Appendix H Addendum

Offshore Ornithology - Supporting Information

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

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Energy for generations

ORIEL WIND FARM PROJECT

Natura Impact Statement Addendum

Appendix H Addendum: Offshore Ornithology – Supporting Information

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1 OFFSHORE ORNITHOLOGY

1.1 Introduction

This Addendum provides supplementary information to the description of potential impacts of the Oriel Wind Farm Project (hereafter referred to as "the Project") on Offshore Ornithology as presented in Appendix H: Offshore Ornithology - Supporting Information of the Natura Impact Statement (NIS, 2024). The supplementary information is provided in response to a request for further information (RFI) from An Coimisiún Pleanála (ACP) (formerly An Bord Pleanála) on the planning application (case reference ABP-319799-24) for the Oriel Wind Farm Project (hereafter referred to as "the Project").

Table 1A-5 in the NIS Addendum lists the schedule of information requested for Offshore Ornithology (RFI 9) and outlines which information requests resulted in further information requirements for the NIS and this Addendum to appendix H. Table 1A-5 in the NIS Addendum also describes if the supplementary information amends the NIS conclusions.

The headings and subheadings in this Addendum correspond to those used in Appendix H of the NIS. The reader is directed to review the information presented in this Addendum alongside the information presented in Appendix H.

The additional assessment presented is this Addendum is informed by the following additional technical reports:

- Annex 8 Addendum: Offshore Ornithology Population Viability Analysis; and
- Annex 9: Migratory Collision Risk Modelling: Phase One Projects Cumulative Assessment.

1.2 Purpose

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

1.3 Zone of Influence

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

1.4 Consultation

Table 1A-1 provides a summary of further consultation undertaken with NPWS in October 2025 (i.e. post application).

Table 1A-1: Summary of key issues raised on Offshore Ornithology.

Date	Consultee and type of response	Issue raised	Response to issue raised and/or where consider in this appendix
October 2025	National Parks and Wildlife Service (NPWS) – in person meeting. Discussion of DAU submission and approach to RFI response.	Collision risk to migratory birds; Kittiwake displacement and combined displacement / collision; Construction at the landfall location.	Collision risk to migratory birds has been assessed in section 5.3 of this Addendum, while section 3.2 provides a clear, evidence-based justification for inclusion/exclusion of species with regards to this assessment. Disturbance and displacement impacts to Kittiwake have now been assessed in section 5.1.2.6 of this Addendum. Regarding construction at the landfall location, the Project proposes to use open cut trenching to install the export cable in the intertidal area. An ecologist will supervise works. Habitat at the landfall is expected to recover

Date	Consultee and type of response	Issue raised	Response to issue raised and/or where consider in this appendix
			quickly. Justification as to why HDD is not feasible from an engineering perspective was requested from NPWS and it is provided in section 2 of the NIS Addendum. Measures relating to timing of works at the landfall to reduce disturbance of bird species using adjacent subtidal waters are outlined in appendix I: Onshore Biodiversity Supporting Information (2024) (and further details are presented in appendix I Addendum).

2 METHODOLOGY TO INFORM THE BASELINE

2.1 Desktop study

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

2.2 Site-specific surveys

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

2.3 Identification of relevant European sites and features

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

3 BASELINE ENVIRONMENT

3.1 Relevant European sites

The following relevant European sites, which are listed in 'Table 3-1: Relevant European sites and qualifying features' in appendix H: Offshore Ornithology Supporting information (2024), have updated Site Specific Conservation Objective (SSCO) documents:

- Skerries Island SPA;
- Lambay Island SPA;
- Ireland's Eye SPA;
- Howth Head Coast SPA;
- Wicklow Head SPA;
- West Donegal Coast SPA;
- Beara Peninsula SPA;
- Duvillaun Islands SPA; and
- Deenish Island and Scariff Island SPA.

However, there are no changes to special conservation interests or attributes have resulted and therefore no other changes are required in 'Table 3-1: Relevant European sites and qualifying features'.

3.2 Relevant qualifying features recorded in the Offshore Ornithology Study Area

In response to RFI 7.A, 7.D and 7.I a clear, evidence-based justification for inclusion/exclusion of species is provided below.

A total of 31 bird species were recorded during the site-specific surveys undertaken between May 2018 and September 2020, of which 22 are qualifying features of SPAs in Table 3-1 in appendix H: Offshore Ornithology Supporting information (2024). The 22 qualifying features also are presented in Table 3-2 in appendix H: Offshore Ornithology Supporting information (2024). Further details of the baseline characterisation for each species are included in annex 1: Offshore Ornithology Technical Report, and annex 2: Ornithological and Marine Megafauna Aerial Survey Results (in appendix H: Offshore Ornithology Supporting Information).

When determining which species to assess in the NIS for each impact (disturbance and displacement, and collision), the Applicant applied a screening process based on species abundance recorded during the site-specific surveys and their sensitivity to effects.

Where seabirds were not recorded at all over the duration of site-specific surveys (19 surveys[1]), it is considered objectively reasonable using expert judgement to exclude them from further assessment. Seabirds not recorded would likely not use the offshore wind farm area in numbers large enough to warrant further consideration. Therefore, the seabirds, and their relevant SPAs, which were not recorded at all during site-specific surveys have been excluded from further assessment.

[1] This was incorrectly stated as 18 surveys in the NIS appendix H Offshore Ornithology Supporting information (2024).

The total abundance presented Table 3-2 (in appendix H: Offshore Ornithology Supporting Information) is derived from summing all records during the site-specific surveys. The level of abundance is categorised as follows: very low < 49 individuals; low: 50 to 199; moderate: 200 to 999; high: 1000 to 4,999 and very high: > 5,000. If a qualifying feature was present in very low numbers (<49 individuals recorded throughout the combined the site-specific surveys) it is concluded that no adverse impact would occur during any phase of the Project (these species are highlighted in grey).

Accordingly, the following species were excluded from the assessment of effects in the NIS due to very low abundance in the Offshore Ornithology Study Area (Table 3-2):

- Arctic tern: Only a single bird recorded;
- Black-headed gull: 24 birds recorded;
- Little gull: only one bird recorded; and
- Sandwich tern: 19 birds recorded.

Species recorded in low numbers (50 to 199 individuals) across all site-specific surveys (19 surveys), are presented within Table 3-3 (in appendix H: Offshore Ornithology Supporting Information) to understand the importance of the sites to the SPA populations (these species are highlighted in yellow). To account for small populations of species recorded in low numbers a further screening of SPAs within the connectivity range is presented in Table 3-3 for species which were defined as “low” abundance. A species was taken forward to further assessment (e.g. an assessment of collision risk or disturbance and displacement) if the peak count during one survey represents >10% of a single SPA’s population. At least 10 % of a single SPA’s population was used as in reality the birds would come from multiple different SPAs (and non-SPA) colonies and therefore presuming that all individuals within the survey area are from one SPA is highly unlikely and not realistic.

For species with the peak count during one survey representing <10% of a single SPA’s population, further screening was undertaken based on the sensitivity and distribution of the species within the Offshore Ornithology Study Area (Table 3-3). Due to the sensitively of red-throated diver to disturbance and that the cable corridor overlaps with the North-west Irish Sea SPA, this species and site, are taken through to further assessment. However, the following species were not taken for further assessment:

- Common tern. Low sensitivity to disturbance and displacement; Moderate sensitivity to collision. Low abundance (77 birds). The peak count on a single survey was 21 birds (recorded in September 2018 and August 2019 during the post-breeding migration);
- Cormorant. Despite moderate sensitivity to disturbance, the species' low abundance (78 birds) meant further assessment was unnecessary;
- Fulmar. The species is not considered susceptible to collisions or displacement and is therefore excluded from further assessment;
- Lesser black-backed gull. Given the low numbers (52 birds) a collision risk assessment was not required; and;
- Puffin. Low sensitivity to disturbance & displacement; Very low sensitivity to collision. Low abundance (72 birds). Puffin were recorded in 12 of the 24 months of surveys, which coincided with the breeding period and post-breeding migration. The highest count recorded during a DAS survey was 24 birds in September 2020, coinciding with post-breeding migration. Only two sightings were recorded inside the array area during the DAS surveys conducted between April and September 2020. Only five birds (across four sightings) were recorded in the array area during boat-based surveys conducted between May 2018 and May 2020. Puffin are considered susceptible to displacement, along with other auk species; however, given the small number present within the array area (two to four birds), further assessment of displacement was not considered necessary as the species was distributed outside the array area.

Species which are recorded in at least moderate numbers (>200 individuals), are instantly taken through for additional assessment (these species are highlighted in green in appendix H: Offshore Ornithology Supporting Information). It should be noted that assessments for other wind farm projects may take a different approach to what is outlined above due to the differences in geographic location and peak site-specific survey counts for seabirds. Differences in seabird peak counts between projects is expected to vary and will result in differences in which seabirds are included/ excluded for further assessment.

3.2.1 Seasonality

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

3.2.2 Reference populations

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

4 KEY PARAMETERS FOR ASSESSMENT

4.1 Project design parameters

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

4.2 Measures included in the Project

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

4.3 Impacts scoped out of the assessment

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

5 POTENTIAL IMPACTS

The structure of this Addendum is the same as the structure of NIS appendix H: Offshore Ornithology (2024) (i.e. the section and subsection heading titles in this Addendum correspond to those used in the appendix).

In response to the RFI, supplementary information is provided under the relevant headings. However, for section 5 titled '*Potential impacts*', a different approach to presenting the updates has been taken to provide clarity to the reader. Where there is a change in the assessment, the text from NIS appendix H: Offshore Ornithology (2024) is repeated and changes arising from the further information (where they relate to the assessment) are shown in blue (e.g. example text). Where text from NIS appendix H: Offshore Ornithology (2024) has been superseded or is no longer relevant, this text has been included in this Addendum with a strikethrough (e.g. ~~example text~~) in order to present the changes as clearly as possible. Where there is no change to the assessment then, this is noted as 'There are no changes to the NIS appendix H: Offshore Ornithology'. Additional assessment is presented in blue text.

5.1 Disturbance and displacement

5.1.1 Construction phase

Disturbance as a result of activities during the construction of a wind farm (such as installing foundations, wind turbines, inter-array cabling and associated vessel movements) and the offshore cable has the potential to displace birds from an area of sea in which the activity is occurring. This in effect represents indirect, temporary habitat loss, potentially reducing the area available for those seabirds sensitive to disturbance to forage, loaf and / or moult in the way that they are currently able to within and around the offshore wind farm area and offshore cable corridor. Such disturbance could ultimately affect the demographic fitness (i.e. survival rates and breeding productivity) of displaced birds, as well as potentially impacting on birds in areas that displaced birds move to due to increased competition for resources.

Disturbance associated with construction vessel movements will be of limited duration at any one location, because it is a transient impact as marine vessels move through an area relatively quickly. Vessel movements for the construction of the offshore infrastructure will also be infrequent, amounting to 475 round trips during a construction period of 15 months (averaging just over one round trip per day). Construction activities also result in a point source of disturbance, for example when construction vessels are at a location to undertake piling, drilling and install foundations or the wind turbines. The level of disturbance associated with each location would vary depending on the activity undertaken. As the potential impacts are spatially and temporally restricted, the potential impact is reversible in the short-term as birds are likely to return when activities have been completed at that location. However, there is potential for disturbance around each point source throughout the construction period of 15 months.

Species differ greatly in their susceptibility to disturbance (SNCB, 2022). For example, some auk species (e.g. guillemot and razorbill) have been shown to be disturbed by boats hundreds of metres away (Furness and Wade*,* 2012); amongst sea ducks, scoters are particularly vulnerable to disturbance by vessels (Kaiser *et al.,* 2006 and Furness *et al*., 2012) and divers show a higher degree of sensitivity and are especially sensitive to approaching boats at a distance of more than 1 km (Garthe and Hüppop, 1994, Schwemmer *et al*., 2011 and Furness and Wade, 2012). Gull species however are known to be attracted by human activities at sea, such as fishing vessels (Garthe and Hüppop*,* 1994 and Welcker *et al*., 2016), and are usually assumed to be insensitive to anthropogenic disturbance. Assuming there is a single point source of disturbance, potentially affecting birds within an area of 2 km (or 4 km for great northern divers and 10 km for red-throated divers), that would result in a consistently affected area of approximately 12.56 km^2 (or 50.26 km^2 for great northern diver and 314.16 km^2 for red-throated divers) which varies in its location within the offshore wind farm area and offshore cable corridor. It is therefore possible to apply the mean-peak density of birds recorded in the Offshore Ornithology Study Area to estimate the number of birds potentially displaced temporarily by construction activities. Both diver species (great northern diver and red-throated diver) are more susceptible to distance to vessels traffic~~ and ~~; therefore, disturbance radius of 4 km (great northern diver) and 10 km (red-throated diver) have been applied, corresponding to displacement areas of 50.27 km^2 and 314.16 km^2, respectively ~~therefore a higher disturbance distance is proposed of 4 km, therefore total displacement of 50.27 km^2~~.

Species sensitivity to disturbance in response to offshore wind farms has been quantified by several means. A study undertaken by Garthe and Hüppop (2004) developed a scoring system to assess species sensitivity to disturbance by using nine factors derived from the species' attributes; each factor was scored on a five point scale from 1 (low vulnerability) to 5 (high vulnerability). Furness and Wade (2012) reviewed evidence for likely impacts on seabirds in Scottish waters, and constructed indices assessing the relative vulnerability of seabird species' populations to impacts of turbines. Bradbury *et al*. (2014) built upon Furness and Wade (2012) and produced a sensitivity score for species within English waters. The sensitivity scores presented within Bradbury *et al*. (2014) included assessment of displacement/disturbance alongside collision, therefore the sensitivities presented in Table 5A-1 are taken from Bradbury *et al*. (2014), unless stated otherwise. This assessment follows the latest guidance from the joint SCNBs (SNCB, 2022) as to which species should be included within the displacement assessment. A screening assessment for construction disturbance has been carried out for each species with consideration of the species' sensitivity rating and abundance in the Offshore Ornithology Study Area (Table 5A-1). Only species that were recorded in abundances within the offshore wind farm area and offshore cable corridor of moderate or above **AND** with a sensitivity of moderate or above will be screened in and taken forward for assessment. These criteria do not apply to red-throated diver, as the SNCB guidance (2022) states that assessment should be undertaken for this species.

Table 5A-1: Screening for assessment of disturbance and displacement during construction (This table replaces Table 5-1).

Offshore Ornithology IEF	Sensitivity to disturbance and displacement during construction	Abundance recorded in offshore wind farm area and offshore cable corridor	Screened IN or OUT
Common gull	Low	Low	Low sensitivity to disturbance and displacement; low abundance recorded during site-specific surveys within the offshore wind farm area and offshore cable corridor. **Screened OUT**
Common scoter	High	Low	High sensitivity to disturbance and displacement. Generally recorded in low numbers in inshore areas with the exception of April 2020 which recorded over 2,000 individuals, although that was not within the offshore wind farm area or offshore cable corridor. **Screened OUT**
Gannet	Very low	High	High abundance recorded during site-specific surveys however very low sensitivity to disturbance and displacement during construction. **Screened OUT**
Great black-backed gull	Very low	Moderate	Moderate abundance recorded during site-specific surveys however very low sensitivity to disturbance and displacement. **Screened OUT**
Great northern diver	High	Moderate	High sensitivity to disturbance and displacement and moderate abundance. **Screened IN for precaution**
Guillemot	Moderate	Very high	Very high abundance recorded in the surveys area and moderate sensitivity to disturbance and displacement. **Screened IN**

Offshore Ornithology IEF	Sensitivity to disturbance and displacement during construction	Abundance recorded in offshore wind farm area and offshore cable corridor	Screened IN or OUT
Herring gull	Very low	Low	Very low sensitivity to disturbance and displacement and low abundance recorded during site-specific surveys. **Screened OUT**
Kittiwake	Very low	Moderate	Moderate abundance recorded during site-specific surveys however very low sensitivity to disturbance and displacement. **Screened OUT**
Manx shearwater	Very low	Very high	Very high abundance but very low sensitivity to disturbance and displacement. **Screened OUT**
Razorbill	Moderate	Very high	Very high abundance recorded in the survey area and has moderate sensitivity to disturbance and displacement. **Screened IN**
Red-throated diver	Very high	Low	Very high sensitivity to disturbance and displacement but low abundance. **Screened IN for precaution**

5.1.1.1 Great northern diver

Assessment of impact – all seasons

The peak levels of activity were recorded during the spring migration (total records of 306 individuals during spring migration (March to May) and winter periods (181 total records), with smaller numbers recorded in the autumn migration (90 total records). Birds recorded in the autumn and spring migration seasons are likely to remain in a location for a shorter period of time as they are on the move and will be less sensitive to displacement as a result. However, the assessment takes a precautionary approach and considers displacement in the context of the peak number of birds recorded during the entire non-breeding bio-season defined as September to May, which includes the autumn and spring migration periods.

A mean-peak density of 1.59 birds/km^2 was estimated in the offshore wind farm area during the non-breeding bio-season (September – May) during the boat-based surveys. The mean-peak density of birds within the Offshore Ornithology Study Area during DAS was higher with 2.42 birds/km^2 (Table 32 in annex 2 of appendix H: Ornithological and Marine Megafauna Aerial Survey Results).

Based on a mean-peak density of 2.42 birds/km^2 within the Offshore Ornithology Study Area during the DAS and a disturbance distance of 50.27 km^2 (using a radial displacement around a single point of displacement of 4km) there would be approximately 122 birds at risk of temporary displacement during one or two non-breeding seasons during which construction would occur. Great northern diver are sensitive to disturbance and can be displaced from 4 km away from the development (Bradbury *et al*., 2014; SNCB, 2022). There is no evidence that great northern diver are being displaced beyond 4 km from the offshore wind farm (SNCB, 2022).

A worst-case approach is taken to the assessment, which assumes 100 % displacement from the potential zone of influence within 4 km of the source of construction disturbance.

A value of 0.5 % mortality has been used in assessing the number of individuals that could be at risk of mortality due to disturbance and displacement during the construction phase, reflecting the absence of constraint to specific locations by non-breeding birds (SNCB, 2022). Topping and Petersen (2011) found no evidence for population effect in the related species, red-throated diver as a result of displacement from offshore wind farms. Furthermore, great northern diver may have a stronger tolerance to disturbance compared to other diver species (e.g. red-throated and black-throated) (Gittings *et al*., 2015), although the literature on this subject is sparse. Based on a 100% displacement rate and a 0.5% mortality rate, the offshore wind farm construction would result in additional annual mortality of 0.61 birds within a 4 km buffer.

Additionally, a 10% mortality rate has been presented to provide the maximum range of mortality rate in the estimates of predicted mortalities, in response to RFI 7.E. Based on a 100% displacement rate and 10% mortality rate, the offshore wind farm construction would result in additional mortality of 12.2 birds annually. A 10% mortality rate has been included to provide the maximum range of mortality rate in the estimates of predicted mortalities, given the location of the site partially within the North-west Irish Sea SPA. However, this scenario is not considered ecologically realistic, as there is no evidence to support such high mortality rate. Therefore, the 10% mortality rate scenario should be treated as excessively precautionary rather than a plausible outcome.

~~A mean-peak density of 1.59 birds/km^2 was estimated in the offshore wind farm area during the non-breeding bio-season (September – May) during the boat-based survey (average peak of 44 birds over the offshore wind farm area). The mean-peak density of birds within the Offshore Ornithology Study Area during DAS was slightly higher with 1.78 birds/km^2.~~

~~Based on a mean-peak density of 1.59 birds/ km^2 within the offshore wind farm area and a disturbance distance of up to 50.27 km^2, there could be approximately 89 birds at risk of temporary displacement during one or two non-breeding seasons during which construction would occur. Due to the temporary nature of construction a displacement mortality of 90% displacement and 0.5% mortality is considered realistic. Therefore, the additional mortality of up to 0.45 birds may occur.~~

The offshore cable corridor overlaps with the North-west Irish Sea SPA, however there is unlikely to be any construction activity during the non-breeding season, with construction occurring in spring or summer. Therefore, there is little potential to have an adverse effect on the site's integrity for all SPAs assessed from the Project alone.

5.1.1.2 Guillemot

Guillemots were recorded in the Offshore Ornithology Study Area at high densities across all months during the site-specific surveys. Peak occurrences were observed during the DAS undertaken in July, August and September 2020 with peak counts of 3,235, 3,077 and 6,163 individuals on transect respectively.

A mean-peak density of 10.3 birds/km^2 was estimated in the offshore wind farm area during the breeding bio-season from the boat-based surveys, with a peak of 21.4 birds/km^2 from the DAS. In the non-breeding bio-season, there was an estimated mean-peak density of 30.5 birds/km^2 from boat-based surveys and a peak density of 61.9 birds/km^2 from the DAS.

Assessment of impact – all seasons

During the breeding season, based on a mean-peak density of 10.3 to 21.4 birds/km^2 within an area of 12.56 km^2 (radial displacement around a single point of displacement), there would be approximately 129 to 269 birds at risk of temporary disturbance and displacement during one or two breeding seasons during which construction would occur.

During the non-breeding season, based on a mean-peak density of 30.5 to 61.9 birds/km^2 within an area of 12.56 km^2(radial displacement around a single point of displacement), there would be approximately 383 to 777 birds at risk of temporary disturbance and displacement during one or two non-breeding seasons during which construction would occur.

