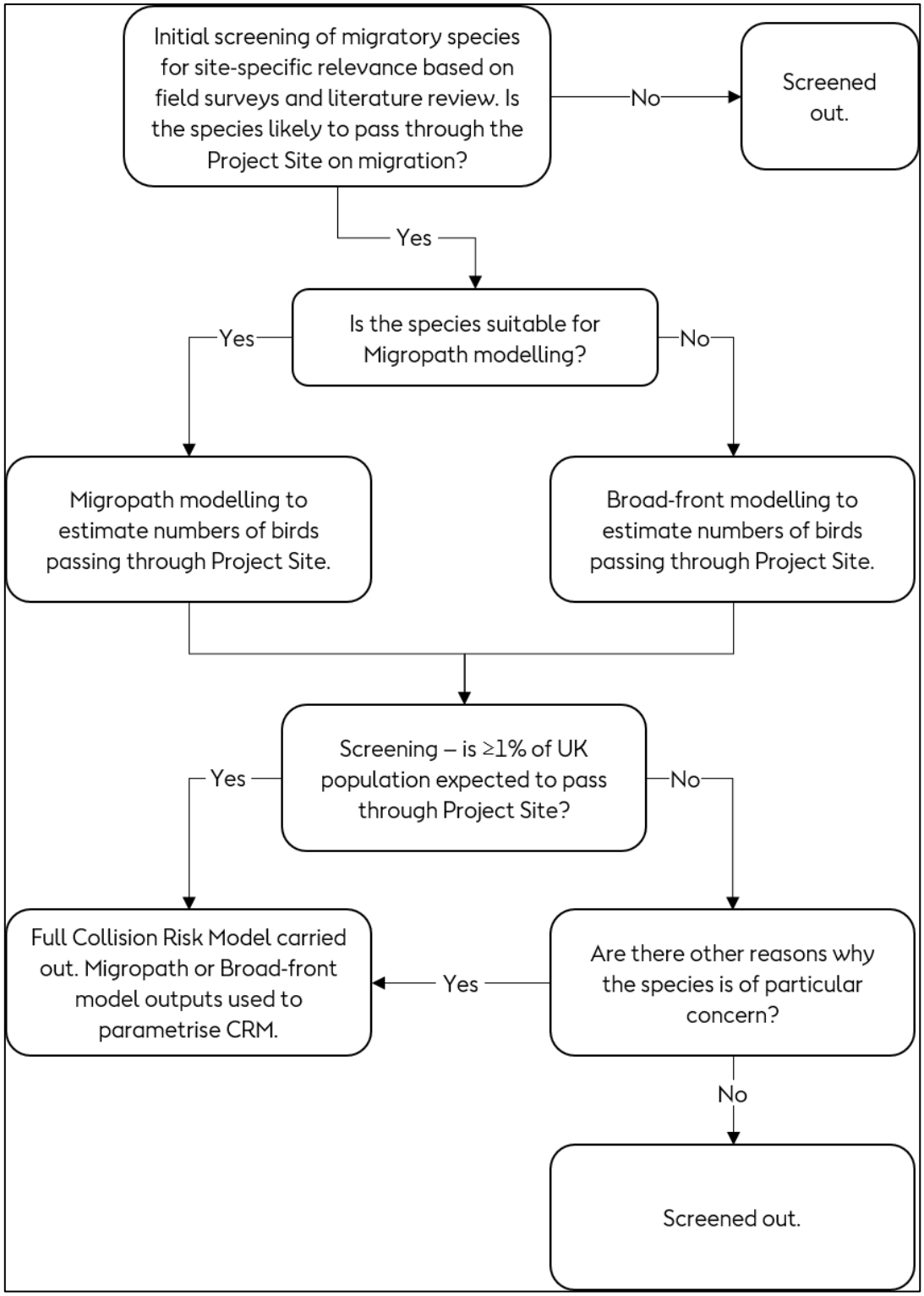

Figure 1 **Flowchart showing approach to screening and collision risk modelling for migratory species.**

2.2 Screening results

An initial screening exercise was completed to identify any migratory species that may pass through or nearby to the AyM array area. A review of AyM and Gwynt y Môr (GyM) aerial 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 1**, and the full approach to assessment is detailed in the screening matrix presented in **Appendix 1**.

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 AyM array area in any meaningful numbers on migration. In addition, pintail was screened in for Migropath modelling at the request of NRW, despite being considered low risk in the screening matrix.

Table 1 Migratory Birds Screened in for AyM and modelling approach.

Migropath modelling		
Whooper swan	Red-breasted merganser	Dunlin
'Greenland' white-fronted goose	Cormorant	Snipe
Shelduck	Hen harrier	Black-tailed godwit
Wigeon	Oystercatcher	Bar-tailed godwit
Gadwall	Ringed plover	Whimbrel
Teal	Golden plover	Curlew
Mallard	Grey plover	Greenshank
Pintail	Lapwing	Redshank
Shoveler	Knot	Turnstone
Tufted duck	Sanderling	
'Broad front' modelling		
Sandwich tern	Common gull	
Common tern	Little tern	
Arctic tern		

3. Migropath modelling methodology (migratory non-seabirds)

3.1 Migropath modelling approach

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 (for example, daily passage rate and duration of migration events).

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.

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 would 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.

3.2 Migropath modelling assumption

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 1 of the EU Birds Directive ('Annex 1 species') that regularly migrate across UK waters. Annex 1 species that only occasionally migrate across UK waters are excluded.

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 AyM array area are not considered to be at collision risk from AyM, based on the assumption of straight-line migration. Such no-risk (no risk from AyM) movements can be factored in to estimated proportions of birds arriving on / departing from SPAs but not encountering the AyM array area.

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.

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 AyM 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 **Volume 2, Chapter 4: Offshore Ornithology (application ref: 6.2.4)**.

Migropath does not consider flight height, and as a precautionary assumption where the migratory route intersects the AyM 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.

3.3 Migropath modelling technical methodology

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 1 km segments, and each segment labelled with a unique ID. Using the ET Geowizard or MMQGIS Hub Lines tool, each segment along the European or Icelandic coast was joined to the centre of each SPA, with each line classified as either passing within or out from the AyM array area. Flight pathways connecting the UK to Iceland are referred to as the North route, while flight pathways to continental Europe are referred to as the South route (notwithstanding that continental Europe includes Scandinavia and therefore some flight pathways on the South route have a northerly bearing).

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).

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.

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).

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.

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

The proportion of birds modelled to pass through the AyM 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.

Where the proportion of birds passing through the AyM 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).

4. ‘Broad Front’ modelling (migratory seabirds)

4.1 Approach

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 6.2**. 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 AyM 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.

To ensure the estimates are precautionary, the maximum ‘broad front’ corridor is assumed to extend from the UK coast to the Irish coast based on AyM location. This represents the width intersecting the array area perpendicular to birds migrating in a North/South flight pattern and was measured as being 205 km. The width of the array area within that corridor is calculated to be 16.6 km 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.

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

The total number of bird species determined to be screened in for Migropath modelling was 30 species. Other than hen harrier, these were all waterfowl and waders. The majority 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. Following a request from NRW via the offshore ornithology ETG (see also **Document 8.2**), pintail was also included in Migropath modelling.

The mean proportion of the UK population expected to pass through the AyM array area and the number of birds this equates to is presented in **Table 2**. The upper and lower confidence limits are presented in **Appendix 2**.

Where the UK population is uncertain, the range of outputs has been presented in **Table 2**.

Where different populations or seasons were modelled separately in Migropath, all results were included in the CRM to give an annual total across all populations for each species.