Following the guidance presented by the SNCB (2022), the recommended displacement rate for auk species is between 30 % and 70 %, while advice provided by NatureScot recommends a displacement rate of 60 % and a mortality rate of 1 % (from Marine Scotland Scoping opinion for Seagreen development in the Firth of Forth). For the purposes of this report and considering the temporary and intermittent nature of the construction disturbance, the impact is assessed in the context of 50 % displacement rate and 1 % mortality rate.

However, the maximum impact has also been included in the context of a 70% displacement rate and 10% mortality rate, given the location of the site partially within the North-west Irish Sea SPA and proximity to colonies, Lambay Island SPA & Irelands Eye SPA. It is important to consider that drawing conclusions based solely on the maximum range of displacement and mortality rates is excessively precautionary and not ecologically realistic.

Based on these rates, the construction of the offshore wind farm and offshore cable would result in additional mortality of:

- Breeding season: ~~6.5~~ 0.65 to ~~13.4~~ 1.34 birds; and
- Non-breeding season: ~~19.2~~ 1.92 to ~~38.9~~ 3.89 birds.

Based on the 70% displacement rate and 10% mortality rate, the construction of the offshore wind farm and offshore cable would result in additional mortality of:

- Breeding season: 9.0 to 18.8 birds; and
- Non-breeding season: 26.8 to 54.4 birds.

Due to the lesser estimate of potential mortality during construction than during operational and maintenance, it was not deemed necessary to apportion the impact on the five SPAs for which guillemot is a qualifying feature. Reference to the operational and maintenance assessment should be viewed (section 5.1.2.3). As the increase in baseline mortality during the operational and maintenance phase is <1 %, the impact during the construction phase is not considered to have an adverse effect on the site's integrity for all SPAs assessed from the Project alone.

5.1.1.3 Razorbill

During the site-specific surveys, razorbill was recorded on transect throughout the survey period with a peak count observed in September 2020 (1,064 individuals). The peak in September 2020 is likely related to post-breeding dispersal of adults and juveniles from breeding sites. However, as there are no large razorbill breeding colonies within close proximity to the Project, numbers during the breeding season (April to July) were relatively low.

A mean-peak density of 0.25 birds/km^2 was estimated in the offshore wind farm area during the breeding bio-season from the boat-based surveys, with a peak of 5.6 birds/km^2 from the DAS. In the non-breeding bio-season, there was an estimated mean-peak density of 10.5 birds/km^2 from boat-based surveys and a peak density of 9.6 birds/km^2 from the DAS.

Assessment of impact – all seasons

During the breeding period, based on a mean-peak density of 0.25 to 5.6 birds/km^2 within an area of 12.56 km^2. There would be approximately 3 to 70 birds at risk of temporary disturbance and displacement during one or two breeding seasons during which construction would occur.

During the non-breeding period, based on a mean-peak density of 9.6 to 10.5 birds/km^2 within an area of 12.56 km^2. There would be approximately 121 to 132 birds at risk of temporary disturbance and displacement during one or two non-breeding seasons during which construction would occur.

Following the guidance presented by the SNCB (2022), the recommended displacement rate for auk species is between 30% and 70% and mortality between 1 and 10%, while advice provided by NatureScot recommends a displacement rate of 60% and a mortality rate of 1% (from Marine Scotland Scoping opinion for Seagreen development in the Firth of Forth). For the purposes of this assessment and considering the temporary and intermittent nature of the construction disturbance, the impact is assessed in the context of 50% displacement rate and 1% mortality rate.

However, the maximum impact has also been included in the context of a 70% displacement rate and 10% mortality rate, given the location of the site partially within the North-west Irish Sea SPA and proximity to colonies, Lambay Island SPA & Irelands Eye SPA. It is important to consider that drawing conclusions based solely on the maximum range of displacement and mortality rates is excessively precautionary and not ecologically realistic.

Based on these rates, the construction of the offshore wind farm and offshore cable would result in additional mortality of:

- Breeding season: 0.2 to 3.5 birds; and
- Non-breeding season: 6.0 to 6.6 birds.

Based on the 70% displacement rate and 10% mortality rate, the construction of the offshore wind farm and offshore cable would result in additional mortality of:

- Breeding season: 0.2 to 4.9 birds; and
- Non-breeding season: 8.5 to 9.2 birds.

Due to the lesser estimate of potential mortality during construction than during operational and maintenance, it was not deemed necessary to apportion the impact on the five SPAs for which razorbill is a qualifying feature. Reference to the operation and maintenance assessment should be viewed (section 5.1.2.4). As the increase in baseline mortality is <1 % during the operational and maintenance phase, the impact during the construction phase is not considered to have an adverse effect on the site's integrity for all SPAs assessed from the Project alone.

5.1.1.4 Red-throated diver

Assessment of impact – all seasons

The peak levels of activity were recorded during the spring migration (total records of 27 individuals during spring migration (March to May) and winter periods (24 total records during one winter period), with smaller numbers recorded in the autumn migration (13 total records during one autumn period). Birds recorded in the autumn and spring migration seasons are likely to remain in a location for a shorter period of time as they are on the move and will be less sensitive to displacement as a result. However, the assessment takes a precautionary approach and considers displacement in the context of the peak number of birds recorded during the entire non-breeding bio-season defined as September-May, which includes the autumn and spring migration periods.

A mean-peak density of 0.06 birds/km2 was estimated in the offshore wind farm area during the non-breeding bio-season (September – May) during the boat-based survey. The peak density of birds within the Offshore Ornithology Study Area during DAS was higher with 0.09 birds/km^2 (during the April 2020 survey) (Table 31 in annex 2 of appendix H: Ornithological and Marine Megafauna Aerial Survey Results).

Based on a peak density of 0.09 birds/km2 within the offshore wind farm area and a disturbance distance of up to 50.27 km^2 (using a radial displacement of 4km around a single point of displacement) there could be approximately five birds at risk of temporary displacement during one or two non-breeding seasons during which construction would occur.

Based on a disturbance distance of up to 314.16 km^2 (using a radial displacement of 10km around a single point of displacement), there could be approximately 28 birds at risk of temporary displacement during one or two non-breeding seasons during which construction would occur.

Due to the temporary nature of construction, a displacement rate of 100% and a mortality rate 1% is considered realistic. Therefore, the additional mortality of up to 0.05 birds may occur (using a 4 km buffer) and 0.28 (using 10 km buffer).

Using the upper range of mortality effects for displaced individuals (up to 10% mortality) combined with a 100% displacement rate would result in an additional mortality of up to 0.50 birds within a 4 km buffer and 2.8 birds within a 10 km buffer. However, this scenario is not considered ecologically realistic, as there is no evidence to support a 10% mortality rate for displacement of birds.

~~A peak density of 0.10 birds/km^2 was estimated in the offshore wind farm area during the non-breeding bio-season (September – May) during the boat-based survey (during the February 2019 survey). The peak density of birds within the Offshore Ornithology Study Area during DAS was slightly lower with 0.09 birds/km^2 (during the April 2020 survey).~~

~~Based on a peak density of 0.10 birds/km^2 within the offshore wind farm area and a disturbance distance of up to 50.27 km^2, there could be approximately five birds at risk of temporary displacement during one or two non-breeding seasons during which construction would occur. Due to the temporary nature of construction a displacement mortality of 100% displacement and 1% mortality is considered realistic. Therefore, the additional mortality of up to 0.05 birds may occur.~~

The offshore cable corridor overlaps with the North-west Irish Sea SPA, for which red-throated diver is a component, however there is unlikely to be any construction activity during the non-breeding season, with construction occurring in spring or summer. Therefore there is little potential to have an adverse effect on the site's integrity for all SPAs assessed from the Project alone.

5.1.2 Operational and maintenance phase

During the operational and maintenance phase, the presence of operational turbines has the potential to directly disturb seabirds leading to displacement from the offshore wind farm area including an area of variable size or buffer (depending on sensitivity) around it (Furness *et al*., 2013 and Bradbury *et al.*, 2014). This would most affect those seabird species that are more sensitive to disturbance, although their sensitivity can vary by season and location. For example, the greatest impact is likely to be on breeding seabirds from nearby colonies that have highly specialised (and limited) habitat requirements and limited foraging ranges; it is unlikely that passage birds would be adversely affected by operational and maintenance activities as they are only present in the wind farm area for short periods during migration periods.

The period of time and constancy that individuals within a population may be subject to displacement impacts is uncertain, however it is likely that the impacts will be of higher intensity during the first years of operation, such that additional mortality in the population might be at its greatest in these early years, while in subsequent years it is possible that birds may become habituated to a certain extent, thereby reducing mortality rates.

Similar to the construction phase, seabird species differ in their reactions to offshore operational infrastructure and maintenance activities that accompany them, however the extent to which is still uncertain and subject to ongoing research. Although some species may show little avoidance, others such as divers, auks and pelagic seabirds may not forage or fly within hundreds of metres, or even several kilometres, of turbines. Comparatively, some gull species, cormorant and terns have generally shown little avoidance to wind farms and for instance were seen regularly foraging within the Egmond aan Zee offshore wind farm (Krijgsveld *et al*., 2009 and 2011).

Dierschke *et al.* (2016) reviewed studies from 20 operational wind farms in Europe, assessing the extent of displacement or attraction of 33 seabird species. They found that diver species and gannets showed consistent and strong avoidance behaviour of operational wind farms, whereas fulmar, common scoter, Manx shearwater, razorbill, common guillemot, little gull and sandwich tern showed less consistent displacement. Dierschke *et al.* (2016) suggested that displacement seemed more likely to be a response to the structures themselves, which appeared stronger when the turbines were rotating. However, for some species such as cormorant and shag, the attraction to offshore wind farms is beneficial for providing roosting and basking opportunities and increases in food availability are also apparent for some species.

Studies have shown that generally, migrants appear to be more obviously displaced than resident birds, perhaps due to a lack of habituation (Peterson *et al.,* 2005) and habituation is likely to occur for some species once turbines are operational and human activity is reduced.

As described in the sections above relating to the construction phase, species' sensitivity to disturbance in response to offshore wind farms has been quantified by several means, including studies by Garthe and Hüppop (2004) whereby species sensitivity to disturbance was assessed using nine factors derived from the species' attributes and used a five point scale from 1 (low vulnerability) to 5 (high vulnerability), and Furness *et al.* (2013) which reviewed evidence for likely impacts on seabirds, and constructed indices assessing the relative vulnerability of seabird species' populations to impacts of turbines. Similarly, Bradbury *et al.* (2014) expanded on Furness *et al.* (2013) to incorporate more species and also include an assessment of disturbance and displacement.

There is currently no detailed Irish guidance regarding the method of assessment of displacement of seabirds as a result of offshore wind farms. Guidance for offshore renewable energy Projects published by the DCCAE includes reference to emerging methods for displacement assessment at the time of its publication, namely JNCC report 551 (Busch *et al.*, 2015). However, such proposed approaches have largely been superseded. This analysis therefore draws on the most recent recommendations of the joint SNCB guidance (SNCB, 2022), which promotes a displacement matrix approach.

The methodology presented in SNCB (2022) recommends that a matrix is compiled for each key species for a range of displacement levels (at 10% increments) across a range of likely adult mortality levels (at 0, 1%, 2%, 3%, 4%, 5%, 10% and then 10% increments) in each relevant biological season for that species.

Using available evidence on seabird sensitivity and habitat flexibility, a value, or small range of values of displacement rate and associated mortality levels are selected to provide an estimate of the potential losses. The consequent potential losses to the population as a result of displacement is then assessed for each season against an appropriate population scale. For the breeding season, the appropriate regional population covers the total colony counts within mean-maximum foraging range; for the non-breeding season assessment is done against the BDMPS (Furness, 2015).

In order to focus the potential impact of operational and maintenance activities on species' disturbance and displacement within the offshore wind farm area, a screening exercise was undertaken as detailed within Table 5A-2 below. Species with a low sensitivity to disturbance and displacement or recorded in low abundances within the offshore wind farm area during the breeding and non-breeding seasons, were screened out from further consideration as potential effects are highly unlikely for those species. Therefore, only species that were recorded in abundances within the offshore wind farm area and offshore cable corridor of moderate or above **AND** with a sensitivity of moderate or above will be screened in and taken forward for assessment of potential impacts. These criteria do not apply to gannet or red-throated diver, as the SNCB guidance (2022) states that assessment should be undertaken for these species.

Table 5A-2: Screening for assessment of disturbance and displacement during operation and maintenance (This table replaces Table 5-2)(changes shown in blue text/strikethrough).

Offshore Ornithological IEF	Sensitivity to disturbance and displacement during operation and maintenance	Abundance recorded in offshore wind farm area and offshore cable corridor	Screened IN or OUT
Common gull	Low	Low	Low sensitivity to disturbance and displacement; low abundance recorded during site-specific surveys. **Screened OUT**
Common scoter	High	Low	High sensitivity to disturbance and displacement. Generally recorded in low numbers in inshore areas with the exception of April 2020 which recorded over 2,000 individuals, although that was not within the offshore wind farm area or offshore cable corridor. **Screened OUT**
Gannet	Very low	High	High abundance recorded during site-specific surveys however very low sensitivity to

Offshore Ornithological IEF	Sensitivity to disturbance and displacement during operation and maintenance	Abundance recorded in offshore wind farm area and offshore cable corridor	Screened IN or OUT
			disturbance and displacement. Following SNCB guidance (2022), this species is screened in due to the empirical studies demonstrating they are sensitive to disturbance and displacement post construction (Krijgsveld *et al.*, 2011 and Vanermen *et al.*, 2013) **Screened IN**
Great black-backed gull	Very low	Moderate	Moderate abundance recorded during site-specific surveys however very low sensitivity to disturbance and displacement. **Screened OUT**
Great northern diver	High	Moderate	High sensitivity to disturbance and displacement and moderate abundance. **Screened IN**
Guillemot	Moderate	Very high	Very high abundance recorded in the surveys area and moderate sensitivity to disturbance and displacement. **Screened IN**
Herring gull	Very low	Low	Very low sensitivity to disturbance and displacement and low abundance recorded during site-specific surveys. **Screened OUT**
Kittiwake	Very low	Moderate	Moderate abundance recorded during site-specific surveys however very low sensitivity to disturbance and displacement. ~~**Screened OUT**~~ **Screened IN for precaution; see response to RFI 7.M for full justification**
Manx shearwater	Very low	Very high	Very high abundance recorded in the survey area, and very low sensitivity to disturbance and displacement. ~~**Screened OUT**~~ **Screened IN for precaution; see response to RFI 7.F for full justification**
Razorbill	Moderate	Very high	High abundance recorded in the survey area and moderate sensitivity to disturbance and displacement. **Screened IN**
Red-throated diver	Very high	Low	Very high sensitivity to disturbance and displacement but low abundance. **Screened IN for precaution**

Displacement matrices are presented for each of the qualifying features screened into the assessment (gannet, great northern diver, guillemot, and razorbill). For guillemot and razorbill, only “sitting” birds (which includes birds observed diving, landing and taking off) were included from the site-specific survey data in the displacement analysis as it is representative of their foraging use of the site, with the behaviour of these species being predominately from the water’s surface. For gannet and divers all behaviours (flying and sitting) were included for displacement assessment as both sitting and flying birds may be actively foraging in the area.

Following the SNCB (2022) guidance, displacement assessment is based on bio-season mean peak abundances. The peak abundance within a bio-season is the highest recorded abundance from surveys within a single bio-season. Mean peak abundance is the mean of peak abundances for each bio-season across a number of years.

The displacement and disturbance during the breeding (Table 5A-3) and non-breeding (Table 5A-4) periods for the five seven species included within the assessment. Full displacement matrices are presented within annex 5: Offshore Ornithology Displacement Analysis. For the lower mortality estimate 1 % mortality and 30 % displacement were used for guillemot and razorbill, 1 % mortality and 90 % displacement for great northern diver and red-throated diver and 1 % mortality and 60 % displacement for gannet, 1 % mortality and 30 % displacement for kittiwake, and 1 % mortality and 30% displacement for Manx shearwater. For the higher estimate 5 % mortality and 70 % displacement were used for guillemot and razorbill, 1 % mortality and 100 % displacement for great northern diver and red-throated diver and 1 % mortality and 80 % displacement for gannet, 3 % mortality and 30 % displacement for kittiwake, and 10 % mortality and 70% displacement for Manx shearwater. It is considered that the actual impact would be between the high and low estimate.

For the maximum range of displacement and mortality rates, a 10 % mortality and 70 % displacement were used for guillemot and razorbill, 10 % mortality and 100 % displacement for great northern diver and red-throated diver and 10 % mortality and 80 % displacement for gannet, 3 % mortality and 30 % displacement for kittiwake, and 10 % mortality and 70% displacement for Manx shearwater. The maximum displacement and mortality rates presented are excessively precautionary and lack empirical support; consequently, they should not be considered plausible outcomes.

Table 5A-3: Estimated mortality for gannet, guillemot and razorbill during the breeding period (all age classes) (This table replaces Table 5-3)(changes shown in blue text).

Species	Density estimate used	Density estimate (offshore wind farm plus 2 km)	Mortality estimate – low	Mortality estimate – high	Mortality estimate – using maximum displacement and mortality rates
Gannet	Boat-based	246	1	2	20
	DAS	149	1	1	12
Guillemot	Boat-based	820	2	29	57
	DAS	1594	5	56	112
Razorbill	Boat-based	12	0	0	1
	DAS	353	1	12	25
Kittiwake	Boat-based	74	0	1	1
	DAS	65	0	1	1
Manx shearwater	Boat-based	690	2	48	48
	DAS	189	1	32	32

Table 5A-4: Estimated mortality for gannet, great northern diver, guillemot, ~~and~~ razorbill, kittiwake and Manx shearwater during the non-breeding period (all age classes) (This table replaces Table 5-4) (changes shown in blue text/strikethrough).

Species	Bio-season	Density estimate used	Density estimate (offshore wind farm plus 2 km) except for great northern diver (4 km) and red-throated diver (10 km)	Mortality estimate – low	Mortality estimate – high	Mortality estimate – using maximum displacement and mortality rates
Gannet	Spring migration	Boat	43	0	0	3
	Autumn migration	Boat	336	2	3	27
Great northern diver	Winter	Boat-based	~~281~~ 251	~~2.5~~ 2	~~2.8~~ 2	25
		DAS	412 382	~~3.7~~ 3	~~4.1~~ 4	38
Guillemot	Winter	Boat-based	2,670	8	93	187
		DAS	4,938	15	173	346
Razorbill	Spring migration	Boat-based	859	3	30	60
	Autumn migration	Boat-based	962	3	34	67
		DAS	566	2	20	40
	Winter	Boat-based	512	2	18	36
Red-throated diver	Winter	~~Boat-based and~~ DAS	~~29~~ 48	~~0.26~~ 0.43	~~0.29~~ 0.48	4.80
Kittiwake	Return migration season	Boat-based	768	2	7	7
		DAS	n/a	n/a	n/a	
	Post-breeding migration season	Boat-based	305	1	3	3
		DAS	24	0	0	0
Manx shearwater	Winter	Boat-based	517	2	36	36
		DAS	32	1	2	2

5.1.2.1 Gannet

See section 5.4, for the combined disturbance and displacement and collision assessment for gannet.

5.1.2.2 Great northern diver

Divers are generally regarded as being highly sensitive to disturbance and displacement, showing a very high flush distance (i.e. the linear distance from an observer vessel to the birds at the moment of take-off from the water) and are likely to avoid disturbed areas (Garthe *et al.*, 1994; Furness *et al.*, 2012; and Bradbury *et al*, 2014). Furthermore, the guidance for undertaking ESAS surveys refer to the need to scan the sea area ahead of the ship “to detect the take-off of usually very wary seaduck and divers well ahead of the approaching platform” (Camphuysen *et al.*, 2004 and Gittings *et al.,* 2015).

The worst-case scenario for great northern diver is that displacement will occur at a constant level within 4 km of the offshore wind farm area, of which between 90 and 100 % of birds will be displaced, leading to a mortality rate of up to 1 % (JNCC, 2022).

5.1.2.2.1 Apportioned non-breeding impact

There is no agreed way to apportion to a marine SPA, whereby the foraging, roosting or aggregation of waterbirds is protected. Due to the offshore cable corridor going through the North-west Irish Sea SPA 100 % of the impacts could be apportioned to this SPA. However, interchange between areas during the non-breeding period is high for a migratory species and therefore the interannual variation will be high.

Burke *et al.* (2018) estimated a non-breeding population of 2,128 for Ireland and given that the peak-mean population estimate for the area within 4 km of the offshore wind farm area was ~~309~~251 to ~~412~~ 382 individuals, it is reasonable to assess the impact against the Irish population estimate of 2,128 individuals in the non-breeding season. Approximate background mortality at a rate of 0.161 gives a background annual mortality of 343 birds. Additional mortality of between ~~2.5~~ 3 and ~~4.1~~ 4 birds during the non-breeding season would increase annual mortality by ~~0.72~~ 0.87 to ~~1.20~~ 1.17 % when considering the boat-based density or DAS density estimate. However, this approach is very highly precautionary, considering that all birds within the area up to 4 km from the offshore wind farm area are displaced. It is more realistic to consider that there may be high displacement rate in areas closer to the offshore wind farm area with less displacement as distance increases. ~~For example, if there was 100 % displacement within the area up to 2 km from the offshore wind farm area and 50 % displacement between 2 – 4 km from the offshore wind farm area the overall impact would be less~~ Using the upper range of mortality effects for displaced individuals (up to 10 % mortality) combined with a 100 % displacement rate would result in an increase of a baseline mortality by 11%, based on the DAS density estimate However, this scenario is not considered ecologically realistic, as there is no evidence to support a 10 % mortality rate. ~~When considering this, the impact would be reduced to 2.0 birds is using the boat-based density estimate and 3.2 for the DAS density estimate. Which would represent up to a 0.93% increase in baseline mortality.~~

As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site's integrity for all SPAs assessed from the Project alone.

5.1.2.3 Guillemot

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

5.1.2.3.1 SPA weighted proportions during the breeding season

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

5.1.2.3.2 Apportioned breeding impacts

Apportioned mortality for guillemot during the breeding season is presented in Table 5A-5 for the greatest range of impacts (2 to ~~56~~112 from Table 5A-3). The lower value is taken from the boat-based survey density estimate and the high value from DAS density estimate.

Estimated number of mortalities from displacement range from <0.1 to 2.7 adult birds, depending on the SPA. This increased baseline mortality between < 0.01 and 0.06 % in adult birds. To align with all projects, the numbers presented within Table 5A-5 are for an impact with 50 % displacement occurs and 1 % mortality. Conclusions regarding an adverse effect on the site's integrity are therefore based on this scenario. For completeness, the increase in baseline mortality under an 70% displacement with 10%

mortality scenario is also presented; however, this scenario is considered overly precautionary and is not supported by empirical evidence.

Table 5A-5: Apportioned mortality of adult guillemot resulting from displacement during the breeding season (This table replaces Table 5-6) (changes shown in blue text).

	50% displacement and 1% mortality scenario			70% displacement and 10% mortality scenario	
SPA	Estimated mortality from displacement	Baseline mortality	Increase in baseline mortality (%)	Estimated mortality from displacement	Increase in baseline mortality (%)
Howth Head Coast	0.0 to 0.0	71	0.02 to 0.04	0.18 to 0.35	0.25% to 0.49%
Ireland's Eye	0.1 to 0.1	360	0.02 to 0.04	1.00 to 1.96	0.28% to 0.54%
Lambay Island	1.4 to 2.7	4,903	0.03 to 0.06	19.18 to 37.69	0.39% to 0.77%
Rathlin Island	0.3 to 0.6	12,221	<0.01 to 0.01	4.33 to 8.51	0.04% to 0.07%
Wicklow Head	0.0 to 0.0	49	0.01 to 0.01	0.03 to 0.07	0.07% to 0.14%

The impact of disturbance and displacement caused by operational and maintenance activities during the breeding season is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. It is predicted that the impact will affect the receptor both directly and indirectly. As the increase in baseline mortality is <1 % (Table 5A-5) the impact is not considered to have an adverse effect on the site's integrity for all SPAs assessed from the Project alone.

5.1.2.3.3 Apportioned non-breeding impacts

Apportioned mortality for guillemot during the non-breeding season is presented in Table 5A-6 for the most impactful and therefore precautionary estimate (8 to ~~173~~ 356 from Table 5A-3). Estimated number of mortalities from displacement range from <0.1 to 3.19 birds, depending on the colony. This increased baseline mortality between 0.01 and 0.03 %. To align with all projects, the numbers presented within Table 5A-6 are for an impact with 50 % displacement occurs and 1 % mortality.

For completeness, the increase in baseline mortality under an 70% displacement with 10% mortality scenario is also presented; however, this scenario is considered overly precautionary and is not supported by empirical evidence.

Table 5A-6: Apportioned mortality of adult guillemot resulting from displacement during the non-breeding season (This table replaces Table 5-7) (changes shown in blue text).

			50% displacement and 1% mortality scenario		80% displacement and 10% mortality scenario	
SPA	BDMPS	Proportion SPA / BDRMS	Estimated mortality	Increase in baseline mortality (%)	Estimated mortality	Increase in baseline mortality (%)
Howth Head Coast	902,773	0.0013	0.01 to 0.02	0.01 to 0.03	0.14 to 0.26	0.20% to 0.37%
Ireland's Eye	902,773	0.0065	0.05 to 0.09	0.01 to 0.03	0.70 to 1.34	0.20% to 0.37%
Lambay Island	902,773	0.0890	0.67 to 1.28	0.01 to 0.03	9.57 to 18.23	0.20% to 0.37%
Rathlin Island	902,773	0.2219	1.66 to 3.19	0.01 to 0.03	23.86 to 45.43	0.20% to 0.37%
Wicklow Head	902,773	0.0009	0.01 to 0.01	0.01 to 0.03	0.10 to 0.18	0.20% to 0.37%

The impact of disturbance and displacement caused by operational and maintenance activities during the non-breeding season is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. It is predicted that the impact will affect the receptor both directly and indirectly. As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site's integrity for all SPAs assessed from the Project alone.

5.1.2.3.4 Assessment of impact – all seasons

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

5.1.2.4 Razorbill

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

5.1.2.4.1 SPA weighted proportions during the breeding season

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

5.1.2.4.2 Apportioned breeding impacts

Apportioned mortality for razorbill during the breeding season is presented in Table 5A-7 for the greatest range of impacts (0 to ~~12~~ 25 from Table 5A-3). The lower value is taken from the boat-based survey density estimate and the high value from DAS density estimate. To align with all projects, the numbers presented within the following tables are for an impact with 50 % displacement occurs and 1 % mortality. Estimated number of mortalities from displacement range from 0 to 0.6 adult birds, depending on the SPA. This increased baseline mortality between 0 and 0.06 % in adult birds. For completeness, the increase in baseline mortality under an 70% displacement with 10% mortality scenario is also presented; however, this scenario is considered overly precautionary and is not supported by empirical evidence.

Table 5A-7: Apportioned mortality of adult razorbill resulting from displacement during the breeding season (This table replaces Table 5-10) (changes shown in blue text).

	50% displacement and 1% mortality scenario			70% displacement and 10% mortality scenario	
SPA	**Estimated mortality from displacement**	**Baseline mortality**	**Increase in baseline mortality (%)**	**Estimated mortality from displacement**	**Increase in baseline mortality (%)**
Howth Head Coast	0 to <0.1	39	0 to 0.04	0.01 to 0.18	0.02% to 0.45%
Ireland's Eye	0.0 to 0.1	225	0 to 0.04	0.04 to 1.11	0.02% to 0.50%
Lambay Island	0.0 to 0.6	1,035	0 to 0.06	0.29 to 7.26	0.03% to 0.70%
Rathlin Island	0.0 to 0.2	3,155	0 to 0.01	0.08 to 2.12	0.00% to 0.07%
Wicklow Head	0 to <0.1	26	0 to 0.01	0.00 to 0.03	0.01% to 0.13%

The impact of disturbance and displacement caused by operational and maintenance activities during the breeding season is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. It is predicted that the impact will affect the receptor both directly and indirectly. As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site's integrity for all SPAs assessed from the Project alone.

5.1.2.4.3 Apportioned non-breeding impacts

Apportioned mortality for razorbill during the non-breeding season is presented in Table 5A-8 for the most impactful and therefore precautionary estimate (~~8~~ 3 to ~~173~~ 67 from Table 5A-3). ~~Estimated number of~~

~~mortalities from displacement range from <0.1 to 0.3 birds, depending on the colony. This increased baseline mortality between <0.01 and 0.01 %.~~

To align with all projects, the numbers presented within Table 5A-8 are for an impact with 50 % displacement occurs and 1 % mortality. Estimated number of mortalities from displacement range from <0.1 to 0.3 birds, depending on the colony. This increased baseline mortality between <0.01 and 0.01 %.

For completeness, the increase in baseline mortality under an 70% displacement with 10% mortality scenario is also presented; however, this scenario is considered overly precautionary and is not supported by empirical evidence.

Table 5A-8: Apportioned mortality of adult razorbill resulting from displacement during the non-breeding season (This table replaces Table 5-11) (changes shown in blue text).

				50% displacement and 1% mortality scenario		70% displacement and 10% mortality scenario	
Bio-season	**SPA colony**	**BDMPS**	**Proportion SPA / BDRMS**	**Estimated mortality**	**Increase in baseline mortality (%)**	**Estimated mortality**	**Increase in baseline mortality (%)**
Autumn migration	Howth Head Coast	316,928	0.0012	<0.1 to <0.1	0.01 to 0.01	0.03 to 0.05	0.07% to 0.11%
	Ireland's Eye	316,928	0.0068	<0.1 to <0.1	0.01 to 0.01	0.15 to 0.26	0.07% to 0.11%
	Lambay Island	316,928	0.0311	0.1 to 0.1	0.01 to 0.01	0.71 to 1.19	0.07% to 0.11%
	Rathlin Island	316,928	0.0948	0.2 to 0.3	0.01 to 0.01	2.17 to 3.63	0.07% to 0.11%
	Wicklow Head	316,928	0.0010	<0.1 to <0.1	0.01 to 0.01	0.02 to 0.03	0.07% to 0.11%
Spring migration	Howth Head Coast	316,928	0.0012	<0.1 to <0.1	0.01 to 0.01	0.00 to 0.04	0.00% to 0.10%
	Ireland's Eye	316,928	0.0068	<0.1 to <0.1	0.01 to 0.01	0.00 to 0.23	0.00% to 0.10%
	Lambay Island	316,928	0.0311	0.1 to 0.1	0.01 to 0.01	0.00 to 1.07	0.00% to 0.10%
	Rathlin Island	316,928	0.0948	0.2 to 0.2	0.01 to 0.01	0.00 to 3.25	0.00% to 0.10%
	Wicklow Head	316,928	0.0010	<0.1 to <0.1	0.01 to 0.01	0.00 to 0.03	0.00% to 0.10%
Winter	Howth Head Coast	178,289	0.0008	<0.1 to <0.1	<0.01 to <0.01	0.00 to 0.02	0.00% to 0.04%
	Ireland's Eye	178,289	0.0048	<0.1 to <0.1	<0.01 to <0.01	0.00 to 0.10	0.00% to 0.04%
	Lambay Island	178,289	0.0221	<0.1 to <0.1	<0.01 to <0.01	0.00 to 0.45	0.00% to 0.04%
	Rathlin Island	178,289	0.0674	0.1 to 0.1	<0.01 to <0.01	0.00 to 1.39	0.00% to 0.04%
	Wicklow Head	178,289	0.0007	<0.1 to <0.1	<0.01 to <0.01	0.00 to 0.01	0.00% to 0.04%

The impact of disturbance and displacement caused by operational and maintenance activities during the non-breeding season is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. It is predicted that the impact will affect the receptor both directly and indirectly. As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site's integrity for all SPAs assessed from the Project alone.

5.1.2.4.4 Assessment of impact – all seasons

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

5.1.2.5 Red-throated diver

In response to RFI 7.L regarding the displacement of red-throated diver species an assessment of disturbance and displacement based on site-specific survey data within a 10 km buffer is provided below.

5.1.2.5.1 Apportioned non-breeding impact

There is no agreed way to apportion to a marine SPA, whereby the foraging, roosting or aggregation of waterbirds is protected. Due to the offshore cable corridor going through the North-west Irish Sea SPA 100 % of the impacts could be apportioned to this SPA. However, interchange between areas during the non-breeding period is high for a migratory species and therefore the interannual variation will be high. For precaution, all impacts are presented for the North-west Irish Sea SPA.

~~During the site specific surveys the peak estimate of red-throated diver present within the Offshore Study Area was 29 birds. Therefore when using between 90 and 100 % displacement rate and 1% mortality, between 0.261 to 0.29 additional mortalities.~~

During the site-specific surveys, the peak estimate of red-throated divers present within the Offshore Study Area plus the 10 km buffer zone was 48 birds. This estimate was based on the peak density of 0.09 birds/km² recorded within the Offshore Ornithology Study Area during the April 2020 survey (Table 31 in annex 2 of appendix H: Ornithological and Marine Megafauna Aerial Survey Results). Therefore, using a displacement rate between 90% and 100% and a mortality rate of 1%, the additional mortalities are estimated to range from 0.43 to 0.48 birds. Using the upper range of mortality effects for displaced individuals (up to 10% mortality) combined with a 100% displacement rate would result in an additional mortality of up to 4.80 birds. However, this scenario is not considered ecologically realistic, as there is no evidence to support a 10% mortality rate.

The documentation for the North-west Irish Sea SPA indicate a population of 827 individual birds (NPWS, 2023). Approximate background mortality at a rate of 0.313 gives a background annual mortality of 259 birds. Additional mortality of between ~~0.26~~ 0.43 and ~~0.29~~ 0.48 birds during the non-breeding season would increase annual mortality by ~~0.10~~ 0.17 to ~~0.11~~ 0.19 %.

As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site's integrity for the North-west Irish Sea SPA from the Project alone.

5.1.2.6 Kittiwake

In response to Item 7.M, the Applicant has provided an assessment of the disturbance and displacement of kittiwake during the operational and maintenance phase in line with NatureScot advice (but contrary to Natural England and Natural Resources Wales advice). The most precautionary scenario for kittiwake is that displacement will occur at a constant level within 2 km of the offshore wind farm area, of which 30 % of birds will be displaced, leading to a mortality rate of between 1 and 3 % (NatureScot, 2023).

5.1.2.6.1 SPA weighted proportions during the breeding season

Using the NatureScot apportioning tool, 34.7 % of the birds recorded in the Project in the breeding season would be predicted to originate from the Lambay Island SPA (Table 5A-9). The proportional weight column will not equal one as multiple non-SPA colonies make up the regional breeding population but have been excluded from this report.

Table 5A-9: Breeding kittiwake colony weighting factors used for apportioning impacts on SPAs (This is a new table).

SPA Colony	Colony size (breeding individuals)	Distance to the Project centre (km)	NatureScot colony weight	Proportional weight
Ailsa Craig SPA	980	161	0.01	0.00
Helvick Head to Ballyquin SPA	260	230	0.00	0.00
Horn Head to Fanad Head SPA	3,640	190	0.02	0.01
Howth Head Coast SPA	3,546	59	0.36	0.12
Ireland's Eye SPA	910	57	0.10	0.03
Lambay Island SPA	6,640	48	1.05	0.35
North Colonsay and Western Cliffs SPA	6,694	242	0.03	0.01
Rathlin Island SPA	27,412	155	0.33	0.11
Saltee Island SPA	2,076	204	0.01	0.00
Wicklow Head SPA	1,546	106	0.05	0.02

5.1.2.6.2 Apportioned breeding impacts

Apportioned mortality for kittiwake during the breeding season is presented in Table 5A-10 for the greatest range of impacts in Table 5A-3. The higher value is taken from the boat-based survey density estimate.

Estimated number of mortalities from displacement range from 0 to 0.16 adult birds, depending on the SPA. This increased baseline mortality between < 0.01 and 0.02 % in adult birds assuming displacement and mortality rates of 30% and 3% respectively, as advocated by NatureScot (NatureScot, 2023).

Table 5A-10: Apportioned mortality of adult kittiwake resulting from displacement during the breeding season (using displacement and mortality rates of 30% and 3% respectively) (This is a new table).

SPA	Estimated mortality from displacement	Baseline mortality	Increase in baseline mortality (%)
Ailsa Craig	0.00 to 0.00	143	0.00% to 0.00%
Helvick Head to Ballyquin	0.00 to 0.00	38	0.00% to 0.00%
Horn Head to Fanad Head	0.00 to 0.00	531	0.00% to 0.00%
Howth Head Coast	0.06 to 0.06	518	0.01% to 0.01%
Ireland's Eye	0.02 to 0.02	133	0.01% to 0.01%
Lambay Island	0.16 to 0.16	969	0.02% to 0.02%
North Colonsay and Western Cliffs	0.01 to 0.01	977	0.00% to 0.00%
Rathlin Island	0.05 to 0.05	4,002	0.00% to 0.00%
Saltee Islands	0.00 to 0.00	303	0.00% to 0.00%
Wicklow Head	0.01 to 0.01	226	0.00% to 0.00%

The impact of disturbance and displacement caused by operational and maintenance activities during the breeding season is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. It is predicted that the impact will affect the receptor both directly and indirectly. As the increase in baseline mortality is <1 % (Table 5A-5), the impact is not considered to have an adverse effect on the site's integrity for all SPAs assessed from the Project alone.

5.1.2.6.3 Apportioned non-breeding impacts

Apportioned mortality for kittiwake during the non-breeding season is presented in Table 5A-11 and ranges from <0.01 to 0.01 % increase in baseline mortality.

Table 5A-11: Apportioned mortality of adult kittiwake resulting from displacement during the non-breeding season (using displacement and mortality rates of 30% and 3% respectively) (This is a new table).

Bio-season	SPA colony	BDMPS	Proportion SPA / BDRMS	Estimated mortality	Increase in baseline mortality (%)
Post-breeding	Ailsa Craig	508,068	0.0017	0.00 to 0.00	0.00% to 0.00%
	Helvick Head to Ballyquin	508,068	0.0005	0.00 to 0.00	0.00% to 0.00%
	Horn Head to Fanad Head	508,068	0.0064	0.00 to 0.01	0.00% to 0.00%
	Howth Head Coast	508,068	0.0063	0.00 to 0.01	0.00% to 0.00%
	Ireland's Eye	508,068	0.0018	0.00 to 0.00	0.00% to 0.00%
	Lambay Island	508,068	0.0131	0.00 to 0.02	0.00% to 0.00%
	North Colonsay and Western Cliffs	508,068	0.0119	0.00 to 0.02	0.00% to 0.00%
	Rathlin Island	508,068	0.0540	0.00 to 0.09	0.00% to 0.00%
	Saltee Islands	508,068	0.0020	0.00 to 0.00	0.00% to 0.00%
	Wicklow Head	508,068	0.0015	0.00 to 0.00	0.00% to 0.00%
	North-west Irish Sea	508,068	0.0056	0.00 to 0.01	0.00% to 0.00%
Pre-breeding	Ailsa Craig	420,138	0.0019	0.00 to 0.01	0.00% to 0.00%
	Helvick Head to Ballyquin	420,138	0.0005	0.00 to 0.00	0.00% to 0.00%
	Horn Head to Fanad Head	420,138	0.0069	0.00 to 0.03	0.00% to 0.00%
	Howth Head Coast	420,138	0.0068	0.00 to 0.03	0.00% to 0.00%
	Ireland's Eye	420,138	0.0022	0.00 to 0.01	0.00% to 0.01%
	Lambay Island	420,138	0.0158	0.00 to 0.06	0.00% to 0.01%
	North Colonsay and Western Cliffs	420,138	0.0127	0.00 to 0.05	0.00% to 0.00%
	Rathlin Island	420,138	0.0652	0.00 to 0.24	0.00% to 0.01%
	Saltee Islands	420,138	0.0025	0.00 to 0.01	0.00% to 0.00%
	Wicklow Head	420,138	0.0018	0.00 to 0.01	0.00% to 0.00%
	North-west Irish Sea	420,138	0.0019	0.00 to 0.00	0.00% to 0.00%

The impact of disturbance and displacement caused by operational and maintenance activities during the non-breeding season is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. It is predicted that the impact will affect the receptor both directly and indirectly. As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site's integrity for all SPAs assessed from the Project alone.

5.1.2.6.4 Assessment of impact – all seasons

Combining the impacts from both the breeding and non-breeding seasons provides the annual impact on each SPA that is designated for kittiwake. Apportioned annual mortality for kittiwake is presented in Table 5A-12 for the most impactful and therefore precautionary estimate. Estimated number of mortalities from displacement range from 0.16 to 0.38 birds, depending on the SPA. This increased baseline mortality between 0.02 and 0.03 %, which is considered undetectable in each individual SPA population. Only SPAs which have more than a >0.05 % increase in baseline population and an estimated mortality of >0.1 bird from the project alone are presented witing an in-combination assessment.

Table 5A-12: Apportioned mortality of adult kittiwake resulting from displacement annually (using displacement and mortality rates of 30% and 3% respectively) (This is a new table).

SPA colony	Estimated mortality from displacement		Increase in baseline mortality (%)	
	Lower estimate	Upper estimate	Lower estimate	Upper estimate
Ailsa Craig	0.00	0.01	0.00	0.01
Helvick Head to Ballyquin	0.00	0.00	0.00	0.01
Horn Head to Fanad Head	0.00	0.04	0.00	0.01
Howth Head Coast	0.06	0.09	0.01	0.02
Ireland's Eye	0.02	0.03	0.01	0.02
Lambay Island	0.16	0.24	0.02	0.03
North Colonsay and Western Cliffs	0.01	0.07	0.00	0.01
Rathlin Island	0.05	0.38	0.00	0.01
Saltee Islands	0.00	0.01	0.00	0.00
Wicklow Head	0.01	0.02	0.00	0.01
North-west Irish Sea	0.00	0.01	0.00	0.00

The impact of disturbance and displacement caused by operational and maintenance activities annually is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. It is predicted that the impact will affect the receptor both directly and indirectly. As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site's integrity for all SPAs assessed from the Project alone.

5.1.2.7 Manx shearwater

In response to RFI 7.F, the Applicant has provided an assessment of the disturbance and displacement of Manx shearwater during the operational and maintenance phase using the maximum displacement and mortality rates for Manx shearwater (70% displacement, 10% mortality). However, it is noted that this species is not considered sensitive to displacement, and there is currently no evidence to support any specific range of displacement and mortality rates.

5.1.2.7.1 SPA weighted proportions during the breeding season

Using the NatureScot apportioning tool, 69.5 % of the birds recorded in the Project in the breeding season would be predicted to originate from the Skomer, Skokholm and the Seas off Pembrokeshire SPA (Table 5A-13). The proportional weight column will not equal one as multiple non-SPA colonies make up the regional breeding population but have been excluded from this report.

Table 5A-13: Breeding Manx shearwater colony weighting factors used for apportioning impacts on SPAs (This is a new table).