Table 2 Results from Migropath modelling to estimate the number of birds of each species passing through the AyM 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 route	Migration Season	Number of birds passing through the AyM array area each migration (mean; see Appendix A for details)	Percentage of migratory population passing through the AyM array area each migration (mean; see Appendix A for details)	Percentage of UK population passing through AyM array area annually (mean)
Whooper swan (wintering)	19,500	North	Spring/Autumn	0	0.00%	0.01%
		South		1	0.79%	
White-fronted goose (*flavirostris*; wintering)	14,000	North	Spring/Autumn	0	0.00%	0.00%
Shelduck	51,000	South		44	0.09%	0.09%
Wigeon (wintering)	450,000	North	Spring/Autumn	2,929	1.12%	0.85%
		South	Spring/Autumn	874	0.33%	
Gadwall (wintering)	31,000	North	Spring/Autumn	7	0.83%	0.16%
		South	Spring/Autumn	44	0.15%	
Teal (wintering)	430,000	North	Spring/Autumn	98	1.96%	0.20%
		South	Spring/Autumn	772	0.30%	
Mallard (wintering)	675,000	South	Spring/Autumn	2,407	0.36%	0.36%
Pintail (wintering)	20,000	North	Spring/Autumn	20	2.03%	0.33%
		South	Spring/Autumn	46	0.25%	
Shoveler (wintering)	19,500	South	Spring/Autumn	51	0.27%	0.26%
Tufted duck (wintering)	140,000	North	Spring/Autumn	0	0.00%	0.23%
		South	Spring/Autumn	315	0.48%	
	11,000	North	Spring/Autumn	355	4.44%	3.23%

Species/ Population	UK Population	Migration route	Migration Season	Number of birds passing through the AyM array area each migration (mean; see Appendix A for details)	Percentage of migratory population passing through the AyM array area each migration (mean; see Appendix A for details)	Percentage of UK population passing through AyM array area annually (mean)
Red-breasted merganser (wintering)		South	Spring/Autumn	0	0.00%	
Cormorant (migratory breeding)	17,800	South	Spring/Autumn	757	4.62%	4.25%
Cormorant (wintering)	64,500	South	Spring/Autumn	315	0.51%	0.49%
Hen harrier (wintering)	545	South	Spring/Autumn	3	0.42%	0.55%
Oystercatcher (wintering)	305,000	North	Spring/Autumn	0	0.00%	1.64%
		South	Spring/Autumn	4,995	1.38%	
Ringed plover (migratory breeding)	10,900	South	Spring/Autumn	194	1.83%	1.78%
Ringed plover (passage)	42,500	North	Spring/Autumn	237	0.57%	2.22%
		South	Spring/Autumn	707	1.70%	
Golden plover (migratory breeding)	65,000 – 101,000	South	Spring/Autumn	2,697 – 4,191	4.15%	4.15%
Golden plover (wintering)	410,000	North	Spring/Autumn	0	0.00%	0.53%
		South	Spring/Autumn	2,158	0.54%	
Grey plover (wintering)	33,500	South	Spring/Autumn	95	0.28%	0.28%

Species/ Population	UK Population	Migration route	Migration Season	Number of birds passing through the AyM array area each migration (mean; see Appendix A for details)	Percentage of migratory population passing through the AyM array area each migration (mean; see Appendix A for details)	Percentage of UK population passing through AyM array area annually (mean)
Lapwing (wintering)	635,000	South	Spring/Autumn	1,877	0.30%	0.30%
Knot (wintering)	265,000	North	Spring/Autumn	2,904	1.10%	1.55%
		South	Spring/Autumn	1,197	0.45%	
Sanderling (wintering)	20,000	North	Spring/Autumn	475	2.38%	2.79%
		South	Spring/Autumn	83	0.42%	
Dunlin (migratory breeding)	17,200 – 21,000	South	Spring/Autumn	220 - 270	1.28%	1.28%
Dunlin (wintering)	350,000	North	Spring/Autumn	0	0.00%	0.00%
		South	Spring/Autumn	0	0.00%	
Snipe (wintering)	1,100,000	North	Spring/Autumn	0	0.00%	0.00%
		South	Spring/Autumn	0	0.00%	0.00%
Black-tailed godwit (*Islandica*; wintering)	41,000	North	Spring/Autumn	1,370	3.51%	3.34%
Bar-tailed godwit (wintering)	53,500	South	Spring/Autumn	160	0.37%	0.30%
Whimbrel (passage)	3,840	North	Spring/Autumn	0	0.00%	0.00%
		South	Spring/Autumn	0	0.00%	
Curlew (migratory breeding)	117,000	South	Spring/Autumn	0	0.00%	0.00%
Curlew (wintering)	140,000	South	Spring/Autumn	2,069	1.48%	1.48%
Greenshank (migratory breeding)	2,200	South	Spring/Autumn	94	4.27%	4.27%

Species/ Population	UK Population	Migration route	Migration Season	Number of birds passing through the AyM array area each migration (mean; see Appendix A for details)	Percentage of migratory population passing through the AyM array area each migration (mean; see Appendix A for details)	Percentage of UK population passing through AyM array area annually (mean)
Redshank (*britannica*; migratory breeding)	44,000	South	Spring/Autumn	761	1.73%	1.73%
Redshank (*robusta*; wintering)	150,000 – 400,000	North	Spring/Autumn	2,761 - 7362	1.84%	1.84%
Redshank (*totanus*; wintering)	25,000	South	Spring/Autumn	279	1.12%	1.12%
Turnstone (wintering)	43,000	North	Spring/Autumn	570	1.90%	1.5%
		South	Spring/Autumn	75	0.75%	

6. Results of 'Broad Front' modelling (migratory seabirds)

6.1 Species screened in

The total number of bird species determined to be required to be screened in for 'broad front' modelling was five seabirds (see **Table 1**). These were: common gull, Sandwich tern, common tern, Arctic tern and little 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.

6.1.1 Common gull

The common gull has a circumpolar distribution and can be found breeding in most of Europe, Asia and North America except from the extreme north and south, with an estimated population of the nominate race *canus* at 1,200,000-2,250,000 individuals (Wright et al. 2012). The British and Irish breeding distribution is largely confined to Scotland and northwest Ireland and it is only when numbers are boosted by continental migrants in the winter period, that common gull is encountered more widely in the British Isles (Wernham et al. 2002).

Common gulls breeding in Britain and Ireland are partial migrants, with some being sedentary while others move in a south-westerly direction from breeding sites, but predominantly remaining within the British Isles (Wernham et al. 2002). In comparison, common gulls breeding on the continent are more migratory and generally move in a westerly direction post breeding. Norwegian breeding common gulls migrate in a south-westerly direction, crossing the North Sea in large numbers to join resident Scottish birds for the winter. Ringing recoveries show that common gulls wintering in Britain and Ireland originate mainly from Norway, Sweden, Denmark and Finland (Wernham et al. 2002).

Migration of common gulls into Britain begins in August and September, as seen by birds arriving on the east coast of Britain and continues into winter. Potentially there are two routes into Britain. Across the North Sea into east Scotland and northeast England, and across the southern North Sea and the Channel, taken by birds travelling westward along the northwest European coast (Wernham et al. 2002). There is some tendency for more northerly breeding common gulls to winter further north in Britain, but this is not a clear trend, and it is likely that birds which have crossed the North Sea in Britain move further south as the winter progresses (Wernham et al. 2002).

Common gull return migration to continental breeding areas occurs over a short period, mostly in March and April (Wernham et al. 2002). Large flocks have been recorded leaving northeast Scotland in April (Bourne & Patterson 1962).

Significant declines in the large breeding populations of Norway, Denmark and Estonia have been noted in Tucker & Heath (1994). The drivers of these reported declines are uncertain but are most likely related to the breeding grounds rather than in the passage and wintering range of these populations (Wernham et al. 2002).