SPA Colony	Colony size (breeding individuals)	Distance to the Project centre (km)	NatureScot colony weight	Proportional weight
Aberdaron Coast and Bardsey Island SPA	32,366	155	0.153	0.095
Ailsa Craig SPA	40	161	0.000	0.000
Canna and Sanday SPA	4	350	0.000	0.000
Copeland Islands SPA	6,888	92	0.093	0.058
Fetlar SPA	14	808	0.000	0.000
Forth Islands SPA	2	322	0.000	0.000
Isles of Scilly SPA	852	445	0.000	0.000
Rathlin Island SPA	640	154	0.003	0.002
Rum SPA	240,000	343	0.231	0.144
Skomer, Skokholm and the Seas off Pembrokeshire / Sgomer, Sgogwm a Moroedd Penfro SPA	699,326	267	1.116	0.695
St Kilda SPA	6,886	463	0.004	0.002
Treshnish Isles SPA	3,984	287	0.005	0.003

5.1.2.7.2 Apportioned breeding impacts

Apportioned mortality for Manx shearwater during the breeding season is presented in Table 5A-14 for the greatest range of impacts in Table 5A-3. The higher value is taken from the boat-based survey density estimate.

Estimated number of mortalities from displacement range from < 0.0.1 to 18.01 adult birds, depending on the SPA. This increased baseline mortality between < 0.01 and 0.27 % in adult birds assuming displacement and mortality rates of 70% and 10% respectively.

Table 5A-14: Apportioned mortality of adult Manx shearwater resulting from displacement during the breeding season for two scenarios (30% displacement and 1% mortality; 70% displacement and 10% mortality) (This is a new table).

SPA	30% displacement and 1% mortality			70% displacement and 1% mortality	
	Estimated mortality from displacement	Baseline mortality	Increase in baseline mortality (%)	Estimated mortality from displacement	
Aberdaron Coast and Bardsey Island SPA	0.05 to 0.10	4,208	0.00% to 0.00%	0.10 to 1.85	0.00% to 0.04%
Ailsa Craig SPA	0.00 to 0.00	5	0.00% to 0.00%	0.00 to 0.00	0.00% to 0.04%
Canna and Sanday SPA	0.00 to 0.00	1	0.00% to 0.00%	0.00 to 0.00	0.00% to 0.01%
Copeland Islands SPA	0.03 to 0.06	895	0.00% to 0.01%	0.06 to 1.13	0.01% to 0.13%
Fetlar SPA	0.00 to 0.00	2	0.00% to 0.00%	0.00 to 0.00	0.00% to 0.00%
Forth Islands SPA	0.00 to 0.00	0	0.00% to 0.00%	0.00 to 0.00	0.00% to 0.01%
Isles of Scilly SPA	0.00 to 0.00	111	0.00% to 0.00%	0.00 to 0.01	0.00% to 0.01%

SPA	30% displacement and 1% mortality			70% displacement and 1% mortality	
	Estimated mortality from displacement	Baseline mortality	Increase in baseline mortality (%)	Estimated mortality from displacement	
Rathlin Island SPA	0.00 to 0.00	83	0.00% to 0.00%	0.00 to 0.04	0.00% to 0.04%
Rum SPA	0.08 to 0.16	31,200	0.00% to 0.00%	0.16 to 2.80	0.00% to 0.01%
Skomer, Skokholm and the Seas off Pembrokeshire / Sgomer, Sgogwm a Moroedd Penfro SPA	0.38 to 0.75	90,912	0.00% to 0.00%	0.75 to 13.50	0.00% to 0.01%
St Kilda SPA	0.00 to 0.00	895	0.00% to 0.00%	0.00 to 0.04	0.00% to 0.00%
Treshnish Isles SPA	0.00 to 0.00	518	0.00% to 0.00%	0.00 to 0.07	0.00% to 0.01%

The impact of disturbance and displacement caused by operational and maintenance activities during the breeding season is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. It is predicted that the impact will affect the receptor both directly and indirectly. As the increase in baseline mortality is <1 % (Table 5A-5), the impact is not considered to have an adverse effect on the site's integrity for all SPAs assessed from the Project alone.

5.1.2.7.3 Apportioned non-breeding impacts

Apportioned mortality for Manx shearwater during the non-breeding season is presented in Table 5A-15 and is below 0.01 % increase in baseline mortality assuming displacement and mortality rates of 30% and 1% respectively.

Table 5A-15: Apportioned mortality of adult Manx shearwater resulting from displacement during the non-breeding season for two scenarios (30% displacement and 1% mortality; 70% displacement and 10% mortality) (This is a new table).

					30% displacement and 1% mortality	70% displacement and 1% mortality	
Bio-season	SPA colony	BDMPS	Proportion SPA / BDRMS	Estimated mortality	Increase in baseline mortality (%)	Estimated mortality	Increase in baseline mortality (%)
non-breeding	Aberdaron Coast and Bardsey Island SPA	32,366	1.00	0.00 to 0.01	0.00% to 0.00%	0.14 to 0.20	0.00% to 0.00%
	Ailsa Craig SPA	40	1.00	0.00 to 0.00	0.00% to 0.00%	0.00 to 0.00	0.00% to 0.00%
	Canna and Sanday SPA	4	1.00	0.00 to 0.00	0.00% to 0.00%	0.00 to 0.00	0.00% to 0.00%
	Copeland Islands SPA	6,888	1.00	0.00 to 0.00	0.00% to 0.00%	0.03 to 0.04	0.00% to 0.00%
	Fetlar SPA	14	1.00	0.00 to 0.00	0.00% to 0.00%	0.00 to 0.00	0.00% to 0.00%
	Forth Islands SPA	2	1.00	0.00 to 0.00	0.00% to 0.00%	0.00 to 0.00	0.00% to 0.00%

				30% displacement and 1% mortality		70% displacement and 1% mortality	
Bio-season	SPA colony	BDMPS	Proportion SPA / BDRMS	Estimated mortality	Increase in baseline mortality (%)	Estimated mortality	Increase in baseline mortality (%)
	Isles of Scilly SPA	852	1.00	0.00 to 0.00	0.00% to 0.00%	0.00 to 0.01	0.00% to 0.00%
	Rathlin Island SPA	640	1.00	0.00 to 0.00	0.00% to 0.00%	0.00 to 0.00	0.00% to 0.00%
	Rum SPA	240,000	1.00	0.00 to 0.06	0.00% to 0.00%	1.01 to 1.51	0.00% to 0.00%
	Skomer, Skokholm and the Seas off Pembrokeshire / Sgomer, Sgogwm a Moroedd Penfro SPA	699,326	1.00	0.00 to 0.18	0.00% to 0.00%	2.93 to 4.40	0.00% to 0.00%
	St Kilda SPA	6,886	1.00	0.00 to 0.00	0.00% to 0.00%	0.03 to 0.04	0.00% to 0.00%
	Treshnish Isles SPA	3,984	1.00	0.00 to 0.00	0.00% to 0.00%	0.02 to 0.03	0.00% to 0.00%

The impact of disturbance and displacement caused by operational and maintenance activities during the non-breeding season is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. It is predicted that the impact will affect the receptor both directly and indirectly. As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site's integrity for all SPAs assessed from the Project alone.

5.1.2.7.4 Assessment of impact – all seasons

Combining the impacts from both the breeding and non-breeding seasons provides the annual impact on each SPA that is designated for Manx shearwater. Apportioned annual mortality for Manx shearwater is presented in Table 5A-16 for the most impactful and therefore precautionary estimate.

Estimated number of mortalities from displacement range from < 0.01 to 0.93 birds, depending on the SPA. This increased baseline mortality between < 0.01 and 0.01 %, which is considered undetectable in each individual SPA population.

Only SPAs which have more than a >0.05 % increase in baseline population and an estimated mortality of >0.1 bird from the project alone are presented witing an in-combination assessment.

Table 5A-16: Apportioned mortality of adult Manx shearwater resulting from displacement annually (using displacement and mortality rates of 30% and 1% respectively) (This is a new table).

SPA colony	Estimated mortality from displacement		Increase in baseline mortality (%)	
	Lower estimate	Upper estimate	Lower estimate	Upper estimate
Aberdaron Coast and Bardsey Island SPA	0.05	0.11	0.00%	0.00%
Ailsa Craig SPA	0.00	0.00	0.00%	0.00%

SPA colony	Estimated mortality from displacement		Increase in baseline mortality (%)	
	Lower estimate	Upper estimate	Lower estimate	Upper estimate
Canna and Sanday SPA	0.00	0.00	0.00%	0.00%
Copeland Islands SPA	0.03	0.06	0.00%	0.01%
Fetlar SPA	0.00	0.00	0.00%	0.00%
Forth Islands SPA	0.00	0.00	0.00%	0.00%
Isles of Scilly SPA	0.00	0.00	0.00%	0.00%
Rathlin Island SPA	0.00	0.00	0.00%	0.00%
Rum SPA	0.08	0.22	0.00%	0.00%
Skomer, Skokholm and the Seas off Pembrokeshire / Sgomer, Sgogwm a Moroedd Penfro SPA	0.38	0.93	0.00%	0.00%
St Kilda SPA	0.00	0.00	0.00%	0.00%
Treshnish Isles SPA	0.00	0.00	0.00%	0.00%

The impact of disturbance and displacement caused by operational and maintenance activities annually is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. It is predicted that the impact will affect the receptor both directly and indirectly. As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site's integrity for all SPAs assessed from the Project alone.

5.1.3 Decommissioning phase

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

5.2 Indirect disturbance and displacement resulting from changes to prey and habitats

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

5.2.1 Construction phase

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

5.2.1.1 Potential impact

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

5.2.2 Operational and maintenance phase

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

5.2.2.1 Potential impact

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

5.2.3 Decommissioning phase

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

5.3 Collision risk during operational and maintenance phase

In response to RFI 7.H an updated collision assessment which does not consider macro-avoidance in is outlined below.

Table 5A-17: Estimated collisions (both Natural England and JNCC AR) during the breeding and non-breeding season for Band Option 1 and 2 for both the boat-based and DAS density estimate (This table replaces Table 5-15 within appendix H: Offshore Ornithology Supporting Information)(changes are shown in blue text).

Ornithological receptor	Band Model Option	Density estimate	Natural England AR			JNCC AR		
			Breeding season	Non-breeding	Annual	Breeding season	Non-breeding	Annual
Common gull	1	Boat-based	0	10.71	10.71	0	10.78	10.78
	2	Boat-based	0	20.27	20.27	0	20.45	20.45
Gannet (70% macro-avoidance applied)	1	Boat-based	10.31	10.40	20.71	8.96	9.01	17.96
	2	Boat-based	5.08	5.10	10.18	4.34	4.38	8.72
	2	DAS	4.10	N/A	N/A	3.61	N/A	N/A
Gannet (no macro-avoidance included	1	Boat-based	34.38	34.65	69.03	29.84	30.02	59.86
	2	Boat-based	16.9	17.02	33.92	14.47	14.61	29.08
	2	DAS	13.69	N/A	N/A	12.04	N/A	N/A
Great black-backed gull	1	Boat-based	12.68	40.47	53.16	1.95	6.09	8.03
	2	Boat-based	15.70	50.21	65.91	2.44	7.54	9.98
	2	DAS	2.00	N/A	N/A	0.30	N/A	N/A
Herring gull	1	Boat-based	26.32	50.79	77.11	20.99	40.64	61.63
	2	Boat-based	31.34	60.46	91.80	25.12	48.38	73.50
Kittiwake	1	Boat-based	3.99	43.83	47.82	1.52	13.45	14.97
	2	Boat-based	5.83	50.45	56.28	1.74	15.37	17.11
	2	DAS	3.68	N/A	N/A	1.12	N/A	N/A

5.3.1 Common gull

5.3.1.1 Assessment of impact – non-breeding season

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

5.3.2 Gannet

See section 5.4, for the combined disturbance and displacement and collision assessment for gannet.

5.3.3 Great black-backed gull

5.3.3.1 Assessment of impact – non-breeding season

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

5.3.4 Herring gull

5.3.4.1 SPA weighted proportions during the breeding season

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

5.3.4.2 Apportioned breeding impacts

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

5.3.4.3 Apportioned non-breeding impacts

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

5.3.4.4 Assessment of impact – all seasons

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

5.3.5 Kittiwake

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

5.4 Combined disturbance and displacement and collision risk during the operational and maintenance phase on gannet

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

5.5 Barrier effect

There are no changes to NIS appendix H: Offshore Ornithology Supporting Information.

6 IN-COMBINATION EFFECTS

An updated in-combination assessment is provided in this section. Table 6A-1 lists the projects that are examined in the updated in-combination assessment. The changes in project information are noted in blue and strikethrough. New projects considered in the updated assessment are also shown in blue.

6.1 Methodology

The in-combination assessment takes into account the impact associated with the Project together with other projects. The projects selected as relevant to the in-combination assessment (ICA) are based upon the results of an updated screening exercise (see appendix J Addendum: Screening In-Combination Effects). Each Project has been considered on a case by case basis for screening in or out of this assessment based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved.

The approach to in-combination examines the effects of the Project alongside the following projects if they fall within the Cumulative Offshore Ornithology Study Area:

- Other projects with consent but not yet constructed/construction not completed;
- Other projects in a consent application process but not yet determined (including planning applications, foreshore lease/licence applications, Dumping at Sea Permit applications;
- Other projects currently operational that were not operational when baseline data were collected, and/or those that are operational but have an ongoing impact; and
- Projects, which satisfy the definition of ‘relevant maritime usage’ under the Maritime Area Planning Act (2021) (i.e. wind farm projects designated as ‘Relevant Projects’ or ‘Phase 1 Projects’) including Arklow Bank II, Dublin Array (formerly Bray Bank and Kish Bank); North Irish Sea Array (NISA), Codling Wind Park (I and II).

The specific projects screened in to the in-combination assessment are outlined in Table 6A-1. The location of screened in Projects in relation to the Project is illustrated in Figure 6A-1.

Table 6A-1: List of other Projects considered within the in-combination assessment.

Project/Plan	Status	Distance from offshore wind farm area (km)	Distance from offshore cable corridor (km)	Description of Project	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with Project
North Irish Sea Array (NISA) Offshore Wind Farm	Maritime Area Consent; Planning	16.2	18.1	~~EIAR (2024) refers to the construction of an offshore wind farm of up to 500 MW, consisting of up to 49 turbines (Option 1) with a maximum height of 316 m (Option 1) and rotor diameter of up to 276 m and one Offshore substation platforms.~~ EIAR (2024) details two Project options consisting of a wind farm with a maximum of 49 turbines and a maximum rotor diameter of 276m. One offshore substation is required. The proposed export capacity is 700 MW [2]	~~Unknown~~ Estimated 2027-2030	~~Unknown~~ (Design life minimum 35 years) Estimated commencement in 2030	Potential for construction, operation and maintenance and decommissioning phases to overlap with the Project.
Dublin Array Offshore Wind Farm	Maritime Area Consent; Planning	61.2	57	~~Scoping report (2020) refers to the construction of Bray and Kish offshore wind farm of up to 900 MW, consisting of up to 61 turbines with a maximum height of 308 m and rotor diameter of up to 285 m and up to three offshore substation platforms.~~[3] EIAR (2025) refers to the construction of an offshore wind farm with an export capacity of 824 MW. The EIAR considers three design options with a maximum number of turbines of 50 and a maximum rotor diameter of 278 m.[4]	~~Unknown~~ Estimated 2027-2030 Construction is anticipated to range from 18 to 30 months.	~~Unknown~~ (Design life minimum 35 years) Estimated commencement in 2030	Potential for construction, operation and maintenance and decommissioning phases to overlap with the Project.
Codling Wind Park	Maritime Area Consent; Planning	61.4	57.2	~~EIA Scoping report (2020) refers to the construction of an offshore wind farm of up to 1500 MW, consisting of up to~~	~~Unknown~~ Estimated 2027-2030	~~Unknown~~	Potential for overlap with construction, operation and maintenance and

[2] https://northirishseaarraysid.ie/
[3] Project website: https://dublinarray.com/project-information/key-facts/: states between 39 and 50 turbines (total project capacity 824 MW) individual tip heights between approx. 270 m and 310 m.
[4] https://dublinarray-marineplanning.ie/eiar/

Project/Plan	Status	Distance from offshore wind farm area (km)	Distance from offshore cable corridor (km)	Description of Project	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with Project
				~~140 turbines with a maximum height of 320 m and rotor diameter of up to 288 m. The project will also contain up to five offshore substation platforms.~~[5] EIAR (2024) refers to the construction of an offshore wind farm with the export capacity of 1300 MW. Two WTG Layout Options are proposed, with a maximum number of turbines of 75 and a maximum rotor diameter of 276. Three offshore substations are required.[6]	Construction anticipated to range from three to four years.	~~(Design life minimum 35 years)~~ Estimated commencement in 2030 25-year operational lifetime	decommissioning phases.
Arklow Bank Wind Farm Phase 2	Maritime Area Consent; Planning	107.1	104.7	~~EIA Scoping Report: The project will include between 37 and 56 turbines ad up to two Offshore Substation Platforms (OSP) and foundation substructures. The area in which the proposed wind turbines, inter-array cables and OSP(s) will be located on Arklow Bank covers an area of seabed approximately 64km2.~~[7] EIAR (2024) refers to an offshore wind farm with an export capacity of 800 MW. Two Project Design Options are proposed with a maximum number of turbines of 56 and maximum rotor diameter of 250 m. Two offshore substations are required.[8]	~~Unknown~~ Estimated 2027-2030	~~Unknown~~ (Design life minimum 35 years) Estimated commencement in 2030	Potential for overlap with construction, operation and maintenance and decommissioning phases.

[5] Project website: https://codlingwindpark.ie/the-project/: states max energy output 1300 MW, 100 turbines, turbine tip height max 320 m.

[6] https://codlingwindparkplanningapplication.ie/environmental-impact-assessment-report-eiar/

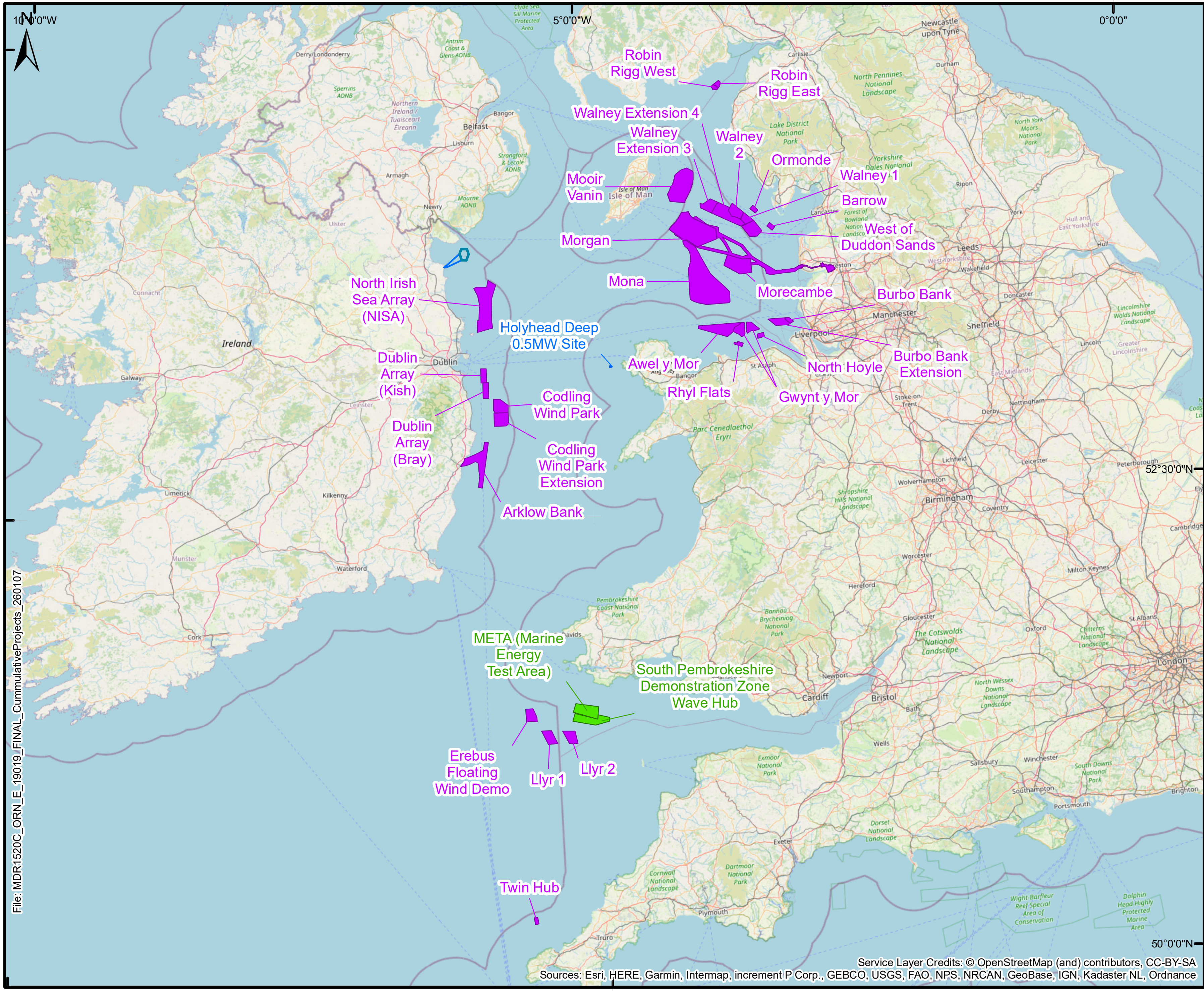
[7] Project website https://www.sserenewables.com/: states between 36 and 60 turbines (up to 800MW) along with one to two OSS and foundation substructures, a network of inter-array cabling and two offshore export cables.