The understanding of partial migratory movements of British and Irish breeding common gulls is relatively poor, especially with regards to the movements of birds once they reach adulthood (Wernham et al. 2002).

During the 24 months of site-specific aerial digital surveys conducted for AyM (detailed in Volume 4, Annex 4.1: Offshore Ornithology Baseline Characterisation Report (application ref: 6.4.4.1)) common gulls were recorded within the AyM array area during four surveys. Peak abundances were highest in February 2020 (n = 41) for the first year of data and January 2021 (n= 33) for the second year of data. Common gulls were present in greatest abundance in the AyM array area during the return migration bio-season with an estimated mean peak abundance of 37 individuals.

6.1.2 Sandwich tern

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).

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).

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).

In the UK and Ireland, Sandwich terns are primarily concentrated in three main areas: Northeast Scotland, Northumberland, and Norfolk, these main areas alone make up over 60% of the UK and Ireland breeding population (Wernham et al. 2002). On the west coast of the UK and Ireland the main colonies of Sandwich terns are located in Northern Ireland (Carlingford, Larne and Strangford Lough), Northern England (Morecombe Bay and Duddon Esturary) and Ilse of Anglesey (Cemlyn Bay) (Furness 2015). The UK Western waters BDMPS for Sandwich terns is defined by Furness (2015) as 10,761 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.

Sandwich tern is listed in Stienen et al. (2007) as an inshore species that is most abundant within 20 km from the shoreline. An assessment of Sandwich tern migration undertaken by WWT and MacArthur Green (2014) concluded that the majority of UK Sandwich terns migrate within 10 km from the UK coastline based on observations from coastal watches and offshore surveys.

During the 24 months of site-specific aerial digital surveys conducted for AyM (detailed in Volume 4, Annex 4.1: Offshore Ornithology Baseline Characterisation Report (application ref: 6.4.4.1)) no Sandwich terns were recorded within the AyM array area; however,

Sandwich terns were recorded during three surveys within the surrounding 4 km buffer; July 2019, August 2019 and July 2020, with a peak estimated abundance of 17 individuals in July 2019.

6.1.3 Common tern

The common tern has a circumpolar distribution and can be found breeding in most of Europe, Asia and North America except the extreme north and south with a total population at least 250,000 pairs, possibly 500,000 pairs, consisting of 140,000 pairs in Europe, ~35,000 pairs in North America and several 100,000's pairs in the former USSR (del Hoyo et al. 1992-2013). Although they are mainly coastal, common terns also nest widely inland. Birds that breed in the British Isles, Netherlands, Belgium, France, Spain, Switzerland, Austria, and western Germany winter principally along the West African coast (BirdGuides 2011) and those from eastern Europe along the east and southern African coast. Birds from eastern Europe take an easterly route through north east Africa and then along the coast or overland through the Rift Valley to their wintering grounds (del Hoyo et al. 1992-2013).

Post-fledging dispersal of juveniles occurs between July and October, with adults migrating mainly between August and October. Much of the movement of these coastal birds within Britain may be overland. There is known to be a significant movement from North Sea estuaries over to western waters in autumn (Ward 2000; Furness 2015; Wernham et al. 2002). During September, and especially October, there is a strong southward movement of common terns along the coast of southwest Europe and away from Britain and Ireland, migration follows the coasts (Wernham et al. 2002). Many UK breeding birds are back at their breeding areas by April. The lack of records at west coast observatories implies that there is little movement through the Irish Sea to the Scottish colonies, and the frequency of inland sightings suggests that much of the spring passage takes place directly overland to the breeding sites. In fact, the only British observatories to record substantial numbers in spring are Dungeness and Portland Bill. At both sites, spring passage peaks in late April and early May and is mainly eastward, suggesting that these birds are most likely to be on their way to breeding areas elsewhere in northern Europe (Wernham et al. 2002).

Another assessment of common tern migration undertaken by WWT and MacArthur Green (2014) concluded that the majority of UK common terns migrate within 10 km of the UK coastline based on observations from coastal watches and offshore surveys.

The BDMPS for common terns is defined by Furness (2015) as 64,659 for both the spring and autumn migration seasons in Western waters (April to May and late July to early September). Understanding of common tern movements is relatively poor, especially with regards to overseas populations due to limited ring recoveries in the UK and no studies conducted using geolocators.

During the 24 months of site-specific aerial digital surveys conducted for AyM (detailed in Annex 4.1: Offshore Ornithology Baseline Characterisation Report), no common terns were recorded to species level within the AyM array area. However, common and / or Arctic terns were recorded in two surveys: August and September 2019 with an estimated peak abundance of eight individuals.

6.1.4 Arctic tern

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).

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

The BDMPS for Arctic terns is defined by Furness (2015) as 71,398 for both the spring and autumn migration seasons in Western waters (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.

During the 24 months of site-specific aerial digital video surveys conducted for AyM (detailed in Annex 4.1: Offshore Ornithology Baseline Characterisation Report), no Arctic terns were recorded to species level within the AyM array area. However, Arctic and / or common tern were recorded in two surveys: August and September 2029 with an estimated peak abundance of eight individuals.

6.1.5 Little tern

The little tern has a wide breeding range that includes the Palearctic, Afrotropic and Australasian regions. Nominate *Sternula albifrons* breeds in Britain 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 Britain 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).

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).

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 & MacArthur Green (2014) concluded that the majority of little tern migration is likely to track coastlines in a narrow band from 0 to 10 km from shore. The BDMPS for little tern is defined by Furness (2015) as 1,602 for both spring and autumn migration seasons in UK western waters (mid-April to May and late July to early September).

During the 24 months of site-specific aerial digital video surveys conducted for AyM (detailed in Annex 4.1: Offshore Ornithology Baseline Characterisation Report), no little terns were recorded in AyM array area plus 4km buffer.

Based on the above evidence gathered from the literature review, little tern has been screened out from CRM assessment. This is due to preference of migrating close inshore, meaning it is highly unlikely to be found migrating through the AyM array area. Furthermore, the majority of little tern colonies to the North of AyM are evidenced to have a preference of migrating through the North Sea rather than Western waters.

6.2 Summary of 'Broad Front' modelling assumptions

The AyM array area is located 10.5 km offshore at its nearest point from the north-east coast of Wales. For the three tern species, a migratory corridor of 20km from the coast was used as identified in the literature searches in **Section 6.1**. It should be noted that this is considered precautionary for common tern as it's suggested that common tern primarily migrate up to 10 km from the coast. For common gull, the literature search did not identify that common gull had any predisposition for following the coast when on migration, it was therefore assumed the migratory corridor spans the entire width of the Irish Sea, taken to be 205 km measured through AyM.

Due to the migratory routes of terns described in **Section 6.1**, the population estimates with potential for connectivity with AyM on migration were identified as the Northern England and Scotland SPA populations located to the north of AyM and as a precautionary measure the total UK western non-SPA colonies, with population estimates derived from Appendix A of Furness (2015). Any Irish colonies or southern England SPA colonies were not included within the population estimates presented in **Table 3,** due to no connectivity identified based on their migration routes.

For common gull, populations with potential migration connectivity with AyM included all populations along the Scottish west coast obtained from Mitchell et al. (2004). Numbers in Mitchell et al. (2004) are presented as AON, therefore the population size presented has been multiplied by 2.5 to give number of individuals, including juveniles. Half of the Orkney population was also included based on expert judgement, this is due to limited data on the migration routes of the Orkney population so on a precautionary basis, it is assumed half the population migrates through the Irish Sea and the other half through the North Sea. Based on migration routes of common gull no Irish populations were identified to have connectivity with AyM and were not included in the population estimate presented in **Table 3**.

Table 3 Estimated number of migratory seabirds predicted to pass through the AyM array area in spring and autumn.

Species	Spring Migration	Autumn Migration
Sandwich tern	4,329	4,329
Common tern	6,244	6,244
Arctic tern	42,180	42,180
Common gull	34,139	34,139

7. Collision risk modelling for migratory birds

7.1 Collision risk modelling methodology

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.

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

The CRM input parameters for each species run through the Band (2012) model are presented in **Table 4**. Species biometrics for all species were obtained from Robinson (2005).

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 4**. 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 4.** Nocturnal activity scores were obtained from (King et al. 2009).

The Large Array Correction factor was applied, using the longest line through the array area as the width (17.3 km).

The “width of migration corridor” value used within the Band model for calculating migrant flux density was calculated as the width of the AyM array area perpendicular to the direction of migration, which was measured as 16.6 km.

Table 4 Species biometrics used in the migratory collision risk modelling of the proposed AyM for all species selected

Species	Body Length (m)	Wingspan (m)	Flight Speed (ms^{-1})	Nocturnal Activity	Flight Type
Red-breasted merganser	0.55	0.78	20.0	3	Flapping
Oystercatcher	0.42	0.83	13	5	Flapping
Golden plover	0.28	0.72	13.7[1]	5	Flapping
Ringed plover	0.19	0.52	19.5	5	Flapping
Curlew	0.55	0.9	16.3	5	Flapping
Black-tailed godwit	0.42	0.76	18.3[2]	5	Flapping
Turnstone	0.23	0.54	14.9	5[3]	Flapping
Knot	0.24	0.59	20.1	5	Flapping
Sanderling	0.2	0.42	21.4[4]	5	Flapping
Dunlin	0.18	0.4	15.3	5	Flapping
Redshank	0.28	0.62	12.3[5]	5	Flapping
Greenshank	0.32	0.69	12.3	5	Flapping
Sandwich tern	0.38	1	10.0[6]	1	Flapping
Common tern	0.33	0.88	10.05	1	Flapping
Arctic tern	0.34	0.8	10.9	1	Flapping
Cormorant	0.90	1.45	15.2	1	Flapping

[1] Used Pluvialis dominica value

[2] Used Limosa lapponica value
[3] Used Calidris spp. value (C. alpina, C. alba and C. canutus all have nocturnal activity rating of 5)
[4] Howell et al. (2020)
[5] Used Tringa nebularia value
[6] Cook et al. (2014)

7.2.1 Avoidance rates

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.

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. For common gull an additional avoidance rate of 99.2% was used as suggested by Cook et al. (2014).

7.2.2 Proportion at Potential Collision Height

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 5). For BO1, for common tern, 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 common tern, Arctic tern, Sandwich tern and Cormorant 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 5 Proportion at Potential Collision Height (PCH) for all migratory species used for BO1 CRM.

Species	Proportion at PCH (%)
Red-breasted merganser	15.0
Cormorant	19.0
Oystercatcher	25.0
Golden plover	25.0
Ringed plover	25.0
Curlew	25.0
Black-tailed godwit	25.0
Turnstone	25.0
Knot	25.0
Sanderling	25.0
Dunlin	25.0
Greenshank	25.0
Redshank	25.0
Sandwich tern	3.6
Common tern	12.7
Arctic tern	2.8
Common gull	22.9

7.2.3 Turbine Parameters

Input parameters for the wind turbine specifications used within the CRM are presented in Section 2.2 of **Volume 4, Annex 4.3: Offshore Ornithology Collision Risk Modelling (application ref: 6.4.4.3)**.

7.3 CRM results

Species for which less than 1% of the UK population are expected to pass through the AyM array area were screened out, and the Band (2012) CRM was run for remaining species. The species screened out were: whooper swan, white-fronted goose (*flavirostris*), shelduck, wigeon, gadwall, teal, mallard, pintail, shoveler, tufted duck, cormorant (wintering only), hen harrier, golden plover (wintering only), grey plover, lapwing, dunlin (wintering only), snipe, bar-tailed godwit, whimbrel and curlew (breeding only). 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 6**. Results are presented using both Band Option 1 (BO1) and Band Option 2 (BO2), where possible.

Table 6 Summary of annual collision risk for species screened in.

Species	Avoidance Rate	Annual Collision Rate BO1	Annual Collision Rate BO2
Arctic tern	95.0%	1.97	1.13
	98.0%	0.79	0.45
	99.0%	0.39	0.23
	99.5%	0.20	0.11
Black-tailed godwit	95.0%	0.71	N/A
	98.0%	0.28	N/A
	99.0%	0.14	N/A
	99.5%	0.07	N/A
Common gull	95.0%	1.38	0.84
	98.0%	0.55	0.34
	99.0%	0.28	0.17
	99.2%	0.22	0.14
	99.5%	0.14	0.08
Common tern	95.0%	1.33	0.37
	98.0%	0.53	0.15
	99.0%	0.27	0.07
	99.5%	0.13	0.04
Cormorant (breeding)	95.0%	0.37	0.01
	98.0%	0.15	0.00

Species	Avoidance Rate	Annual Collision Rate BO1	Annual Collision Rate BO2
	99.0%	0.07	0.00
	99.5%	0.04	0.00
Curlew	95.0%	1.16	N/A
	98.0%	0.47	N/A
	99.0%	0.23	N/A
	99.5%	0.12	N/A
Dunlin (breeding)	95.0%	0.10 – 0.13	N/A
	98.0%	0.04 – 0.05	N/A
	99.0%	0.02 – 0.03	N/A
	99.5%	0.01 – 0.01	N/A
Golden plover (breeding)	95.0%	1.47 – 2.17	N/A
	98.0%	0.59 – 0.87	N/A
	99.0%	0.29 – 0.43	N/A
	99.5%	0.15 – 0.22	N/A
Greenshank (breeding)	95.0%	0.02	N/A
	98.0%	0.01	N/A
	99.0%	0.00	N/A
	99.5%	0.00	N/A
Knot	95.0%	1.43	N/A
	98.0%	0.57	N/A
	99.0%	0.29	N/A
	99.5%	0.14	N/A
Oystercatcher	95.0%	2.78	N/A
	98.0%	1.11	N/A
	99.0%	0.56	N/A
	99.5%	0.28	N/A
Red-breasted merganser	95.0%	0.11	N/A
	98.0%	0.04	N/A
	99.0%	0.02	N/A
	99.5%	0.01	N/A
Redshank *britannica* (breeding)	95.0%	0.40	N/A
	98.0%	0.16	N/A
	99.0%	0.08	N/A
	99.5%	0.04	N/A
Redshank *robusta*	95.0%	1.44 – 3.83	N/A
	98.0%	0.58 – 1.53	N/A
	99.0%	0.29 – 0.77	N/A
	99.5%	0.14 – 0.38	N/A
Redshank *totanus*	95.0%	0.15	N/A

Species	Avoidance Rate	Annual Collision Rate BO1	Annual Collision Rate BO2
	98.0%	0.06	N/A
	99.0%	0.03	N/A
	99.5%	0.01	N/A
Ringed plover (breeding)	95.0%	0.09	N/A
	98.0%	0.04	N/A
	99.0%	0.02	N/A
	99.5%	0.01	N/A
Ringed plover (passage)	95.0%	0.34	N/A
	98.0%	0.14	N/A
	99.0%	0.07	N/A
	99.5%	0.03	N/A
Sanderling	95.0%	0.23	N/A
	98.0%	0.09	N/A
	99.0%	0.05	N/A
	99.5%	0.02	N/A
Sandwich tern	95.0%	0.27	0.25
	98.0%	0.11	0.10
	99.0%	0.05	0.05
	99.5%	0.03	0.02
Turnstone	95.0%	0.28	N/A
	98.0%	0.11	N/A
	99.0%	0.06	N/A
	99.5%	0.03	N/A