[8] https://www.arklowbank2offshoreplanning.ie/eiar/

Project/Plan	Status	Distance from offshore wind farm area (km)	Distance from offshore cable corridor (km)	Description of Project	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with Project
Holyhead Deep – Phase 1 (Minesto Tidal Kite)	Operational (partial)	105.7	108	Underwater tidal kites, one 0.5MW tidal kite operational in 2017, plans for up to 60 1.2MW devices.	2017 to ongoing	2018 to ongoing	Potential for overlap with construction, operation and maintenance and decommissioning phases.
Morgan Offshore Wind Farm – Generation Assets	Consented (not yet constructed)	119.5	124	~~PEIR indicates up to 107 wind Turbines~~ Up to 96 wind turbines. 1,500MW capacity.	~~Unknown~~ 2026 to 2029	~~Unknown~~ 2030 to 2065	Potential for overlap with construction, operation and maintenance and decommissioning phases.
Arklow Bank Wind Farm Phase 1	Operational; Application to decommission	120.2	117.5	Seven 3.6 MW turbines. Hub height 73.5m. Rotor diameter 124m.	2002 to 2003	2004 to 2028	Potential for overlap with operation and maintenance phase.
Mona Offshore Wind Farm	Consented (not yet constructed)	127.1	131.4	~~PEIR indicates up to 107 wind Turbines~~ Up to 96 wind turbines. 1,500MW capacity.	~~Unknown~~ 2026 to 2029	~~Unknown~~ 2030 to 2065	Potential for overlap with construction, operation and maintenance and decommissioning phases.
Walney Extension 3 Offshore Wind Farm	Operational	139.9	144.6	40 8.25MW turbines. Hub height 113m. Rotor diameter 164m	2017	2018 to 2039	Potential for overlap with operation and maintenance phase.
Awel y Môr Offshore Wind Farm	Consented (not yet constructed)	142.4	145.2	~~Up to 50 turbines. Rotor diameter up to 306m and a minimum of 11.5MW per turbine.~~ Up to 100 MW (48 to 91 wind turbines)	2026 to ~~2029~~ 2030	2030 to ~~2065~~ 2055	Potential for overlap with construction, operation and maintenance and decommissioning phases.
Walney Extension 4 Offshore Wind Farm	Operational	146	150.6	47 7MW turbines. Hub height 111m. Rotor diameter 154m	2017	2018 to 2039	Potential for overlap with operation and maintenance phase.
Morecambe Offshore Wind Farm - Generation Assets	~~Planning – PIER submitted~~ Consented (not yet constructed)	151.3	155.2	~~PEIR report indicates up~~ Up to 40 wind turbines. 480MW capacity.	~~Unknown~~ 2026 to 2028	2 ~~Unknown~~ 030 - 2065	Potential for overlap with construction, operation and maintenance and decommissioning phases.

Project/Plan	Status	Distance from offshore wind farm area (km)	Distance from offshore cable corridor (km)	Description of Project	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with Project
Walney 2 Offshore Wind Farm	Operational	155.8	160.5	51 3.6MW turbines. Hub height 84m. Rotor diameter 107m.	2011	2012 to 2032	Potential for overlap with operation and maintenance phase.
Walney 1 Offshore Wind Farm	Operational	162.5	166.7	51 3.6MW turbines. Hub height 84m. Rotor diameter 107m.	2010	2010 to 2032	Potential for overlap with operation and maintenance phase.
West of Duddon Sands Offshore Wind Farm	Operational	162.3	166.7	108 3.6MW turbines. Hub height 90m Rotor diameter 120m.	2013 to 2014	2014 to 2033	Potential for overlap with operation and maintenance phase.
Gwynt y Mor Offshore Wind Farm	Operational	163.4	166.3	160 3.MW turbines. Hub height 98m. Rotor diameter 107m.	2012	2015 to 2032	Potential for overlap with operation and maintenance phase.
Rhyl Flats Offshore Wind Farm	Operational	165.6	168.3	25 3.6MW turbines. Hub height 80m. Rotor diameter 107m.	2007	2009 to 2027	Potential for overlap with operation and maintenance and decommissioning phases.
Ormonde Offshore Wind Farm	Operational	168.6	173.2	30 5MW turbines. Hub Height 100m. Rotor diameter 126m.	2010	2012 to 2036	Potential for overlap with operation and maintenance phase.
Robin Rigg Offshore Wind Farm	Operational	173.3	178.5	58 3MW turbines. Hub height 80m Rotor diameter 90m.	2009	2010 to 2030	Potential for overlap with operation and maintenance phase.
North Hoyle Offshore Wind Farm	Operational	177.1	180.0	30 2MW turbines. Hub height 70m. Rotor diameter 80m.	2003	2004 to 2028	Potential for overlap with operation and maintenance phase.
Barrow Offshore Wind Farm	Operational	177.2	181.6	30 3MW turbines. Hub height 75m. Rotor diameter 90m.	2005	2006 to 2028	Potential for overlap with operation and maintenance phase.
Burbo Bank Offshore Wind Farm Extension	Operational	181.1	184.3	32 8.0MW turbines. Hub height 105m. Rotor diameter 160m	2016	2017 to 2045	Potential for overlap with operation and maintenance phase.

Project/Plan	Status	Distance from offshore wind farm area (km)	Distance from offshore cable corridor (km)	Description of Project	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with Project
Burbo Bank Offshore Wind Farm	Operational	191.1	194.4	23 3.6MW turbines. Hub height 78m. Rotor diameters 107m.	2006	2007 to 2039	Potential for overlap with operation and maintenance phase.
Marine Energy Test Areas (META) Pembrokeshire	Operational	253.9	~250	Tidal, wave and floating offshore wind test site.	2019	2019 to 2029	Potential for overlap with operation and maintenance phase.
Erebus Offshore Wind Farm	Planning – consented (not yet constructed)	267.9	265.4	100MW capacity demonstration & testing site for floating wind.	2025	2026 to 2051	Potential for overlap with construction, operation and maintenance and decommissioning phases.
South Pembrokeshire Demonstration Zone – Wave Hub	Planning	273.8	~270	Wave energy test site of up to 100 MW	2019	2019 to 2048	Potential for overlap with construction, operation and maintenance and decommissioning phases.
Mooir Vannin Wind Farm	Planning –ES submitted	112	127	Up to 87 wind turbines. Up to 1.4GW capacity	Estimated 2030-2032	Estimated 2033 – unknown	Potential for overlap with construction, operation and maintenance and decommissioning phases.
Twinhub	Planning - consented	391	388	Two floating offshore wind platforms, each with two wind turbines. Installed capacity of 32 MW.	2024 – 2025	2026 - unknown	Potential for overlap with construction, operation and maintenance and decommissioning phases.
Llŷr floating offshore wind project	Planning	282	279	Up to 10 wind turbine generators (WTGs)	2027-2029	2039-Unknown	Potential for overlap with construction, operation and maintenance and decommissioning phases.



Legend

- Offshore Wind Farm Area
- Offshore Cable Corridor
- Offshore Wind Farm
- Tidal Project
- Wave Project

Data Sources: Client,

Client

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

Project

Oriel Wind Farm Project

Title **Figure 6A-1**
Other projects screened in for in-combination assessment - SCI seabirds

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Issue Details

Drawn By: MJ	**Project No.** MDR1520C
Checked By: MJ	**File Ref:**
Approved By: EC	MDR1520C_ORN_E_19019_FINAL
Scale: 1:3,000,000 @ A4	**Projection:** ITM (IRENET95) Geographic Co-ordinates: ETRS89
Date: 07/01/2026	

Table 6A-2 presents the relevant project design parameters from Table 4-1 (Appendix H Offshore Ornithology Supporting Information), which are used to assess the potential in-combination effects of the Project with the other Projects identified in Table 6A-1 (where information is available).

Impacts have been carried forward for assessment where there is potential for an effect to occur from the Project alone over a scale that could impact cumulatively with other projects within the Cumulative Offshore Ornithology Study Area. This has been applied whereby the Project could contribute to an increase in baseline mortality of >0.05 %. All impacts <0.05 % are considered inconsequential with no potential to interact cumulatively with other projects.

Other aspects, namely indirect impacts associated with prey distribution and availability are very difficult to quantify, and although it is acknowledged that cumulative effects are possible, the magnitude of these impacts is not considered to be significant at a population level for any offshore ornithology receptor and is therefore not considered further within the ICA. The impacts excluded from the cumulative assessment are:

- Indirect impacts (affecting prey species) from airborne noise, underwater sound and the presence of vessels at any phase of the Project as they will be spatially limited and all were predicted as negligible;
- Barrier effects have not been included in the in-combination assessment; although it is acknowledged that cumulative impacts are possible, the magnitude of these impacts is not considered to be significant at a population level for any ornithological receptor when considered alongside the other proposed Irish Sea wind farms due to a separation distance of a least 16 km; and
- Disturbance and displacement during the construction and decommissioning phases; although it is acknowledged that impacts are possible, the spatial magnitude of these impacts is not considered to be cumulative in nature due to the small area over which construction activities occur (point source impacts). There is low likelihood that temporal overlap might occur and if it does there is at least 16 km between the two construction locations. It is not considered significant at a population level for any ornithological receptor when considered alongside the other proposed projects.

Table 6A-2: Project design parameters considered for the assessment of potential in-combination impacts on offshore ornithology.

Potential in-combination impact	Phase C	O	D	Project design parameters	Justification
Disturbance and displacement	✗	✓	✗	Project design parameters (for operational and maintenance phase) as described for the Project (Table 4-1 in appendix H: Offshore Ornithology Supporting Information) assessed cumulatively with the other projects (Table 6A-1).	Outcome of the in-combination assessment will be greatest when the greatest number of other wind farms are considered
Collision risk	✗	✓	✗	Project design parameters as described for the Project (Table 4-1 in appendix H: Offshore Ornithology Supporting Information) assessed cumulatively with the other projects (Table 6A-1).	Outcome of the in-combination assessment will be greatest when the greatest number of other wind farms are considered

6.2 In-combination assessment

The CIA and ICA are limited by the availability of publicly accessible data. Many older developments did not include specific impact assessments (for example, for displacement or collision risk). Where possible, impacts from those projects have been estimated, using the methodology applied during the recent examinations for the Mona, Morecambe, Morgan offshore wind farms in 2025 (which was agreed with the relevant nature conservation bodies). It should be noted, however, that a substantial proportion of any effects from historical projects may already be reflected in observed species survival rates.

As published data is now available for the other Irish Phase 1 projects, the ‘single output’ included in the NIS (in the planning application documents) has been replaced with the data from the published EIAR and NIS documents.

When the assessment of the Project alone (section 5) concluded that the Project would have an increase in baseline mortality of <0.05 % the impact from the Project alone is considered inconsequential and not proportionate to include within the ICA. The Project would not materially or measurably contribute to the in-combination impact. All assessments which conclude a <0.05 % increase in baseline mortality are within the natural variation and confidence intervals within which the estimates of density, survival and impacts have been produced.

Impacts on guillemot, razorbill, common gull, great black-backed gull, herring gull, kittiwake and gannet are presented within the ICA.

6.2.1 Disturbance and displacement during operational and maintenance phase

6.2.1.1 Guillemot

Due to variation in methods used to assess annual disturbance and displacement impacts the mid-point of the alone assessment was used, and therefore the estimated number of mortalities is using a 50 % displacement and a 1 % mortality estimate. The number presented for the Project is the higher of either the DAS or boat-based surveys for precaution.

Table 6A-3 and Table 6A-4 replace Table 6-3 presented in appendix H: Offshore Ornithology Supporting Information in the NIS (2024). Where Table 6A-3 and Table 6A-4 show no connectivity, this means the SPA is too far away to be used by foraging guillemot from the project during the breeding season.

Table 6A-3: Estimated adult mortality of guillemot from disturbance and displacement apportioned to the Ireland Eye SPA from the in-combination projects.

Project	Annual	Breeding	Non-breeding
Holyhead Deep - Phase 1 (Minesto Tidal Kite)	0.00	No connectivity	0.00
North Hoyle Offshore Wind Farm	0.00	No connectivity	0.00
Barrow Offshore Wind Farm	0.00	No connectivity	0.00
Arklow Bank Wind Farm Phase 2	0.00	0.00	0.00
Colding	0.63	0.38	0.25
Dublin Array	5.73	5.69	0.04
NISA	1.86	1.30	0.56
Llyr 1	No connectivity	No connectivity	0.25
Mooir Vannin Wind Farm	No connectivity	No connectivity	0.04

Project	Annual	Breeding	Non-breeding
Arklow Bank Wind Farm Phase 1	0.30	0.21	0.10
Awel y Môr Offshore Wind Farm	No connectivity	No connectivity	0.06
Burbo Bank (gap-filled)	No connectivity	No connectivity	0.00
Burbo Bank Extension Offshore Wind Farm	No connectivity	No connectivity	0.03
Gwynt Y Mor (gap-filled)	No connectivity	No connectivity	0.00
Erebus Floating Wind Demo	No connectivity	No connectivity	0.53
Ormonde Wind Farm (partially gap-filled)	0.00	No connectivity	0.00
Robin Rigg (partially gap-filled)	0.00	No connectivity	0.00
Rhyl Flats Offshore Wind Farm (gap-filled)	0.00	No connectivity	0.00
TwinHub (Wave Hub Floating Wind Farm)	0.00	No connectivity	0.00
Walney 1 & 2 (gap-filled)	0.00	No connectivity	0.00
Walney (3 & 4) Extension Offshore Wind Farm	0.04	No connectivity	0.04
West of Duddon Sands Offshore Wind Farm (partially gap-filled)	0.00	No connectivity	0.00
Morecambe Offshore Windfarm Generation Assets	0.16	No connectivity	0.16
Morgan Offshore Wind Project Generation Assets	0.07	No connectivity	0.07
Mona Offshore Wind Project	0.07	No connectivity	0.07
Oriel Wind Farm Project	0.14	0.09	0.05
Total adult birds	**9.02**	**7.67**	**2.26**
Adult baseline mortality of SPA	**360**		
In-combination total as a % increase on baseline mortality	**2.50%**		

Table 6A-4: Estimated adult mortality of guillemot from disturbance and displacement apportioned to the Lambay Island SPA from the in-combination projects.

Project	Annual	Breeding	Non-breeding
Holyhead Deep - Phase 1 (Minesto Tidal Kite)	0.00	No connectivity	0.00
North Hoyle Offshore Wind Farm	0.02	No connectivity	0.02
Barrow Offshore Wind Farm	0.02	No connectivity	0.02
Arklow Bank Wind Farm Phase 2	0.00	0.00	0.00
Colding	7.16	3.74	3.42
Dublin Array	39.73	39.20	0.53
NISA	44.57	36.93	7.63
Llyr 1	3.34	No connectivity	3.34
Mooir Vannin Wind Farm	0.59	No connectivity	0.59

Project	Annual	Breeding	Non-breeding
Arklow Bank Wind Farm Phase 1	2.50	1.20	1.30
Awel y Môr Offshore Wind Farm	0.75	No connectivity	0.75
Burbo Bank (gap-filled)	0.01	No connectivity	0.01
Burbo Bank Extension Offshore Wind Farm	0.40	No connectivity	0.40
Gwynt Y Mor (gap-filled)	0.05	No connectivity	0.05
Erebus Floating Wind Demo	7.27	No connectivity	7.27
Ormonde Wind Farm (partially gap-filled)	0.01	No connectivity	0.01
Robin Rigg (partially gap-filled)	0.02	No connectivity	0.02
Rhyl Flats Offshore Wind Farm (gap-filled)	0.02	No connectivity	0.02
TwinHub (Wave Hub Floating Wind Farm)	0.06	No connectivity	0.06
Walney 1 & 2 (gap-filled)	0.06	No connectivity	0.06
Walney (3 & 4) Extension Offshore Wind Farm	0.49	No connectivity	0.49
West of Duddon Sands Offshore Wind Farm (partially gap-filled)	0.04	No connectivity	0.04
Morecambe Offshore Windfarm Generation Assets	2.13	No connectivity	2.13
Morgan Offshore Wind Project Generation Assets	0.98	No connectivity	0.98
Mona Offshore Wind Project	0.96	No connectivity	0.96
Oriel Wind Farm Project	2.36	1.67	0.68
Total adult birds	**113.53**	**82.75**	**30.79**
Adult baseline mortality of SPA	**4903**		
In-combination total as a % increase on baseline mortality	**2.32%**		

When considering all of the projects within the Cumulative Offshore Ornithology Study Area the increase in baseline mortality for both sites is >1 % and therefore additional analysis was undertaken, in the form of a PVA. Full details are provided within annex 8 Addendum: Offshore Ornithology Population Viability Analysis, for impacted SPAs.

Following the PVA, it was concluded that the counterfactual growth rate was ≥0.995 for Lambay Island SPA, and Ireland's Eye SPA. A counterfactual growth rate of ≥0.995 is considered to be within natural fluctuations of the population and no significant impact is predicted from the increase in mortality.

Full calculations and methods are presented in annex 8 Addendum: Offshore Ornithology Population Viability Analysis, for impacted SPAs. As the counterfactual growth rate was ≥0.995, the impact is not considered to have an adverse effect on the site's integrity for all SPAs assessed in-combination.

6.2.1.2 Razorbill

Due to variation in methods used to assess annual disturbance and displacement impacts the mid-point of the alone assessment was used, and therefore the estimated number of mortalities is using a 50 % displacement and a 1 % mortality estimate. The number presented for the Project is the higher of either the DAS or boat-based surveys for precaution.

Table 6A-5 and Table 6A-6 replace Table 6-4 presented in appendix H: Offshore Ornithology Supporting Information in the NIS (2024). Where Table 6A-5 and Table 6A-6 show no connectivity, this means the SPA is too far away to be used by foraging razorbill from the project during the breeding season.

Table 6A-5: Estimated adult mortality of razorbill from disturbance and displacement apportioned to the Ireland Eye SPA from the in-combination Projects.

Project	Annual	Breeding	pre-breeding	post-breeding	Non-breeding
Holyhead Deep - Phase 1 (Minesto Tidal Kite)	0.00	0.00	0.00	0.00	0.00
North Hoyle Offshore Wind Farm	0.00	0.00	0.00	0.00	0.00
Barrow Offshore Wind Farm	0.00	no connectivity	0.00	0.00	0.00
Arklow Bank Wind Farm Phase 2	0.74	0.07	0.33	0.21	0.13
Colding	0.60	0.13	0.04	0.39	0.04
Dublin Array	0.94	0.70	0.04	0.18	0.02
NISA	0.51	0.04	0.04	0.30	0.13
Llyr 1	0.22	no connectivity	0.02	0.17	0.03
Mooir Vannin Wind Farm	0.18	no connectivity	0.11	0.06	0.01
Arklow Bank Wind Farm Phase 1	0.00	0.00	0.00	0.00	0.00
Awel y Môr Offshore Wind Farm	0.05	no connectivity	0.03	0.01	0.01
Burbo Bank (gap-filled)	0.00	no connectivity	0.00	0.00	0.00
Burbo Bank Extension Offshore Wind Farm	0.00	no connectivity	0.00	0.00	0.00
Gwynt Y Mor (gap-filled)	0.01	no connectivity	0.00	0.00	0.00
Erebus Floating Wind Demo	0.30	no connectivity	0.08	0.15	0.07
Ormonde Wind Farm (partially gap-filled)	0.00	no connectivity	0.00	0.00	0.00
Robin Rigg (partially gap-filled)	0.00	no connectivity	0.00	0.00	0.00
Rhyl Flats Offshore Wind Farm (gap-filled)	0.00	no connectivity	0.00	0.00	0.00
TwinHub (Wave Hub Floating Wind Farm)	0.00	no connectivity	0.00	0.00	0.00
Walney 1 & 2 (gap-filled)	0.01	no connectivity	0.00	0.00	0.00
Walney (3 & 4) Extension Offshore Wind Farm	0.27	no connectivity	0.00	0.08	0.19
West of Duddon Sands Offshore Wind Farm (partially gap-filled)	0.01	no connectivity	0.00	0.00	0.01
Morecambe Offshore Windfarm Generation Assets	0.14	no connectivity	0.03	0.06	0.04
Morgan Offshore Wind Project Generation Assets	0.13	no connectivity	0.03	0.02	0.07
Mona Offshore Wind Project	0.21	no connectivity	0.17	0.01	0.03
Oriel Wind Farm Project	0.20	0.00	0.08	0.09	0.03
Total adult birds	**4.51**	**0.94**	**1.01**	**1.72**	**0.83**
Adult baseline mortality of SPA	**225**				
In-combination total as a % increase on baseline mortality	**2.00%**				

Table 6A-6: Estimated adult mortality of razorbill from disturbance and displacement apportioned to the Lambay Island SPA from the in-combination Projects.