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Appendix 1 Screening Matrix

Species / Sub-Species	Flight Path through AyM		Observations from surveys		Literature Review	Species of CRM Concern (SOSS 03A)		Perceived Risk from Collision		SOSS 02 Flight Heights		Qualifying Feature of Assessed Western Water SPA						Screened in?	Comments
	Main	Partial	GyM Aerial Surveys (2010 - 2013)	AyM Aerial Surveys (2019 – 2021)	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.	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	Liverpool Bay/ Bae Lerpwl SPA	The Dee Estuary SPA / RAMSAR	Traeth Lafan/ Layan Sands, Conway Bay SPA	Dyfi Estuary/ Aber Dyfi SPA	Burry Inlet SPA/ RAMSAR	Severn Estuary SPA/ RAMSAR		
Bewick's Swan	No	**Yes**	No	No	None	n/a	n/a	high	n/a								**Yes**	No	Only a small number of birds cross from Britain to overwinter in Ireland, in winter 2020/21 only 12 individuals, so unlikely that this species is at risk from AyM due to collision risk.
Whooper Swan	**Yes**	No	**Yes**	No	Mod	low/mod	mod	high	n/a									**Yes**	Tracking studies by Griffin et al. (2010) suggest birds take a fairly direct migratory route between wintering grounds UK/Ireland and breeding grounds in Iceland. None of tracked birds from key populations passed through or near to the AyM array area. Birds from other SPAs following similarly direct flight paths would also be unlikely to pass through AyM array area. However, on a precautionary basis, this species has been screened in.
Bean Goose	No	No	No	No	None	n/a	n/a	mod	n/a									No	Not selected for modelling as Flight path not over site
Pink-footed Goose	No	No	No	No	Low	low	low/mod	mod	n/a									No	Not selected for modelling as Flight path not over site
European White-fronted Goose	No	No	No	No	None	low	low	mod	n/a								**Yes**	No	Not selected for modelling as Flight path not over site
Greenland White-fronted Goose	**Yes**	No	No	No	Low	n/a	n/a	n/a	n/a						**Yes**			**Yes**	Winter in UK and Ireland; migrate to breeding ground via staging grounds in Iceland. The vast majority overwinter in Scotland (WWT, 2014), however although Welsh population small it has been screened in on a precautionary basis.

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Icelandic Greylag Goose	No	No	No	No	None	low	low	n/a	n/a									No	Not selected for modelling as Flight path not over site
Greenland Barnacle Goose	No	No	No	No	None	n/a	n/a	n/a	n/a									No	Not selected for modelling as Flight path not over site
Svalbard Barnacle Goose	No	No	No	No	None	low	low	n/a	n/a									No	Not selected for modelling as Flight path not over site
Dark-bellied Brent Goose	No	No	No	No	None	low	low/mod	mod	n/a									No	Not selected for modelling as Flight path not over site
Canadian Light-bellied Brent Goose	No	**Yes**	No	No	Low	n/a	n/a	n/a	n/a									No	Mostly (approx. 21,750 individuals) winter in Ireland; a few hundred cross from staging grounds in Ireland to UK or continental Europe. More recent records suggest a small, but increasing, population concentrated around Anglesey and the Dee Estuary. Both of these populations are unlikely to interact / fly over AyM when migrating.
Svalbard Light-bellied Brent Goose	No	No	No	No	None	n/a	n/a	mod	n/a									No	Not selected for modelling as Flight path not over site
Shelduck	**Yes**	No	No	No	Low	low	low	n/a	n/a				**Yes**			**Yes**	**Yes**	**Yes**	Majority of migratory movements are across North Sea; however, approx. 14,610 shelduck from Ireland are assumed to cross Irish Sea on moult migrations. The total British wintering population is ~61,000. There may also be coastal movements around the UK. Shelduck is a qualifying feature of a Western Waters SPA assessed for AyM.

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Wigeon	**Yes**	No	No	No	Low	low	low	n/a	n/a							**Yes**		**Yes**	Details of migratory movements are poorly understood; however, there is widespread movement within and between UK, Ireland 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.
Gadwall	**Yes**	No	No	No	Low	low	low	n/a	n/a								**Yes**	**Yes**	Details of migratory movements are poorly understood; however, there is widespread movement within and between UK, Ireland and continental Europe. The highest concentrations of migrating birds are expected to be around the south east UK. However, on a precautionary basis, this species has been screened in.
Teal	**Yes**	No	No	No	Low	low	low	n/a	n/a				**Yes**			**Yes**	**Yes**	**Yes**	Details of migratory movements are poorly understood; however, there is widespread movement within and between UK, Ireland and continental Europe. Approximately 15% are estimated to fly at collision risk height (Wright et al. 2012).Teal is a qualifying feature of a Western Waters SPA assessed for AyM.
Mallard	**Yes**	No	No	No	Low	low	low	n/a	n/a									**Yes**	Most birds are fairly sedentary; however there is evidence of movement within and between UK, Ireland and continental Europe. Unlikely that mallard will migrate through the AyM array area in significant numbers. However, on a precautionary basis, this species has been screened in.

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Pintail	**Yes**	No	No	No	Low	low	low	n/a	n/a				**Yes**			**Yes**	**Yes**	No	Details of migratory movements are poorly understood; however, there is widespread movement within and between UK, Ireland, Iceland, Scandinavia and continental Europe. 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). It should be noted that the largest population (in the region of approx 5,400 individuals or approx 20% of Great Britain's non-breeding population) is in the Dee Estuary (NE, 2014) for which their migratory paths to and from northern breeding grounds would not take them over AyM.
Shoveler	**Yes**	No	No	No	Low	low	low	n/a	n/a							**Yes**		**Yes**	Most migratory movement (approx. 18,000 individuals) is expected to be across the North Sea and English Channel; however, around 2,500 birds overwinter in Ireland and presumably cross the Irish Sea. Shoveler is a qualifying feature of a Western Waters SPA assessed for AyM.

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Pochard	**Yes**	No	No	No	Low	low	low	n/a	n/a									No	Details of migratory movements are poorly understood; however, there is widespread movement within and between UK, Ireland and continental Europe. Approximately 37,780 are assumed to cross the Irish Sea during each migration season, though these are known to be mostly concentrated in sites in Northern Ireland, so unlikely to cross over AyM array area.
Tufted Duck	**Yes**	No	No	No	Low	low	low	n/a	n/a									**Yes**	Details of migratory movements are poorly understood; however, there is widespread movement within and between UK, Ireland, Iceland, Scandinavia and continental Europe.
Scaup	**Yes**	No	**Yes**	No	Low	low	low	low	mod									No	Main migration is between Iceland and UK/Ireland. The northerly distribution of Scaup in Britain and Ireland, and the fact that most migrate to Iceland, suggests that migration routes over UK waters are likely to be concentrated in northerly areas around the coasts and large lakes of Scotland and Northern Ireland.
Eider	No	**Yes**	**Yes**	No	Low	low	low	low	mod	11.54	v low							No	Most breeding birds are fairly sedentary; however there is some evidence of movement around and between Britain and Ireland including across the Irish Sea. Wintering birds crossing from the continent are concentrated on the west coast, especially around Scotland.

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Long-tailed Duck	No	**Yes**	**Yes**	No	n/a	low	low	low	low									No	Most migration is between Scandinavia and Scotland; however, a small number travel further around UK and Ireland. Unlikely to migrate through AyM array area in significant numbers.
Common Scoter	**Yes**	No	**Yes**	**Yes**	n/a	low	low	low	low	0.04	v high	**Yes**						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. It is assumed that common scoter densities during migratory seasons are well represented by site-specific survey data and therefore no separate migratory assessment is required. Common scoter were screened out of collision risk modelling due to low sensitivity.
Velvet Scoter	No	No	No	No	n/a	low	low	low	low									No	Not selected for modelling as Flight path not over site
Goldeneye	**Yes**	No	No	No	Low	low	low	low	low									No	Migration routes are poorly understood; approximately 10,000 birds overwinter in Ireland and are assumed to cross the Irish Sea, but more in northern England, Scotland and Northern Ireland.
Smew	No	No	No	No	n/a	low	low	n/a	n/a									No	No flight path. Scarce UK winter migrant.

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Red-breasted Merganser	**Yes**	No	No	**Yes**	n/a	low	low	low	n/a			**Yes**						**Yes**	Migratory routes are poorly understood; however, birds from breeding grounds in Iceland migrating to wintering sites in Britain and Ireland likely to use the Irish Sea. Red-breasted merganser is a qualifying feature of a Western Waters SPA assessed for AyM.
Goosander	No	No	No	No	Low	low	low	n/a	n/a									No	Not selected for modelling as Flight path not over site
Red-throated Diver	**Yes**	No	**Yes**	**Yes**	Mod	n/a	n/a	low	mod			**Yes**						No	Migratory routes are poorly understood; however movement between wintering sites and breeding grounds includes Irish Sea. It is assumed that red-throated diver densities during migratory seasons are well represented by site-specific survey data and therefore no separate migratory assessment is required. red-throated diver were screened out of collision risk modelling due to low sensitivity.
Black-throated Diver	No	No	No	No	n/a	n/a	n/a	n/a	mod/high	0.61	mod							No	Not selected for modelling as Flight path not over site
Fulmar	**Yes**	No	**Yes**	**Yes**	Low	low	low	low	n/a									No	Wide ranging on migration. Some birds travel long distances out into the Atlantic while others remain around the coasts of Britain and Ireland. It is assumed that fulmar densities during migratory seasons are well represented by site-specific survey data and therefore no separate migratory assessment is required. Fulmar were screened out of collision risk modelling due to low sensitivity.

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Manx Shearwater	**Yes**	No	**Yes**	**Yes**	Low	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. Tracking studies to date (e.g. Guilford et al., 2009) do not have the spatial resolution to consider in detail patterns of movement within the Irish Sea immediately before and after larger scale movements. It is assumed that Manx shearwater densities during migratory seasons are well represented by site-specific survey data and therefore no separate migratory assessment is required. Manx shearwater were screened out of collision risk modelling due to low sensitivity.
Storm Petrel	**Yes**	No	No	No	Low	n/a	n/a	low	low									No	Details of migratory routes are uncertain; however it is likely that birds do use the Irish Sea when migrating between breeding grounds in Britain, Ireland and Iceland and pelagic feeding grounds outside. Species considered of low risk to collision risk modelling.
Leach's Petrel	**Yes**	No	No	No	Low	n/a	n/a	low	low									No	Details of migratory routes are uncertain; however it is likely that birds do use the Irish Sea when migrating between breeding grounds in Britain, Ireland and Iceland and pelagic feeding grounds outside. Species considered of low risk to collision risk modelling.

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Gannet	**Yes**	No	No	**Yes**	Mod	mod/high	mod/high	mod	high									No	Details of migratory routes are uncertain; however it is likely that birds do use the Irish Sea when migrating between breeding grounds in Britain, Ireland and Iceland and wintering grounds to the south. The potential effect from collision risk to gannet is considered in detail in the main assessment. 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.
Cormorant	**Yes**	No	**Yes**	**Yes**	Low	n/a	n/a	mod	low/mod	0.03	v low							**Yes**	Most birds are relatively sedentary; however, there is some movement and in particular a proportion of birds breeding in Britain and Ireland will use the Irish Sea on migratory routes towards wintering sites along the coast of France, Portugal and northern Spain. However, on a precautionary basis, this species has been screened in.
Shag	**Yes**	No	**Yes**	No	Low	n/a	n/a	low	mod	1.45	mod							No	The majority of birds remain within 100 km of their breeding sites, but there is still significant small-scale movement around the coasts of Britain and Ireland. A small proportion of birds undertake larger scale movements including between Britain, Ireland and continental Europe.

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Bittern	**Yes**	No	No	No	n/a	n/a	n/a	n/a	n/a									No	UK-breeding birds are relatively sedentary; however, there is movement of birds from continental Europe into the UK to overwinter, and the details of these movements are poorly understood.
Little Egret	No	No	No	No	n/a	n/a	n/a	n/a	n/a									No	Not selected for modelling as Flight path not over site
Great Crested Grebe	**Yes**	No	**Yes**	**Yes**	Low	n/a	n/a	n/a	low									No	Details of migratory movements are poorly understood; however, there is widespread movement within and between UK, Ireland and continental Europe.
Slavonian Grebe	**Yes**	No	No	No	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.
Honey-buzzard	No	No	No	No	n/a	n/a	n/a	n/a	n/a									No	Not selected for modelling as Flight path not over site
White-tailed Eagle	No	No	No	No	n/a	n/a	n/a	n/a	high									No	Not selected for modelling as Flight path not over site
Marsh Harrier	No	No	No	No	None	n/a	n/a	n/a	n/a									No	Not selected for modelling as Flight path not over site

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Hen Harrier	**Yes**	No	No	No	Low	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. A small proportion of these may cross to Ireland, but the majority head south into France and the Iberian Peninsula, crossing the English Channel between Devon and Brittany. Over winter, the UK population is supplemented by birds from continental Europe, but those are not expected to cross the Irish Sea. However, on a precautionary basis, this species has been screened in.
Montagu's Harrier	No	No	No	No	None	n/a	n/a	n/a	n/a									No	Not selected for modelling as Flight path not over site
Osprey	**Yes**	No	No	No	Low	n/a	n/a	n/a	n/a									No	Birds migrate between breeding sites, largely in Scotland, and wintering sites in Africa. Osprey typically migrate overland or follow the coast so unlikely to migrate through the AyM array area.
Merlin	**Yes**	No	No	No	Low	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 some are likely to cross the Irish Sea.
Spotted Crake	No	No	No	No	None	n/a	n/a	n/a	n/a									No	Not selected for modelling as Flight path not over site

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Corncrake	**Yes**	No	No	No	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, although it is likely that they include the Irish Sea. However, they are known to migrate at very high altitudes from breeding to wintering locations, meaning they are at very low risk.
Coot	No	No	No	No	None	n/a	n/a	n/a	n/a									No	Not selected for modelling as Flight path not over site
Oystercatcher	**Yes**	No	**Yes**	No	Mod	n/a	n/a	n/a	n/a				**Yes**	**Yes**		**Yes**		**Yes**	Details of migratory movements are poorly understood; however, there is widespread movement within and between UK, Ireland, Iceland, Scandinavia and continental Europe. Oystercatcher is a qualifying feature of a Western Waters SPA assessed for AyM.
Avocet	No	No	No	No	None	n/a	n/a	n/a	n/a									No	Not selected for modelling as Flight path not over site
Stone-curlew	No	No	No	No	None	n/a	n/a	n/a	n/a									No	Not selected for modelling as Flight path not over site

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Ringed Plover	**Yes**	No	No	No	Low	n/a	n/a	n/a	n/a								**Yes**	**Yes**	Most ringed plover that breed in the UK remain in the UK; however, a small number cross the Irish Sea to overwinter in Ireland, and others are likely to use the Irish Sea while making short distance movements around the UK, or slightly longer movements to France. In addition, a large number of ringed plover use the Irish Sea on passage between breeding sites in arctic Canada, Greenland, Iceland and Scandinavia and wintering sites in Spain and West Africa. Ringed plover is a qualifying feature of a Western Waters SPA assessed for AyM.
Dotterel	**Yes**	No	No	No	Low	n/a	n/a	n/a	n/a									No	The small UK breeding population migrates southwards to Morocco during the winter, and some birds are expected to pass through the Irish Sea. However, details of the migratory routes taken are unknown.
Golden Plover	**Yes**	No	No	No	Low / mod	n/a	n/a	n/a	n/a									**Yes**	Details of migratory movements are poorly understood, and there is evidence of birds travelling long distances to avoid harsh weather rather than following fixed migratory routes. Nonetheless, it is likely that the Irish Sea is used on passage by both UK-breeding birds and birds that visit the UK during the non-breeding season, especially those from Iceland and the Faeroes.