Project	Annual	Breeding	pre-breeding	post-breeding	Non-breeding
Holyhead Deep - Phase 1 (Minesto Tidal Kite)	0.00	0.00	0.00	0.00	0.00
North Hoyle Offshore Wind Farm	0.00	0.00	0.00	0.00	0.00
Barrow Offshore Wind Farm	0.00	no connectivity	0.00	0.00	0.00
Arklow Bank Wind Farm Phase 2	0.92	0.25	0.33	0.21	0.13
Colding	0.91	0.45	0.04	0.39	0.04
Dublin Array	1.86	1.62	0.04	0.18	0.02
NISA	0.86	0.39	0.04	0.30	0.13
Llyr 1	0.22	no connectivity	0.02	0.17	0.03
Mooir Vannin Wind Farm	0.18	no connectivity	0.11	0.06	0.01
Arklow Bank Wind Farm Phase 1	0.00	0.00	0.00	0.00	0.00
Awel y Môr Offshore Wind Farm	0.05	no connectivity	0.03	0.01	0.01
Burbo Bank (gap-filled)	0.00	no connectivity	0.00	0.00	0.00
Burbo Bank Extension Offshore Wind Farm	0.00	no connectivity	0.00	0.00	0.00
Gwynt Y Mor (gap-filled)	0.01	no connectivity	0.00	0.00	0.00
Erebus Floating Wind Demo	0.30	no connectivity	0.08	0.15	0.07
Ormonde Wind Farm (partially gap-filled)	0.00	no connectivity	0.00	0.00	0.00
Robin Rigg (partially gap-filled)	0.00	no connectivity	0.00	0.00	0.00
Rhyl Flats Offshore Wind Farm (gap-filled)	0.00	no connectivity	0.00	0.00	0.00
TwinHub (Wave Hub Floating Wind Farm)	0.00	no connectivity	0.00	0.00	0.00
Walney 1 & 2 (gap-filled)	0.01	no connectivity	0.00	0.00	0.00
Walney (3 & 4) Extension Offshore Wind Farm	0.27	no connectivity	0.00	0.08	0.19
West of Duddon Sands Offshore Wind Farm (partially gap-filled)	0.01	no connectivity	0.00	0.00	0.01
Morecambe Offshore Windfarm Generation Assets	0.14	no connectivity	0.03	0.06	0.04
Morgan Offshore Wind Project Generation Assets	0.13	no connectivity	0.03	0.02	0.07
Mona Offshore Wind Project	0.21	no connectivity	0.17	0.01	0.03
Total adult birds	**6.29**	**2.73**	**1.01**	**1.72**	**0.83**
Adult baseline mortality of SPA	**1,035**				
In-combination total as a % increase on baseline mortality	**0.61%**				

The impact of disturbance and displacement caused by operational and maintenance activities annually when all projects are considered in-combination is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. As the increase in baseline mortality is <1 % for Lambay Island, the impact is not considered to have an adverse effect on the site's integrity for Lambay Island SPA assessed in-combination.

When considering all of the projects within the Cumulative Offshore Ornithology Study Area the increase in baseline mortality for Ireland Eye is >1 % and therefore additional analysis was undertaken, in the form of a PVA. Full details are provided within annex 8 Addendum: Offshore Ornithology Population Viability Analysis, for impacted SPAs.

Following the PVA, it was concluded that the counterfactual growth rate was ≥0.995 Ireland's Eye SPA. A counterfactual growth rate of ≥0.995 is considered to be within natural fluctuations of the population and no significant impact is predicted from the increase in mortality. As the counterfactual growth rate was ≥0.995, the impact is not considered to have an adverse effect on the site's integrity for the Ireland Eye SPA assessed in-combination.

6.2.2 Collision risk during operational and maintenance phase

The offshore wind farm area, together with that of other Projects may contribute to in-combination collision risk during the operational and maintenance phase. Other projects screened into the assessment within the Cumulative Offshore Ornithology Study Area are presented in Table 6A-1, and these are also considered alongside the species' mean maximum foraging range plus one standard deviation (Woodward *et al*., 2019).

The five species identified as potentially impacted by the Project alone during operational and maintenance phase were common gull, gannet, great black-backed gull, herring gull and kittiwake. Assessment of gannet is considered in section 6.2.3 combined with displacement as the species is susceptible to both.

6.2.2.1 Common gull

Within the alone assessment the Dundalk Bay SPA and the North-west Irish Sea SPA were considered during the winter period only. All birds present within the Dundalk Bay SPA and North-west Irish Sea SPA are part of the larger international population which winters in both the UK and Republic of Ireland. The total population which could be present during the winter period is 756,002 birds (713,129 birds from the UK, Channel Isles and Isle of Man (Banks *et al*., 2007) and an additional 21,438 from Ireland (Burke *et al*., 2018)). Both Dundalk Bay SPA and North-west Irish Sea SPA represent a small proportion of this winter population, 1,594 and 2,866 birds respectively, which proportionally is 0.0021 and 0.0038 of the whole non-breeding population.

Table 6A-7 replace Table 6-5 presented in appendix H: Offshore Ornithology Supporting Information in the NIS (2024).

As the increase in baseline mortality was <1 %, the impact is not considered to have an adverse effect on the site's integrity for all SPAs assessed in-combination.

Table 6A-7: Estimated annual morality of common gull from collisions apportioned to the relevant SPAs from the in-combination Projects.

Project	Site	
	North-west Irish Sea SPA	Dundalk Bay SPA
Holyhead Deep - Phase 1 (Minesto Tidal Kite)	0.00	0.00
North Hoyle Offshore Wind Farm	0.00	0.00
Barrow Offshore Wind Farm	0.00	0.00
Arklow Bank Wind Farm Phase 2	0.01	0.00
Colding	0.01	0.00
Dublin Array	0.01	0.01
NISA	0.02	0.01
Llyr 1	0.00	0.00
Mooir Vannin Wind Farm	0.00	0.00

Project	Site	
	North-west Irish Sea SPA	Dundalk Bay SPA
Arklow Bank Wind Farm Phase 1	0.00	0.00
Awel y Môr Offshore Wind Farm	0.00	0.00
Burbo Bank Offshore Wind Farm	0.00	0.00
Burbo Bank Offshore Wind Farm Extension	0.00	0.00
Gwynt y Mor Offshore Wind Farm	0.00	0.00
Erebus Offshore Wind Farm	0.00	0.00
Ormonde Offshore Wind Farm	0.00	0.00
Robin Rigg Offshore Wind Farm	0.00	0.00
Rhyl Flats Offshore Wind Farm	0.00	0.00
Twinhub Offshore Wind Farm	0.00	0.00
Walney 1+2 Offshore Wind Farms	0.00	0.00
Walney Extension 3+4 Offshore Wind Farms	0.00	0.00
West of Duddon Sands Offshore Wind Farms	0.00	0.00
Morecambe Offshore Windfarm Generation Assets	0.00	0.00
Morgan Offshore Wind Project Generation Assets	0.00	0.00
Mona Offshore Wind Project	0.00	0.00
Oriel Wind Farm Project	0.08	0.04
Total adult birds	**0.05**	**0.07**
Adult baseline mortality of SPA	**725**	**403**
In-combination total as a % increase on baseline mortality	**0.01%**	**0.02%**

6.2.2.2 Great black-backed gull

Within the alone assessment, the North-west Irish Sea SPA was considered during the winter period only. All birds present within the North-west Irish Sea cSPA are part of the larger international population which winters in both the UK and Republic of Ireland. The total population which could be present during the winter period is 53,181 (Furness, 2015). The North-west Irish Sea SPA represent a small proportion of this winter population, with an estimated 982 birds, or a proportion of 0.0185. As it was not always clear which avoidance rates have been used to calculate the impacts, the numbers presented for the older projects are considered an overestimation and have not used the latest evidence on avoidance. When the avoidance rate was known (e.g. Walney Extension and Awel y Môr), the figure presented is has used the latest avoidance rate.

As the increase in baseline mortality was <1 %, the impact is not considered to have an adverse effect on the site's integrity for all SPAs assessed in-combination. Table 6A-8 replaces Table 6-6 presented in appendix H: Offshore Ornithology Supporting Information in the NIS (2024).

Table 6A-8: Estimated adult annual morality of great black-backed gull from collisions apportioned to the SPA from the in-combination Projects.

Project	SPA
	North-west Irish Sea
Holyhead Deep - Phase 1 (Minesto Tidal Kite)	0.00
Arklow Bank Wind Farm Phase 1	0.00
Walney Extension 3+4 Offshore Wind Farms	0.00
Awel y Môr Offshore Wind Farm	0.00
Walney 1+2 Offshore Wind Farms	0.02
West of Duddon Sands Offshore Wind Farms	0.01

Project	SPA North-west Irish Sea
Gwynt y Mor Offshore Wind Farm	0.03
Rhyl Flats Offshore Wind Farm	0.01
Ormonde Offshore Wind Farm	0.00
Robin Rigg Offshore Wind Farm	0.01
North Hoyle Offshore Wind Farm	0.00
Barrow Offshore Wind Farm	0.01
Burbo Bank Offshore Wind Farm Extension	0.02
Burbo Bank Offshore Wind Farm	0.01
Erebus Offshore Wind Farm	0.00
Twinhub Offshore Wind Farm	0.00
Mona Offshore Wind Project	0.02
Morgan Offshore Wind Project Generation Assets	0.03
Morecambe Offshore Windfarm Generation Assets	0.01
Arklow Bank Wind Farm Phase 2	0.01
Colding	0.00
Dublin Array	0.03
NISA	0.08
Llyr 1	0.01
Mooir Vannin Wind Farm	0.00
Oriel Wind Farm Project	0.03
Total adult birds	**0.34**
Adult baseline mortality of SPA	**65**
In-combination total as a % increase on baseline mortality	**0.53%**

6.2.2.3 Herring gull

As stated within section 6.1, only sites for which the Project has a measurable impact (concluded as >0.1 increase in baseline mortality and >0.1 birds) from the project alone, would be included within an in-combination assessment. Therefore, the Ireland’s Eye SPA and the Lambay Island SPA are presented within the in-combination assessment.

It was predicted that up to 9.97 birds would be killed from collisions that originated from the Lambay Island SPA, with a smaller number of birds from the Ireland’s Eye SPA (4.68 birds).

When considering all of the projects within the Cumulative Offshore Ornithology Study Area the increase in baseline mortality for both sites is >1 % (Table 6A-9 and Table 6A-10)(replace Table 6-7 presented in appendix H: Offshore Ornithology Supporting Information in the NIS (2024)) and therefore additional analysis was undertaken, in the form of a PVA. Full details are provided within annex 8 Addendum: Offshore Ornithology Population Viability Analysis, for impacted SPAs.

Table 6A-9: Estimated annual morality of adult herring gull from collisions apportioned to the Ireland’s Eye SPA from the in-combination Projects.

Project	Annual	Breeding Season	Non-breeding
Holyhead Deep - Phase 1 (Minesto Tidal Kite)	0.00	No connectivity	0.00
North Hoyle Offshore Wind Farm	0.01	No connectivity	0.01
Barrow Offshore Wind Farm	0.01	No connectivity	0.01
Arklow Bank Wind Farm Phase 2	0.00	No connectivity	0.00
Colding	0.30	0.30	0.00

Project	Annual	Breeding Season	Non-breeding
Dublin Array	1.50	1.44	0.05
NISA	2.45	2.36	0.09
Llyr 1	0.00	No connectivity	0.00
Mooir Vannin Wind Farm	0.02	No connectivity	0.02
Arklow Bank Wind Farm Phase 1	0.00	No connectivity	0.00
Awel y Môr Offshore Wind Farm	0.00	No connectivity	0.00
Burbo Bank Offshore Wind Farm	0.00	No connectivity	0.00
Burbo Bank Offshore Wind Farm Extension	0.00	No connectivity	0.00
Gwynt y Mor Offshore Wind Farm	0.05	No connectivity	0.05
Erebus Offshore Wind Farm	0.00	No connectivity	0.00
Ormonde Offshore Wind Farm	0.00	No connectivity	0.00
Robin Rigg Offshore Wind Farm	0.01	No connectivity	0.01
Rhyl Flats Offshore Wind Farm	0.01	No connectivity	0.01
Twinhub Offshore Wind Farm	0.00	No connectivity	0.00
Walney 1+2 Offshore Wind Farms	0.03	No connectivity	0.03
Walney Extension 3+4 Offshore Wind Farms	0.07	No connectivity	0.07
West of Duddon Sands Offshore Wind Farms	0.02	No connectivity	0.02
Morecambe Offshore Windfarm Generation Assets	0.01	No connectivity	0.01
Morgan Offshore Wind Project Generation Assets	0.02	No connectivity	0.02
Mona Offshore Wind Project	0.00	No connectivity	0.00
Oriel Wind Farm Farm	0.17	0.14	0.03
Total adult birds	**4.68**	**4.24**	**0.44**
Adult baseline mortality of SPA	**106**		
In-combination total as a % increase on baseline mortality	**4.41%**		

Table 6A-10: Estimated annual mortality of adult herring gull from collisions apportioned to the Lambay Island SPA from the in-combination Projects.

Project	Annual	Breeding Season	Non-breeding
Holyhead Deep - Phase 1 (Minesto Tidal Kite)	0.00	No connectivity	0.00
North Hoyle Offshore Wind Farm	0.01	No connectivity	0.01
Barrow Offshore Wind Farm	0.01	No connectivity	0.01
Arklow Bank Wind Farm Phase 2	0.00	No connectivity	0.00
Colding	0.64	0.63	0.00
Dublin Array	1.68	1.62	0.05
NISA	6.81	6.72	0.09
Llyr 1	0.00	No connectivity	0.00
Mooir Vannin Wind Farm	0.02	No connectivity	0.02
Arklow Bank Wind Farm Phase 1	0.00	No connectivity	0.00
Awel y Môr Offshore Wind Farm	0.00	No connectivity	0.00
Burbo Bank Offshore Wind Farm	0.00	No connectivity	0.00
Burbo Bank Offshore Wind Farm Extension	0.00	No connectivity	0.00
Gwynt y Mor Offshore Wind Farm	0.05	No connectivity	0.05
Erebus Offshore Wind Farm	0.00	No connectivity	0.00

Project	Annual	Breeding Season	Non-breeding
Ormonde Offshore Wind Farm	0.00	No connectivity	0.00
Robin Rigg Offshore Wind Farm	0.01	No connectivity	0.01
Rhyl Flats Offshore Wind Farm	0.01	No connectivity	0.01
Twinhub Offshore Wind Farm	0.00	No connectivity	0.00
Walney 1+2 Offshore Wind Farms	0.03	No connectivity	0.03
Walney Extension 3+4 Offshore Wind Farms	0.07	No connectivity	0.07
West of Duddon Sands Offshore Wind Farms	0.02	No connectivity	0.02
Morecambe Offshore Windfarm Generation Assets	0.01	No connectivity	0.01
Morgan Offshore Wind Project Generation Assets	0.02	No connectivity	0.02
Mona Offshore Wind Project	0.00	No connectivity	0.00
Oriel Wind Farm Project	0.58	0.55	0.03
Total adult birds	**9.97**	**9.53**	**0.44**
Adult baseline mortality of SPA	**301**		
In-combination total as a % increase on baseline mortality	**3.31%**		

Following the PVA, it was concluded that the counterfactual growth rate was 0.993 for Lambay Island SPA, with Ireland's Eye SPA indicating a 0.991 counterfactual growth rate. A counterfactual growth rate of 0.991 and 0.993 are of significance and outside the natural fluctuations of a population, with the impacted population having a 0.9 % and 0.7% change on the growth rate of non-impacted population.

The population of herring gull at Ireland's Eye SPA undertook a 29% increase between the Seabird 2000 and Seabird Count national census (Burnell *et al*., 2023). Therefore with an increasing population a counterfactual growth rate of 0.991 is considered insignificant. In addition, the impact from the Project, included within the in-combination assessment is the Natural England AR, if the JNCC AR was presented the impact would be less, and highly likely to result in >0.995 counterfactual of growth rate.

Full calculations and methods are presented in annex 8: Offshore Ornithology Population Viability Analysis, for impacted SPAs. As the counterfactual growth rate of 0.993 was of significance, the impact is considered to have a low magnitude effect on the site's integrity for the Lambay Island SPA assessed in-combination. The counterfactual growth rate of 0.991 was not of significance, therefore the impact is not considered to have an adverse effect on the site's integrity for all SPAs assessed in-combination.

6.2.2.4 Kittiwake

As stated within section 6.1, only sites for which the Project has a measurable impact (concluded as >0.1 increase in baseline mortality and >0.1 birds) from the project alone, would be included within an in-combination assessment. Therefore, the Ireland's Eye SPA, the Lambay Island SPA, the Howth Head Coast SPA and Rathlin Island SPA are presented within the in-combination assessment for kittiwake. The SPA with the greatest number of predicted mortalities was Rathlin island SPA with up to 24.10 annual mortalities. However it was the Ireland's Eye SPA which the increased annual mortalities had the greatest increase in baseline mortality (1.75 %).

When considering all of the projects within the Cumulative Offshore Ornithology Study Area the increase in baseline mortality for three of the SPAs is >1 % (Table 6A-11, Table 6A-12, Table 6A-13 and Table 6A-14 replace Table 6-8 presented in appendix H: Offshore Ornithology Supporting Information in the NIS (2024)) and therefore additional analysis was undertaken, in the form of a PVA. Full details are provided within annex 8: Offshore Ornithology Population Viability Analysis, for impacted SPAs. No further analysis was undertaken for Rathlin Island SPA as the increase in baseline mortality of 0.60 the impact is not considered to have an adverse effect on the site's integrity.

Table 6A-11: Estimated annual mortality of adult kittiwake from collisions apportioned to the Ireland Eye SPA from the in-combination projects.

Project	Annual	Breeding	pre-breeding	post-breeding
Holyhead Deep - Phase 1 (Minesto Tidal Kite)	0.00	0.00	0.00	0.00
North Hoyle Offshore Wind Farm	0.01	0.01	0.00	0.00
Barrow Offshore Wind Farm	0.01	0.01	0.00	0.00
Arklow Bank Wind Farm Phase 2	0.41	0.19	0.20	0.02
Colding	0.05	0.04	0.00	0.01
Dublin Array	0.37	0.36	0.01	0.01
NISA	0.06	0.05	0.01	0.01
Llyr 1	0.02	0.00	0.00	0.02
Mooir Vannin Wind Farm	0.20	0.16	0.02	0.02
Arklow Bank Wind Farm Phase 1	0.00	0.00	0.00	0.00
Awel y Môr Offshore Wind Farm	0.13	0.09	0.03	0.01
Burbo Bank (gap-filled)	0.01	0.00	0.00	0.00
Burbo Bank Extension Offshore Wind Farm	0.00	0.00	0.00	0.00
Gwynt Y Mor (gap-filled)	0.01	0.01	0.00	0.00
Erebus Floating Wind Demo	0.06	0.01	0.02	0.04
Ormonde Wind Farm (partially gap-filled)	0.00	0.00	0.00	0.00
Robin Rigg (partially gap-filled)	0.01	0.01	0.00	0.00
Rhyl Flats Offshore Wind Farm (gap-filled)	0.01	0.01	0.00	0.00
TwinHub (Wave Hub Floating Wind Farm)	0.00	0.00	0.00	0.00
Walney 1 & 2 (gap-filled)	0.04	0.03	0.00	0.00
Walney (3 & 4) Extension Offshore Wind Farm	0.35	0.20	0.03	0.13
West of Duddon Sands Offshore Wind Farm (partially gap-filled)	0.03	0.03	0.00	0.00
Morecambe Offshore Windfarm Generation Assets	0.12	0.11	0.00	0.01
Morgan Offshore Wind Project Generation Assets	0.11	0.09	0.01	0.02
Mona Offshore Wind Project	0.15	0.13	0.01	0.01
Oriel Wind Farm Project	0.13	0.08	0.03	0.02
Total adult birds	**2.32**	**1.62**	**0.38**	**0.32**
Adult baseline mortality of SPA	**133**			
In-combination total as a % increase on baseline mortality	**1.75%**			

Table 6A-12: Estimated annual mortality of adult kittiwake from collisions apportioned to the Lambay Island SPA from the in-combination projects.

Project	Annual	Breeding	pre-breeding	post-breeding
Holyhead Deep - Phase 1 (Minesto Tidal Kite)	0.00	0.00	0.00	0.00
North Hoyle Offshore Wind Farm	0.03	0.02	0.01	0.01
Barrow Offshore Wind Farm	0.03	0.02	0.01	0.01
Arklow Bank Wind Farm Phase 2	2.71	1.11	1.46	0.14
Colding	0.33	0.22	0.04	0.07
Dublin Array	1.63	1.52	0.05	0.07
NISA	1.00	0.88	0.07	0.05
Llyr 1	0.17	0.00	0.03	0.14
Mooir Vannin Wind Farm	0.67	0.39	0.16	0.11
Arklow Bank Wind Farm Phase 1	0.00	0.00	0.00	0.00
Awel y Môr Offshore Wind Farm	0.49	0.21	0.20	0.09
Burbo Bank (gap-filled)	0.02	0.01	0.00	0.01
Burbo Bank Extension Offshore Wind Farm	0.00	0.00	0.00	0.00
Gwynt Y Mor (gap-filled)	0.03	0.02	0.01	0.01
Erebus Floating Wind Demo	0.43	0.01	0.16	0.26
Ormonde Wind Farm (partially gap-filled)	0.00	0.00	0.00	0.00
Robin Rigg (partially gap-filled)	0.04	0.02	0.01	0.01
Rhyl Flats Offshore Wind Farm (gap-filled)	0.03	0.02	0.01	0.01
TwinHub (Wave Hub Floating Wind Farm)	0.00	0.00	0.00	0.00
Walney 1 & 2 (gap-filled)	0.12	0.09	0.01	0.02
Walney (3 & 4) Extension Offshore Wind Farm	1.61	0.50	0.20	0.92
West of Duddon Sands Offshore Wind Farm (partially gap-filled)	0.12	0.07	0.02	0.03
Morecambe Offshore Windfarm Generation Assets	0.26	0.20	0.01	0.06
Morgan Offshore Wind Project Generation Assets	0.46	0.29	0.04	0.13
Mona Offshore Wind Project	0.44	0.31	0.07	0.06
Oriel Wind Farm Project	1.23	0.84	0.22	0.17
Total adult birds	**11.87**	**6.74**	**2.78**	**2.36**
Adult baseline mortality of SPA	**969**			
In-combination total as a % increase on baseline mortality	**1.22%**			

Table 6A-13: Estimated annual mortality of adult kittiwake from collisions apportioned to the Howth Head Coast SPA from the in-combination projects.