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Grey Plover	**Yes**	No	No	No	Low	n/a	n/a	n/a	n/a				**Yes**			**Yes**		**Yes**	All birds in the UK and Ireland over winter are believed to be from the Russian breeding population. Details of migratory routes are uncertain; however it is evident that birds do not take a single direct route from breeding to wintering grounds and it is likely that birds use the Irish Sea on passage around the UK and crossing from Britain to Ireland. Grey plover is a qualifying feature of a Western Waters SPA assessed for AyM.
Lapwing	**Yes**	No	No	No	Mod	n/a	n/a	n/a	n/a									**Yes**	The majority of UK-breeding lapwings remain close to their breeding grounds; however some do migrate including across the Irish Sea to Ireland, and southwards to continental Europe. In addition, in the non-breeding season birds migrate to the UK and Ireland from Europe and Scandinavia, with some crossing the Irish Sea.
Knot	**Yes**	No	No	No	Low	n/a	n/a	n/a	n/a				**Yes**			**Yes**		**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 exact details of migratory routes are poorly understood, but it is evident that there is extensive movement of birds around all UK waters including the Irish Sea, and large aggregations in estuaries. Knot is a qualifying feature of a Western Waters SPA assessed for AyM.

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Sanderling	**Yes**	No	No	No	Low	n/a	n/a	n/a	n/a									**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. The exact details of migratory routes are poorly understood, but it is evident that there is extensive movement of birds around all UK waters including the Irish Sea.
Purple Sandpiper	**Yes**	No	No	No	None	n/a	n/a	n/a	n/a									No	The population that overwinters in UK and Ireland breeds in Norway, Greenland, arctic Canada, Russia and Svalbard. The UK wintering population is skewed towards the north of the UK, but some movements may include the Irish Sea as far south as AyM.
Dunlin (breeding and passage populations)	**Yes**	No	No	No	Low	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 exact details of migratory routes are poorly understood, but it is evident that there is extensive movement of birds around all UK waters including the Irish Sea.
Dunlin (wintering population)	**Yes**	No	No	No	Mod	n/a	n/a	n/a	n/a				**Yes**			**Yes**	**Yes**	**Yes**	Birds of the alpina race that overwinter in Britain and Ireland migrate from northern Scandinavia and Russia. Birds which overwinter in Ireland (an estimated 88,480 individuals) are expected to cross the Irish Sea from Britain. Dunlin is a qualifying feature of a Western Waters SPA assessed for AyM.

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Ruff	**Yes**	No	No	No	None	n/a	n/a	n/a	n/a									No	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. Therefore, unlikely to pass through the AyM array area in significant numbers.
Snipe	**Yes**	No	No	No	Low	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 birds also continuing southwards to Europe. Details of migratory routes are unknown but it is evident that there is extensive movement of birds around all UK waters including the Irish Sea.
Black-tailed Godwit (breeding population)	No	No	No	No	None	n/a	n/a	n/a	n/a									No	Not selected for modelling as Flight path not over site

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Black-tailed Godwit (Icelandic)	**Yes**	No	No	No	Low	n/a	n/a	n/a	n/a				**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 Irish Sea. Black-tailed godwit is a qualifying feature of a Western Waters SPA assessed for AyM.
Bar-tailed Godwit	**Yes**	No	No	No	Low	n/a	n/a	n/a	n/a				**Yes**					**Yes**	Birds that overwinter in UK and Ireland migrate from breeding sites in Scandinavia and Russia. It is expected that the majority of birds that overwinter in Ireland (16,820 individuals) arrive by crossing the Irish Sea from Britain. Bar-tailed godwit is a qualifying feature of a Western Waters SPA assessed for AyM.
Whimbrel	**Yes**	No	No	No	Low	n/a	n/a	n/a	n/a							**Yes**		**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 Irish Sea. Whimbrel is a qualifying feature of a Western Waters SPA assessed for AyM.

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Curlew	**Yes**	No	No	No	Mod	n/a	n/a	n/a	n/a				**Yes**			**Yes**		**Yes**	Although most UK-breeding birds remain within the UK and Ireland, most do travel significant distances between breeding and wintering sites, including crossing the Irish Sea. In addition, the population is supplemented with birds that breed elsewhere in northern Europe, many of which also continue across the Irish Sea to Ireland. Birds may also use the Irish Sea when moving along the British coastline. Curlew is a qualifying feature of a Western Waters SPA assessed for AyM.
Greenshank	**Yes**	No	No	No	Low	n/a	n/a	n/a	n/a							**Yes**		**Yes**	Migratory routes of UK-breeding birds (breeding sites restricted to Scottish uplands) are not known in details, but they are thought to winter in Ireland, western Britain, southwest Europe or northwest Africa and therefore they may well utilise the Irish Sea on passage. In addition, larger numbers of birds pass through UK waters on passage, and are found all around the UK including within the Irish Sea. However, on a precautionary basis, this species has been screened in.

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Wood Sandpiper	**Yes**	No	No	No	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. Highly unlikely that any significant numbers would cross the AyM array area.
Redshank	**Yes**	No	No	No	Mod	n/a	n/a	n/a	n/a				**Yes**				**Yes**	**Yes**	**Yes**	Details of migratory movements are uncertain, but both the UK-breeding brittanica population and the robusta population (breeding in Iceland and the Faroes) are found all around UK waters on migration, including the Irish Sea. Redshank is a qualifying feature of a Western Waters SPA assessed for AyM.
Turnstone	**Yes**	No	No	No	Mod	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 to continental Europe. Details of migratory routes are uncertain but birds may use all waters around the UK. Turnstone is a qualifying feature of a Western Waters SPA assessed for AyM.

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Red-necked Phalarope	**Yes**	No	No	No	None	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; however, it is possible that some birds may use the Irish Sea. Scarce migrant that is not considered at risk.
Arctic Skua	**Yes**	No	No	No	Low	low/mod	mod/high	mod	high	0.07	mod							No	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; unlikely to migrate through AyM in significant numbers.
Great Skua	**Yes**	No	No	No	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. 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. Therefore, unlikely to migrate through AyM in significant numbers.

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Kittiwake	**Yes**	No	**Yes**	**Yes**	Mod	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. The potential effect from collision risk to kittiwakes is considered in detail in the main assessment. 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.
Black-headed Gull	**Yes**	No	**Yes**	No	Low	low	low	n/a	high	2.01	v high							No	While most UK-breeding birds are fairly sedentary, some migrate including some movement across the Irish Sea between UK and Ireland.
Mediterranean Gull	No	No	No	No	None	n/a	n/a	mod	n/a									No	Not selected for modelling as Flight path not over site
Common Gull	**Yes**	No	**Yes**	**Yes**	Low	low	low	n/a	high									**Yes**	While most UK-breeding birds are fairly sedentary, some migrate including some movement across the Irish Sea between UK and Ireland. Species found in moderate abundance during migratory bio-season from site specific survey data. Screened in for assessment following broad-front approach.

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Lesser Black-backed Gull	**Yes**	No	**Yes**	**Yes**	Low	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. Some of these birds are also likely to use the Irish Sea.
Herring Gull	**Yes**	No	**Yes**	**Yes**	Low	mod	mod	mod	high									No	While most UK-breeding birds are fairly sedentary, some migrate including some movement across the Irish Sea between UK and Ireland. The potential effect from collision risk to herring gulls is considered in detail in the main assessment. 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.
Great Black-backed Gull	**Yes**	No	**Yes**	**Yes**	Low	mod	mod	mod	high									No	While most UK-breeding birds are fairly sedentary, some migrate including some movement across the Irish Sea between UK and Ireland. The potential effect from collision risk to great black-backed gulls is considered in detail in the main assessment. 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.

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Little Tern	**Yes**	No	No	No	Low	low/mod	low/mod	low	mod				**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 unknown, but likely include the Irish Sea.
Black Tern	No	No	No	No	None	low/mod	low/mod	n/a	n/a									No	Both UK-breeding birds and birds which use UK waters on passage overwinter in West Africa. Details of migratory routes are uncertain. Scarce species within the UK.
Sandwich Tern	**Yes**	No	No	**Yes**	Low	low/mod	low/mod	mod	mod/high	0.48	mod		**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. Recorded within AyM array area on migration and screened in for assessment following broad-front approach.
Common Tern	**Yes**	No	No	**Yes**	Low	low/mod	low/mod	mod	mod	0.54	low							**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. Recorded within AyM array area on migration and screened in for assessment following broad-front approach.
Roseate Tern	**Yes**	No	No	No	None	low/mod	low/mod	mod	mod									No	A small number of roseate terns breed in the UK, and those birds migrate southwards to wintering sites on the west coast of Africa. This no doubt includes passage through the Irish Sea. Many birds from colonies around the Irish Sea stage in Dublin Bay prior to onward migration, which may mean they are less likely to use the area around AyM.

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Arctic Tern	**Yes**	No	No	**Yes**	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. Recorded within AyM array area on migration and screened in for assessment following broad-front approach.
Guillemot	**Yes**	No	**Yes**	**Yes**	Mod	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. It is assumed that guillemot densities during migratory seasons are well represented by site-specific survey data and therefore no separate migratory assessment is required. Guillemots were screened out of collision risk modelling due to very low sensitivity.
Razorbill	**Yes**	No	**Yes**	**Yes**	Mod	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. Although more birds go via the North Sea, significant numbers migrate via the Irish Sea too. It is assumed that razorbill densities during migratory seasons are well represented by site-specific survey data and therefore no separate migratory assessment is required. Razorbills were screened out of collision risk modelling due to very low sensitivity.

Species / Sub-Species	Flight Path through AyM		Observations from surveys		Literature Review	Species of CRM Concern (SOSS 03A)		Perceived Risk from Collision		SOSS 02 Flight Heights		Qualifying Feature of Assessed Western Water SPA						Screened in?	Comments
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Puffin	**Yes**	No	**Yes**	**Yes**	Low	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. It is assumed that puffin densities during migratory seasons are well represented by site-specific survey data and therefore no separate migratory assessment is required. Puffins were screened out of collision risk modelling due to very low sensitivity.
Short-eared Owl	**Yes**	No	No	No	None	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 Irish Sea. Unlikely that any significant numbers would cross the AyM array area.
Nightjar	No	**Yes**	No	No	None	n/a	n/a	n/a	n/a									No	A very small number of birds is thought to cross the Irish Sea on migration between Britain and Ireland. Highly unlikely that any significant numbers would cross the AyM array area.
Woodlark	No	No	No	No	n/a	n/a	n/a	n/a	n/a									No	Not selected for modelling as Flight path not over site
Dartford Warbler	No	No	No	No	n/a	n/a	n/a	n/a	n/a									No	Not selected for modelling as Flight path not over site
Aquatic Warbler	No	No	No	No	n/a	n/a	n/a	n/a	n/a									No	Not selected for modelling as Flight path not over site
Great Northern Diver	n/a	n/a	No	No	n/a	n/a	n/a	n/a	mod/high									No	No Flightpath
Long-tailed Skua	n/a	n/a	No	No	n/a	n/a	n/a	n/a	n/a									No	No Flightpath
Pomarine Skua	n/a	n/a	No	No	n/a	n/a	n/a	n/a	n/a									No	No Flightpath
Sabine's Gull	n/a	n/a	No	No	n/a	n/a	n/a	n/a	n/a									No	No Flightpath

Species / Sub-Species	Flight Path through AyM		Observations from surveys		Literature Review	Species of CRM Concern (SOSS 03A)		Perceived Risk from Collision		SOSS 02 Flight Heights		Qualifying Feature of Assessed Western Water SPA						Screened in?	Comments
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Little Gull	n/a	n/a	No	No	n/a	low	low	n/a	n/a	2.14	mod	**Yes**						No	No Flightpath
Little auk	n/a	n/a	No	No	n/a	low	low	n/a	low	0.13	high							No	No Flightpath

Appendix 2 Migropath Confidence Limits

Species/ Population	Migration route	Number of birds passing through the AyM array area each migration (mean)	Number of birds passing through the AyM array area each migration (Lower 95% CL)	Number of birds passing through the AyM array area each migration (Upper 95% CL)
Whooper swan (wintering)	North	0	0	0
	South	1	1	2
White-fronted goose (*flavirostris*; wintering)	North	0	0	0
Shelduck	South	44	40	48
Wigeon (wintering)	North	2,929	2,834	3,034
	South	874	833	914
Gadwall (wintering)	North	7	6	7
	South	44	39	50
Teal (wintering)	North	98	95	102
	South	772	725	821
Mallard (wintering)	South	2,407	2,120	2,654
Pintail (wintering)	North	20	19	21
	South	46	42	49
Shoveler (wintering)	South	51	46	55
Tufted duck (wintering)	North	0	0	0
	South	315	287	339
Red-breasted merganser (wintering)	North	355	345	366
	South	0	0	0
Cormorant (breeding)	South	757	737	781
Cormorant (wintering)	South	315	302	325
Hen harrier (wintering)	South	3	3	3
Oystercatcher (wintering)	North	0	0	0
	South	4,995	4,829	5,145
Ringed plover (breeding)	South	194	179	210
Ringed plover (passage)	North	237	230	247
	South	707	683	729
Golden plover (breeding)	South	2,697 – 4,191	2,560 – 3,978	2,831 – 4,398
Golden plover (wintering)	North	0	0	0
	South	2,158	1,946	2,351

Species/ Population	Migration route	Number of birds passing through the AyM array area each migration (mean)	Number of birds passing through the AyM array area each migration (Lower 95% CL)	Number of birds passing through the AyM array area each migration (Upper 95% CL)
Grey plover (wintering)	South	95	89	100
Lapwing (wintering)	South	1,877	1,791	1,960
Knot (wintering)	North	2,904	2,796	3,026
	South	1,197	1,156	1,253
Sanderling (wintering)	North	475	459	495
	South	83	79	90
Dunlin (breeding)	South	220 - 270	211 – 258	231 – 282
Dunlin (wintering)	North	0	0	0
	South	0	0	0
Snipe (wintering)	North	0	0	0
	South	0	0	0
Black-tailed godwit (*Islandica*; wintering)	North	1,370	1,338	1,397
Bar-tailed godwit (wintering)	South	160	150	169
Whimbrel (passage)	North	0	0	0
	South	0	0	0
Curlew (breeding)	South	0	0	0
Curlew (wintering)	South	2,069	2,005	2,143
Greenshank (breeding)	South	94	88	100
Redshank (*britannica*; breeding)	South	761	702	819
Redshank (*robusta*; wintering)	North	2,761 – 7,362	2702 – 7,206	2827 – 7,540
Redshank (*totanus*; wintering)	South	279	272	286
Turnstone (wintering)	North	570	547	597
	South	75	72	79

Fferm Wynt Alltraeth

AWEL Y MÔR

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