Project	Annual	Breeding	Pre-Breeding	Post-Breeding
Holyhead Deep - Phase 1 (Minesto Tidal Kite)	0.00	0.00	0.00	0.00
North Hoyle Offshore Wind Farm	0.02	0.02	0.00	0.00
Barrow Offshore Wind Farm	0.02	0.02	0.00	0.00
Arklow Bank Wind Farm Phase 2	1.55	0.86	0.63	0.07
Colding	0.21	0.16	0.02	0.03
Dublin Array	2.31	2.25	0.02	0.04
NISA	0.22	0.17	0.03	0.02
Llyr 1	0.08	0.00	0.01	0.07
Mooir Vannin Wind Farm	0.30	0.18	0.07	0.06
Arklow Bank Wind Farm Phase 1	0.00	0.00	0.00	0.00
Awel y Môr Offshore Wind Farm	0.31	0.19	0.08	0.04
Burbo Bank (gap-filled)	0.01	0.01	0.00	0.00
Burbo Bank Extension Offshore Wind Farm	0.00	0.00	0.00	0.00
Gwynt Y Mor (gap-filled)	0.02	0.02	0.00	0.00
Erebus Floating Wind Demo	0.21	0.01	0.07	0.13
Ormonde Wind Farm (partially gap-filled)	0.00	0.00	0.00	0.00
Robin Rigg (partially gap-filled)	0.03	0.02	0.00	0.00
Rhyl Flats Offshore Wind Farm (gap-filled)	0.02	0.01	0.00	0.00
TwinHub (Wave Hub Floating Wind Farm)	0.00	0.00	0.00	0.00
Walney 1 & 2 (gap-filled)	0.09	0.07	0.01	0.01
Walney (3 & 4) Extension Offshore Wind Farm	0.93	0.41	0.08	0.44
West of Duddon Sands Offshore Wind Farm (partially gap-filled)	0.08	0.06	0.01	0.01
Morecambe Offshore Windfarm Generation Assets	0.24	0.20	0.00	0.03
Morgan Offshore Wind Project Generation Assets	0.31	0.23	0.02	0.06
Mona Offshore Wind Project	0.21	0.15	0.03	0.03
Oriel Wind Farm Project	0.46	0.29	0.10	0.08
Total adult birds	**7.64**	**5.32**	**1.19**	**1.13**
Adult baseline mortality of SPA	**518**			
In-combination total as a % increase on baseline mortality	**1.48%**			

Table 6A-14: Estimated annual mortality of adult kittiwake from collisions apportioned to the Rathlin Island SPA from the in-combination projects.

Project	Annual	Breeding	pre-breeding	post-breeding
Holyhead Deep - Phase 1 (Minesto Tidal Kite)	0.00	0.00	0.00	0.00
North Hoyle Offshore Wind Farm	0.07	0.02	0.03	0.03
Barrow Offshore Wind Farm	0.07	0.03	0.02	0.02
Arklow Bank Wind Farm Phase 2	6.56	0.00	5.99	0.57
Colding	0.46	0.03	0.14	0.28
Dublin Array	0.49	0.00	0.19	0.30
NISA	0.53	0.04	0.30	0.20
Llyr 1	0.70	no connectivity	0.10	0.60
Mooir Vannin Wind Farm	1.69	0.55	0.66	0.47
Arklow Bank Wind Farm Phase 1	0.00	0.00	0.00	0.00
Awel y Môr Offshore Wind Farm	1.36	0.19	0.80	0.36
Burbo Bank (gap-filled)	0.05	0.01	0.02	0.02
Burbo Bank Extension Offshore Wind Farm	0.00	0.00	0.00	0.00
Gwynt Y Mor (gap-filled)	0.08	0.02	0.03	0.04
Erebus Floating Wind Demo	1.74	no connectivity	0.66	1.08
Ormonde Wind Farm (partially gap-filled)	0.00	0.00	0.00	0.00
Robin Rigg (partially gap-filled)	0.09	0.03	0.03	0.04
Rhyl Flats Offshore Wind Farm (gap-filled)	0.07	0.01	0.03	0.03
TwinHub (Wave Hub Floating Wind Farm)	0.00	no connectivity	0.00	0.00
Walney 1 & 2 (gap-filled)	0.24	0.11	0.06	0.07
Walney (3 & 4) Extension Offshore Wind Farm	5.19	0.60	0.80	3.79
West of Duddon Sands Offshore Wind Farm (partially gap-filled)	0.29	0.08	0.09	0.12
Morecambe Offshore Windfarm Generation Assets	0.81	0.54	0.02	0.24
Morgan Offshore Wind Project Generation Assets	1.05	0.35	0.18	0.53
Mona Offshore Wind Project	0.71	0.16	0.30	0.24
Oriel Wind Farm Project	1.86	0.26	0.91	0.69
Total adult birds	24.10	3.03	11.35	9.72
Adult baseline mortality of SPA	**4002**			
In-combination total as a % increase on baseline mortality	**0.60%**			

Following the PVA, it was concluded that the counterfactual growth rate was ≥0.995 for all three SPAs assessed. A counterfactual growth rate of ≥0.995 is considered to be within natural fluctuations and no impact is predicted from the increase in mortality in-combination. Full calculations and methods are presented in annex 8: Offshore Ornithology Population Viability Analysis, for impacted SPAs. As the counterfactual growth rate was ≥0.995, the impact is not considered to have an adverse effect on the site's integrity for all SPAs assessed in-combination.

6.2.3 Combined disturbance and displacement and collision risk during the operational and maintenance phase on gannet

As stated within section 6.1, only sites for which the Project has a measurable impact (concluded as >0.1 increase in baseline mortality and >0.1 birds) from the project alone, would be included within an in-combination assessment. Therefore, the Alisa Craig SPA and Saltee Islands SPA are presented within the in-combination assessment.

The SPA with the greatest number of predicted mortalities was Ailsa Craig SPA with up to 36.61 annual mortalities.

When considering all of the projects within the Cumulative Offshore Ornithology Study Area the increase in baseline mortality for the Ailsa Craig SPA is <1 % (Table 6A-15) and therefore no additional analysis was undertaken and the impact is not considered to have an adverse effect on the site's integrity.

When considering all of the projects within the Cumulative Offshore Ornithology Study Area the increase in baseline mortality for the Saltee Island SPA is >1 % (Table 6A-16) and therefore additional analysis was undertaken, in the form of a PVA. Full details are provided within annex 8: Offshore Ornithology Population Viability Analysis, for impacted SPAs

Following the PVA, it was concluded that the counterfactual growth rate was 0.994 for the Saltee Island SPA. A counterfactual growth rate of 0.994 is considered significant and outside the natural fluctuations of a population and a low magnitude impact is predicted from the increase in mortality in-combination. Full calculations and methods are presented in annex 8: Offshore Ornithology Population Viability Analysis, for impacted SPAs. As the counterfactual growth rate of 0.994 was of significance, the impact is considered to have a low magnitude effect on the site's integrity for all SPAs assessed in-combination.

Table 6A-15: Estimated annual mortality of gannet (adults) from disturbance and displacement and collisions apportioned to the Ailsa Craig SPA from the in-combination Projects.

Project	Annual	Pre-breeding	Breeding	Post-breeding
Awel y Môr Offshore Wind Farm (no macro avoidance)	3.11	0.00	2.69	0.43
Burbo Bank Extension Offshore Wind Farm (no macro avoidance)	3.53	0.01	3.50	0.02
Erebus Floating Wind Demo (with macro avoidance)	0.41	0.11	No connectivity	0.30
TwinHub (Wave Hub Floating Wind Farm) (no macro avoidance)	0.10	0.00	No connectivity	0.10
Llyr (no macro avoidance)	0.63	0.07	0.01	0.55
Mona Offshore Wind Project (no macro avoidance)	1.78	0.05	1.63	0.10
Morecambe Offshore Windfarm Generation Assets (70% macro used)	1.30	0.01	1.21	0.08
Morgan Offshore Wind Project Generation Assets (70% macro used)	0.46	0.02	0.39	0.05
Ormonde Wind Farm (no macro avoidance)	2.04	0.00	2.03	0.00
Walney (3 & 4) Extension Offshore Wind Farm (no macro avoidance)	6.45	0.10	4.29	2.06
West of Duddon Sands Offshore Wind Farm (no macro avoidance)	1.40	0.03	1.32	0.05
Barrow (no macro avoidance)	0.12	0.01	0.10	0.01
Burbo Bank (no macro avoidance)	0.10	0.01	0.08	0.01
Gwynt y Môr Offshore Wind Farm (no macro avoidance)	1.76	0.10	1.50	0.15
North Hoyle (no macro avoidance)	0.22	0.01	0.20	0.02
Robin Rigg (no macro avoidance)	0.22	0.01	0.19	0.02
Rhyl Flats Offshore Wind Farm (no macro avoidance)	0.28	0.04	0.22	0.02
Walney 1 and 2 (no macro avoidance)	0.63	0.03	0.54	0.05
Arklow Bank Wind Farm Phase 2	0.12	0.04	0.00	0.08
Colding	0.32	0.15	0.05	0.12
Dublin Array	0.69	0.04	0.58	0.07
NISA	0.93	0.04	0.36	0.53
Mooir Vannin Wind Farm (no macro avoidance)	6.17	0.03	5.80	0.35
Oriel Wind Farm Project (70% macro avoidance)	3.82	0.19	2.41	1.22
Total adult birds	**36.61**	**1.10**	**29.11**	**6.40**
Adult baseline mortality of SPA	**5,221**			
In-combination total as a % increase on baseline mortality	**0.70%**			

Table 6A-16: Estimated annual mortality of gannet (adults) from disturbance and displacement and collisions apportioned to the Saltee Island SPA from the in-combination Projects.

Project	Annual	Pre-breeding	Breeding	Post-breeding
Awel y Môr Offshore Wind Farm (no macro avoidance)	2.73	0.00	2.69	0.05
Burbo Bank Extension Offshore Wind Farm (no macro avoidance)	3.51	0.00	3.50	0.00
Erebus Floating Wind Demo (with macro avoidance)	0.05	0.02	No connectivity	0.03
TwinHub (Wave Hub Floating Wind Farm) (no macro avoidance)	0.01	0.00	No connectivity	0.01
Llyr (no macro avoidance)	0.08	0.01	0.01	0.06
Mona Offshore Wind Project (no macro avoidance)	1.65	0.01	1.63	0.01
Morecambe Offshore Windfarm Generation Assets (70% macro used)	1.22	0.00	1.21	0.01
Morgan Offshore Wind Project Generation Assets (70% macro used)	0.40	0.00	0.39	0.01
Ormonde Wind Farm (no macro avoidance)	2.04	0.00	2.03	0.00
Walney (3 & 4) Extension Offshore Wind Farm (no macro avoidance)	4.53	0.01	4.29	0.23
West of Duddon Sands Offshore Wind Farm (no macro avoidance)	1.33	0.00	1.32	0.01
Barrow (no macro avoidance)	0.11	0.00	0.10	0.00
Burbo Bank (no macro avoidance)	0.08	0.00	0.08	0.00
Gwynt y Môr Offshore Wind Farm (no macro avodance)	1.53	0.02	1.50	0.02
North Hoyle (no macro avoidance)	0.20	0.00	0.20	0.00
Robin Rigg (no macro avoidance)	0.20	0.00	0.19	0.00
Rhyl Flats Offshore Wind Farm (no macro avoidance)	0.23	0.01	0.22	0.00
Walney 1 and 2 (no macro avoidance)	0.55	0.00	0.54	0.01
Arklow Bank Wind Farm Phase 2	0.54	0.01	0.52	0.01
Colding	0.06	0.02	0.03	0.01
Dublin Array	0.19	0.01	0.17	0.01
NISA	0.10	0.01	0.04	0.06
Mooir Vannin Wind Farm (no macro avoidance)	0.21	0.00	0.17	0.04
Oriel Wind Farm (70% macro avoidance)	0.38	0.03	0.21	0.13
Total adult birds	**21.91**	**0.16**	**21.05**	**0.70**
Adult baseline mortality of SPA	**765**			
In-combination total as a % increase on baseline mortality	**2.86%**			

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ANNEX 8 ADDENDUM: OFFSHORE ORNITHOLOGY POPULATION VIABILITY ANALYSIS

ORIEL WIND FARM PROJECT

Natura Impact Statement Addendum

Annex 8 Addendum: Offshore Ornithology Population Viability Analysis

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1 INTRODUCTION

Annex 8: Offshore Ornithology Population Viability Analysis (PVA) is included in the NIS (2024). This report presents an updated PVA which was prepared in response to the Request for Further Information from An Coimisiún Pleanála in April 2025. This report replaces the PVA included as annex 8 in appendix H: Offshore Ornithology in the NIS that supported the planning application submitted in May 2024. The results of this PVA inform the in-combination assessment included in appendix H Addendum: Offshore Ornithology Supporting Information.

1.1 Project Background

Oriel Windfarm Limited ('the Applicant') is proposing to develop the Oriel Wind Farm Project, an offshore wind farm, hereafter referred to as 'the Project". The Project is located in the western Irish Sea and is located within the territorial waters of the Republic of Ireland. The Project will comprise both offshore and onshore infrastructure including 25 offshore wind turbines generators (WTGs), associated foundations and inter-array cabling, offshore substation, offshore cable within a defined offshore cable corridor, a landfall, onshore cable and an onshore substation for connection to the electricity transmission network.

1.2 Background to this Report

Renewable energy projects in the marine environment, such as offshore wind farms, have the potential to impact seabirds through several processes such as collision with wind turbine blades resulting in mortality, or displacement from an area due to the presence of wind turbines. The outputs from the collision risk and displacement analysis are presented within the following annexes; in annex 4: Offshore Ornithology Collision Risk Modelling and annex 5: Offshore Ornithology Displacement Analysis. The estimated mortalities were apportioned by age-class and season to relevant SPAs using the methods and weightings set out in annex 7: Offshore Ornithology Apportioning Impacts to Individual Colonies.

These impacts affect individuals, but the in-combination effects (when the project alone effects are considered alongside any effects from other projects on the same receptor) have the potential to affect the productivity or elevate the baseline mortality of a population. Appropriate Assessment provides for the assessment of such potential effects as a consequence of offshore wind farms at varying population scales, from a single Special Protection Area (SPA) colony to the wider biogeographic population. Other plans and projects included were Awel y Môr Mona Offshore Wind Project, Project Erebus, Minesto Tidal Kite (collisions with tidal kite), Mona Offshore Wind Project, Morgan Offshore Wind Project Generation Assets, Morecambe Offshore Windfarm, Arklow Bank Wind Park, Codling Wind Park, Dublin Array, North Irish Sea Array. North Hoyle Offshore Wind Farm, Barrow Offshore Wind Farm, Mooir Vannin Wind Farm, Burbo Bank, Burbo Bank Extension Offshore Wind Farm, Gwynt Y Mor, Erebus Floating Wind Demo, Ormonde Wind Farm, Robin Rigg, Rhyl Flats Offshore Wind Farm, TwinHub (Wave Hub Floating Wind Farm), Walney 1 & 2, Walney (3 & 4) Extension Offshore Wind Farm and West of Duddon Sands Offshore Wind Farm.

One method to estimate the effect that offshore wind projects alone or in-combination may have on a population is through Population Viability Analysis (PVA). PVA provides a robust framework using demographic parameters to predict changes in the population, using statistical population models to forecast future changes over a set period. Comparisons are made between 'baseline' conditions whereby conditions remain unimpacted and under 'impacted' conditions where an impact is applied to a population by the alteration of demographic parameters. Population metrics that are derived from comparisons of 'baseline' and 'impacted' predictions generated by PVAs can then be used to assess the significance of the anticipated additional mortality associated with planned developments.

As part of the Project's alone and in-combination assessments (as detailed in appendix H Addendum: Offshore Ornithology – Supporting Information), the species taken forward to PVA were:

- Guillemot (*Uria aalge*);
- Razorbill (*Alca torda*);

- Herring gull (*Larus argentatus)*;
- Kittiwake (*Rissa tridactyla)*; and
- Gannet (*Morus bassanus*)

PVA was carried out as part of the in-combination assessment due to appendix H Addendum: Offshore Ornithology – Supporting Information indicating that baseline mortality from the operations and maintenance of the Project, in-combination with other projects would exceed a 1% baseline mortality threshold.

The threshold was exceeded for the following species and SPAs;

- Guillemot populations at two SPAs: Ireland's Eye SPA and Lambay Island SPA;
- Razorbill populations at one SPA: Ireland's Eye SPA;
- Herring gull populations at two SPAs: Ireland's Eye SPA and Lambay Island SPA;
- Kittiwake populations at three SPAs: Howth Head Coast SPA, Ireland's Eye SPA and Lambay Island SPA; and
- Gannet populations at one SPA: Saltee Islands SPA.

Generally, based on findings from PVA for bird species, it would be considered that increases in mortality rates of less than 1% would be undetectable in terms of changes in population size, whereas increases above 1% may produce detectable effects (Natural England, 2022) and hence require further assessment.

The assessment presented within appendix H Addendum: Offshore Ornithology – Supporting Information for all other species in all seasons was below 1% and hence no further assessment was required.

2 METHODOLOGY

PVA was undertaken using the Seabird PVA Tool developed by Natural England (Searle *et al*., 2019). The Seabird PVA Tool was accessed via the 'Shiny App' interface, which is a user-friendly graphical user interface accessible via a standard web-browser that uses the nepva R package to perform the modelling and analysis. The tool constructs a stochastic Leslie matrix and can assess any type of impact in terms of change to demographic parameters, or as a cull or harvest of a fixed size per year (Searle *et al*., 2019). The PVA was run using Tool version 2, with R version 3.5.1, PVA package version: 4.18 (with UI version 1.7).

2.1 Modelling Approach

The potential impacts of the Project on the population growth and size of seabird species inhabiting SPAs were predicted using PVA.

Additional adult annual mortality (combined breeding and non-breeding season mortality estimates) was derived by summing the apportioned collision and/or displacement mortality estimates combined for the species/SPA combination. This was done by age class (adult and immature) based on the age class information from stable age population models using Furness (2015).

All PVA models were undertaken using the 'Simulation' run type, which is used to simulate population trajectories based on the specified demographic parameters, initial population sizes and scenarios the user inputs into the model.

The tool includes an option to switch the model to run as either density independent, or density dependent. Density dependence is self-evident in the natural environment, as without density dependence, populations would grow exponentially. For seabird populations, the mechanisms as to how this operates are largely uncertain. If density dependence is mis-specified in an assessment, the modelled predictions may be unreliable. Therefore, it is more typical to use density independent models for seabird assessments, despite the lack of biologically necessary density dependence. As such, density independent models lack any means by which a population can recover once it has been reduced beyond a certain point, they are therefore appropriate for impact assessment purposes on the grounds that they provide a precautionary approach (Ridge *et al.,* 2019).

Environmental stochasticity, which accounts for the variation arising from environmental changes affecting individuals in the same group (e.g. between-year differences in weather conditions), was incorporated in the models at the level of productivity and survival rates. For each simulated year, a value for each demographic rate was randomly generated from a probability distribution defined by the mean and standard deviation estimates of that rate for the population under consideration.

Demographic stochasticity, which accounts for individual-level variation affecting transition probabilities between age-classes, was included in the models. For large populations, like the ones considered in this analysis, the effects of environmental stochasticity are deemed more important than those associated with demographic stochasticity (Morris and Doak, 2002). However, including demographic stochasticity will not cause any issues when simulating larger populations (WWT Consulting, 2012) and hence has been included.

PVA outputs can either be expressed as the Counterfactual of Population Size (CPS) or the Counterfactual of the Population Growth Rate (CPGR) depending on if density dependence is included within the model. As models within this report have been run using density independence, the CPGR is considered more robust and informative. While both CPS and CPGR are provided, the interpretation of the density independent PVA outputs focusses on the CPGR.

2.2 Model Parameterisation

Input demographic parameters use SPA-specific estimates when available (see appendix A.1: Seabird PVA Parameter Log of this report). In cases where local estimates were unavailable, preference was given to broader scale estimates based on combined independent studies collated in Horswill and Robinson (2015), see Table 2.1. In the absence of local estimates, combined regional and national level estimates are believed to generate parameter values that express more accurately the underlying degree of uncertainty in model simulations.

Table 2.1: Species Demographic Rates Used in Population Viability Analysis

Species		Survival Rates							Productivity (Chicks per pair)	Age at first breeding	Eggs per pair
		$S_{0\to1}$	$S_{1\to2}$	$S_{2\to3}$	$S_{3\to4}$	$S_{4\to5}$	$S_{5\to6}$	S_A			
Guillemot	Mean	0.560	0.792	0.917	0.939	0.939	0.939	0.939	0.56	6	1
	SD	0.013	0.034	0.022	0.015	0.015	0.015	0.015	0.058		
Razorbill	Mean	0.630	0.630	0.895	0.895	0.895	-	0.895	0.570	5	1
	SD	0.209	0.209	0.067	0.067	0.067	-	0.067	0.247		
Herring gull	Mean	0.794	0.834	0.834	0.834	0.834	-	0.834	0.615	5	3
	SD	0.079	0.079	0.079	0.079	0.079	-	0.079	0.476		
Kittiwake	Mean	0.790	0.854	0.854	0.854	-	-	0.854	0.604	4	2
	SD	0.077	0.077	0.077	0.077	-	-	0.077	0.326		
Gannet	Mean	0.424	0.829	0.891	0.895	0.895	-	0.919	0.766	5	1
	SD	0.045	0.026	0.019	0.019	0.019	-	0.042	0.051		

The colony counts for each of the SPAs were provided from JNCC as two validated datasheets of all colony count data for the UK and Ireland within the Seabird Monitoring Programme (SMP) database for 1998 to 2022 (Table 1.2). For the species of interest here (Table 2.2), the database summarised counts by subsites and whole SPAs; "counts" are recorded as individuals or Apparently Occupied Nests (AON) or Apparently Occupied Sites (AOS). Ideally, counts should be concurrent across breeding colonies of interest. However, for many SPAs, counts are divided by subsite and not all subsites are censused every year. Entire counts for SPAs comprising multiple subsites are often only achieved over a period of years.

Table 2.2: SPA Starting Populations

Species	SPA	Breeding Adults	Baseline Mortality	Year of Count
Guillemot	Ireland's Eye	5,909	360	2015
	Lambay Island	80,377	4,903	2015
Razorbill	Ireland's Eye	2,144	225	2015
Herring Gull	Ireland's Eye	636	106	2015
	Lambay Island	1,812	301	2015
Kittiwake	Howth Head Coast	3,546	518	2015
	Ireland's Eye	910	133	2015
	Lambay Island	6,640	1,001	2015
Gannet	Saltee Island SPA	9444	765	2013

2.3 Simulation Parameterisation

All PVA modelling in this technical report was undertaken with environmental and deterministic stochasticity. To ensure robust results, all simulations were set to run 5,000 times. All models were run for a 40-year time span to account for difference in individual project lifespans. A range of years are presented in the result tables below 25, 30, 35 and 40 years (section 3).

Modelling has also been undertaken including 'burn in' within the model. It has been assumed that any impacts on populations commenced the year following latest population counts. A 'burn in' period was applied, which allows for a stable age structure to form when starting to run the model. Models were run for each species/SPA combination separately taking the associated adult population size estimate as a starting condition. Herring gull was modelled within the burn in period due to the model being unable to run, however a burn in period was applied for kittiwake.

Although impacts are only reported with respect to the adult numbers, impacts within the simulations were also applied proportionally to immature age-classes (based upon the stable age distribution from eigen-decomposition of the Leslie matrix).

2.4 Species Specific Input Parameters

2.4.1 Guillemot

The disturbance and displacement risk values used in the PVA assessment for the selected species are based on the in-combination tables (Table 6A-3 and Table 6A-4 within appendix H Addendum: Offshore Ornithology - Supporting Information). The in-combination impact values are presented in Table 2.3.

Table 2.3: Adult guillemot impacts for individual SPA colonies considered within the PVA

SPA	Estimated annual mortality (in-combination)	Increase in baseline morality (%)	Impact on adult survival rate
Ireland's Eye	9.02	2.50	0.002045
Lambay Island	113.53	2.32	0.001893

2.4.2 Razorbill

The disturbance and displacement risk values used in the PVA assessment for the selected species are based on the in-combination table (Table 6A-5) within appendix H Addendum: Offshore Ornithology - Supporting Information. The in-combination impact values are presented in Table 2 4.

Table 2.4: Adult razorbill impacts for individual SPA colonies considered within the PVA

SPA	Estimated annual mortality (in-combination)	Increase in baseline morality (%)	Impact on adult survival rate
Ireland's Eye	4.51	2.00	0.002819

2.4.3 Herring Gull

The collision risk values used in the PVA assessment for the selected species are based on the in-combination tables (Table 6A-9 and Table 6A-10) within appendix H Addendum: Offshore Ornithology - Supporting Information. The in-combination impact values are presented in Table 2.5.

Table 2.5: Adult herring gull impacts for individual SPA colonies considered within the PVA

SPA	Estimated annual mortality (in-combination)	Increase in baseline morality (%)	Impact on adult survival rate
Ireland's Eye	4.68	4.41	0.007356
Lambay Island	9.97	3.31	0.005502

2.4.4 Kittiwake

The collision risk values used in the PVA assessment for the selected species are based on the in-combination tables (Table 6A-11, Table 6A-12 and Table 6A-13) within appendix H Addendum: Offshore Ornithology - Supporting Information. The in-combination impact values are presented in Table 2.6.

Table 2.6: Adult kittiwake impacts for individual SPA colonies considered within the PVA

SPA	Estimated annual mortality (in-combination)	Increase in baseline morality (%)	Impact on adult survival rate
Howth Head Coast	7.64	1.48	0.002155
Ireland's Eye	2.32	1.75	0.002552
Lambay Island	11.87	1.22	0.001787

2.4.5 Gannet

The collision risk values used in the PVA assessment for the selected species are based on the in-combination table (Table 6A-16) within appendix H Addendum: Offshore Ornithology - Supporting Information. The in-combination impact values are presented in Table 2 7.

Table 2.7: Gannet razorbill impacts for individual SPA colonies considered within the PVA

SPA	Estimated annual mortality (in-combination)	Increase in baseline morality (%)	Impact on adult survival rate
Saltee Island	21.91	2.86	0.004641

3 RESULTS

3.1 Guillemot

3.1.1 Ireland's Eye SPA

The counterfactual growth rate for guillemot from the Ireland's Eye SPA remained at 0.998 across the 30 to 40 year model run with the final impacted population size approximately 8.9% less than the unimpacted scenario. A counterfactual growth rate of 0.998, indicating an impact of 0.2%, is considered insignificant and within the natural fluctuations of a population (Table 3.1).

Table 3.1: Growth rates of simulated populations under different impact scenarios for the 25 to 40 years post-construction projections for guillemot at Ireland's Eye SPA

Projection year	Years since impact	Additional adult mortalities	Mean growth rate	2.5 percentile of simulated growth rate	97.5 percentile of simulated growth rate	Mean CPGR	Mean CPS	Reduction in Growth Rate (%)
2050	25	0	1.034	1.023	1.045	-	-	-
		9.02	1.032	1.020	1.043	0.998	0.942	0.2
2055	30	0	1.034	1.024	1.044	-	-	-
		9.02	1.032	1.021	1.042	0.998	0.932	0.2
2060	35	0	1.034	1.025	1.043	-	-	-
		9.02	1.032	1.022	1.041	0.998	0.921	0.2
2065	40	0	1.034	1.025	1.043	-	-	-
		9.02	1.032	1.023	1.040	0.998	0.911	0.2

3.1.2 Lambay Island SPA

The counterfactual growth rate for herring gull from the Ireland's Eye SPA remained at 0.998 across the 30 to 40 year model run with the final impacted population size approximately 8.3% less than the unimpacted scenario. A counterfactual growth rate of 0.998, indicating an impact of 0.2%, is considered insignificant and within the natural fluctuations of a population (Table 3.2).

Table 3.2: Growth rates of simulated populations under different impact scenarios for the 25 to 40 years post-construction projections for guillemot at Ireland's Eye SPA

Projection year	Years since impact	Additional adult mortalities	Mean growth rate	2.5 percentile of simulated growth rate	97.5 percentile of simulated growth rate	Mean CPGR	Mean CPS	Reduction in Growth Rate (%)
2050	25	0	1.034	1.023	1.045	-	-	-
		113.53	1.032	1.020	1.043	0.998	0.946	0.2
2055	30	0	1.034	1.024	1.044	-	-	-
		113.53	1.032	1.022	1.042	0.998	0.936	0.2
2060	35	0	1.034	1.025	1.043	-	-	-
		113.53	1.032	1.022	1.041	0.998	0.926	0.2
2065	40	0	1.034	1.025	1.043	-	-	-
		113.53	1.032	1.023	1.040	0.998	0.917	0.2

3.2 Razorbill

3.2.1 Ireland's Eye SPA

The counterfactual growth rate for herring gull from the Ireland's Eye SPA remained at 0.997 across the 30 to 40 year model run with the final impacted population size approximately 12.1% less than the unimpacted scenario. A counterfactual growth rate of 0.997, indicating an impact of 0.3%, is considered insignificant and within the natural fluctuations of a population (Table 3.3).

Table 3.3: Growth rates of simulated populations under different impact scenarios for the 25 to 40 years post-construction projections for herring gull at Ireland's Eye SPA

Projection year	Years since impact	Additional adult mortalities	Mean growth rate	2.5 percentile of simulated growth rate	97.5 percentile of simulated growth rate	Mean CPGR	Mean CPS	Reduction in Growth Rate (%)
2050	25	0	1.014	0.984	1.04	-	-	-
		6.29	1.011	0.982	1.037	0.997	0.922	0.3
2055	30	0	1.014	0.988	1.038	-	-	-
		6.29	1.011	0.984	1.035	0.997	0.907	0.3
2060	35	0	1.014	0.989	1.037	-	-	-
		6.29	1.010	0.986	1.033	0.997	0.893	0.3
2065	40	0	1.014	0.991	1.035	-	-	-
		6.29	1.010	0.988	1.031	0.997	0.879	0.3

3.3 Herring Gull

3.3.1 Ireland's Eye SPA

The counterfactual growth rate for herring gull from the Ireland's Eye SPA remained at 0.991 across the 30 to 40 year model run with the final impacted population size approximately 28.2% less than the unimpacted scenario. A counterfactual growth rate of 0.991, indicating an impact of 0.9%, is considered significant and outside the natural fluctuations of a population (Table 3.4).

Table 3.4: Growth rates of simulated populations under different impact scenarios for the 25 to 40 years post-construction projections for herring gull at Ireland's Eye SPA

Projection year	Years since impact	Additional adult mortalities	Mean growth rate	2.5 percentile of simulated growth rate	97.5 percentile of simulated growth rate	Mean CPGR	Mean CPS	Reduction in Growth Rate (%)
2050	25	0	0.964	0.926	0.999	-	-	-
		4.68	0.956	0.918	0.991	0.991	0.807	0.9
2055	30	0	0.964	0.929	0.996	-	-	-
		4.68	0.955	0.919	0.988	0.991	0.776	0.9
2060	35	0	0.964	0.932	0.993	-	-	-
		4.68	0.955	0.922	0.985	0.991	0.745	0.9
2065	40	0	0.964	0.934	0.991	-	-	-
		4.68	0.955	0.924	0.983	0.991	0.718	0.9

3.3.2 Lambay Island SPA

The counterfactual growth rate for herring gull from the Lambay Island SPA remained at 0.993 across the 25 to 40 year model run with the final impacted population size (after 40 years) approximately 22.7% less than the unimpacted scenario. A counterfactual growth rate of 0.993, indicating an impact of 0.7%, is considered significant and outside the natural fluctuations of a population (Table 3.5).

Table 3.5: Growth rates of simulated populations under different impact scenarios for the 25 to 40 years post-construction projections for herring gull at Lambay SPA

Projection year	Years since impact	Additional adult mortalities	Mean growth rate	2.5 percentile of simulated growth rate	97.5 percentile of simulated growth rate	Mean CPGR	Mean CPS	Reduction in Growth Rate (%)
2050	25	0	0.964	0.929	0.999	-	-	-
		9.97	0.958	0.922	0.993	0.993	0.846	0.7
2055	30	0	0.964	0.931	0.996	-	-	-
		9.97	0.958	0.925	0.989	0.993	0.82	0.7
2060	35	0	0.964	0.934	0.993	-	-	-
		9.97	0.958	0.927	0.986	0.993	0.795	0.7
2065	40	0	0.964	0.936	0.991	-	-	-
		9.97	0.958	0.929	0.985	0.993	0.773	0.7

3.4 Kittiwake

3.4.1 Howth Head Coast SPA

The counterfactual growth rate for kittiwake from the Howth Head Coast SPA remained at 0.997 across the 25 to 40 year model run with the final impacted population size (after 40 years) approximately 9.3% less than the unimpacted scenario. A counterfactual growth rate of 0.997, indicating an impact of 0.3%, is considered insignificant and within the natural fluctuations of a population (Table 3.6).

Table 3.6: Growth rates of simulated populations under different impact scenarios for the 25 to 40 years post-construction projections for kittiwake at Howth Head Coast SPA

Projection year	Years since impact	Additional adult mortalities	Mean growth rate	2.5 percentile of simulated growth rate	97.5 percentile of simulated growth rate	Mean CPGR	Mean CPS	Reduction in growth rate (%)
2050	25	0	0.999	0.966	1.031	-	-	-
		7.64	0.996	0.963	1.028	0.997	0.938	0.3
2055	30	0	0.999	0.969	1.028	-	-	-
		7.64	0.996	0.967	1.025	0.997	0.926	0.3
2060	35	0	0.999	0.971	1.025	-	-	-
		7.64	0.996	0.968	1.023	0.997	0.915	0.3
2065	40	0	0.999	0.972	1.024	-	-	-
		7.64	0.996	0.970	1.021	0.997	0.903	0.3

3.4.2 Ireland's Eye SPA

The counterfactual growth rate for kittiwake from the Ireland’s Eye SPA remained at 0.997 across the 25 to 40 year model run with the final impacted population size (after 40 years) approximately 10.9% less than the unimpacted scenario. A counterfactual growth rate of 0.997, indicating an impact of 0.3%, is considered insignificant and within the natural fluctuations of a population (Table 3.7).

Table 3.7: Growth rates of simulated populations under different impact scenarios for the 25 to 40 years post-construction projections for kittiwake at Ireland’s Eye SPA

Projection year	Years since impact	Additional adult mortalities	Mean growth rate	2.5 percentile of simulated growth rate	97.5 percentile of simulated growth rate	Mean CPGR	Mean CPS	Reduction in growth rate (%)
2050	25	0	0.999	0.966	1.031	-	-	-
		2.32	0.996	0.963	1.028	0.997	0.929	0.3
2055	30	0	0.999	0.968	1.028	-	-	-
		2.32	0.996	0.965	1.025	0.997	0.917	0.3
2060	35	0	0.999	0.971	1.025	-	-	-
		2.32	0.996	0.967	1.023	0.997	0.903	0.3
2065	40	0	0.999	0.972	1.024	-	-	-
		2.32	0.996	0.969	1.021	0.997	0.891	0.3

3.4.3 Lambay Island SPA

The counterfactual growth rate for kittiwake from the Lambay Island SPA remained at 0.998 across the 25 to 40 year model run with the CPS (after 40 years) approximately 91% less than the unimpacted scenario. A counterfactual growth rate of 0.998, indicating an impact of 0.2%, is considered insignificant and within the natural fluctuations of a population (Table 3.8).

Table 3.8: Growth rates of simulated populations under different impact scenarios for the 25 to 40 years post-construction projections for kittiwake at Lambay Island SPA

Projection year	Years since impact	Additional adult mortalities	Mean growth rate	2.5 percentile of simulated growth rate	97.5 percentile of simulated growth rate	Mean CPGR	Mean CPS	Reduction in growth rate (%)
2050	25	0	0.999	0.966	1.031	-	-	-
		11.87	0.997	0.964	1.028	0.998	0.947	0.2
2055	30	0	0.999	0.97	1.027	-	-	-
		11.87	0.997	0.967	1.025	0.998	0.937	0.2
2060	35	0	0.999	0.971	1.025	-	-	-
		11.87	0.997	0.969	1.023	0.998	0.927	0.2
2065	40	0	0.999	0.972	1.023	-	-	-
		11.87	0.997	0.97	1.021	0.998	0.917	0.2

3.5 Gannet

3.5.1 Saltee Island SPA

The counterfactual growth rate for gannet from the Saltee Island SPA was 0.995 after 25 years and then remained at 0.994 across the 30 to 40 year model run with the final impacted population size (after 40 years) approximately 20.2% less than the unimpacted scenario. A counterfactual growth rate of 0.994, indicating an impact of 0.6%, is considered significant and outside the natural fluctuations of a population (Table 3.9).

Table 3.9: Growth rates of simulated populations under different impact scenarios for the 25 to 40 years post-construction projections for gannet at Saltee SPA.

Projection year	Years since impact	Additional adult mortalities	Mean growth rate	2.5 percentile of simulated growth rate	97.5 percentile of simulated growth rate	Mean CPGR	Mean CPS	Reduction in growth rate (%)
2050	25	0	1.012	0.999	1.025	-	-	-
		21.91	1.007	0.993	1.019	0.995	0.867	0.5
2055	30	0	1.012	1.000	1.024	-	-	-
		21.91	1.007	0.994	1.018	0.994	0.843	0.6
2060	35	0	1.012	1.001	1.023	-	-	-
		21.91	1.007	0.995	1.017	0.994	0.82	0.6
2065	40	0	1.012	1.002	1.022	-	-	-
		21.91	1.007	0.996	1.017	0.994	0.798	0.6

3.6 Summary

The results from the PVA indicate that the impacts are likely to not result in significant deviation from the baseline conditions with the mean reduction in growth rate <0.5 % for six of the nine PVAs undertaken. A mean CPGR of 0.995 or a reduction of growth rate <0.5 % are the same metric. This would be considered insignificant magnitude.

The change in growth rate for herring gull at Ireland's Eye SPA and Lambay Island SPA and gannet at Saltee Island SPA is predicted to be marginally >0.5 %.

For herring gull at Ireland's Eye SPA, a counterfactual growth rate of 0.991, indicating an impact of 0.9%, is considered significant and outside the natural fluctuations of a population. This would be considered of low magnitude. Similarly, a counterfactual growth rate of 0.993 at Lambay island SPA for herring gull, indicating an impact of 0.7%, is considered significant and outside the natural fluctuations of a population. This would be considered of low magnitude.

For gannet at Saltee Islands SPA, a counterfactual growth rate of 0.994, indicating an impact of 0.6%, is considered significant and outside the natural fluctuations of a population. This would be considered of low magnitude.

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APPENDIX A.1: SEABIRD PVA PARAMETER LOG

Guillemot Ireland’s Eye SPA

Basic information

Run had reference name “GU_IrelandsEye”
PVA model run type: simplescenarios
Model to use for environmental stochasticity: betagamma.
Model for density dependence: nodd. I
nclude demographic stochasticity in model?: Yes.
Number of simulations: 5,000. Random seed: 0.
Years for burn-in: 5.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Common guillemot.
Region type to use for breeding success data: Global.
Available colony-specific survival rate: National.
Sector to use within breeding success region: Global.
Age at first breeding: 6.
Is there an upper constraint on productivity in the model?: Yes, constrained to 3 per pair.
Number of subpopulations: 1.
Are demographic rates applied separately to each subpopulation?: No.
Units for initial population size: breeding.adults
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 4410 in 2015
Productivity rate per pair: mean: 0.672 , sd: 0.147
Adult survival rate: mean: 0.939 , sd: 0.025
Immatures survival rates:
Age class 0 to 1 - mean: 0.56 , sd: 0.058 , DD: NA
Age class 1 to 2 - mean: 0.792 , sd: 0.152 , DD: NA
Age class 2 to 3 - mean: 0.917 , sd: 0.098 , DD: NA
Age class 3 to 4 - mean: 0.939 , sd: 0.025 , DD: NA
Age class 4 to 5 - mean: 0.939 , sd: 0.025 , DD: NA
Age class 5 to 6 - mean: 0.939 , sd: 0.025 , DD: NA

Impact scenario inputs

Number of impact scenarios: 1.
Are impacts applied separately to each subpopulation?: No
Are impacts of scenarios specified separately for immatures?: No
Are standard errors of impacts available?: No
Should random seeds be matched for impact scenarios?: Yes
Are impacts specified as a relative value or absolute harvest?: relative
Years in which impacts are assumed to begin and end: 2025 to 2065

Impact scenario outputs
Scenario 1
All subpopulations
Impact on productivity rate mean: 0, se: N/A
Impact on adult survival rate mean: 0.002045, se: N/A

Guillemot Lambay Island SPA

Basic information

Run had reference name "GU_LambayIsland"
PVA model run type: simplescenarios
Model to use for environmental stochasticity: betagamma.
Model for density dependence: nodd. I
nclude demographic stochasticity in model?: Yes.
Number of simulations: 5,000. Random seed: 0.
Years for burn-in: 5.
Case study selected: None.

Baseline demographic rates
Species chosen to set initial values: Common guillemot.
Region type to use for breeding success data: Global.
Available colony-specific survival rate: National.
Sector to use within breeding success region: Global.
Age at first breeding: 6.
Is there an upper constraint on productivity in the model?: Yes, constrained to 3 per pair.
Number of subpopulations: 1.
Are demographic rates applied separately to each subpopulation?: No.
Units for initial population size: breeding.adults
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1
Initial population values: Initial population 59983 in 2015
Productivity rate per pair: mean: 0.672 , sd: 0.147
Adult survival rate: mean: 0.939 , sd: 0.025
Immatures survival rates:
Age class 0 to 1 - mean: 0.56 , sd: 0.058 , DD: NA
Age class 1 to 2 - mean: 0.792 , sd: 0.152 , DD: NA
Age class 2 to 3 - mean: 0.917 , sd: 0.098 , DD: NA
Age class 3 to 4 - mean: 0.939 , sd: 0.025 , DD: NA
Age class 4 to 5 - mean: 0.939 , sd: 0.025 , DD: NA
Age class 5 to 6 - mean: 0.939 , sd: 0.025 , DD: NA

Impact scenario inputs
Number of impact scenarios: 1.
Are impacts applied separately to each subpopulation?: No
Are impacts of scenarios specified separately for immatures?: No
Are standard errors of impacts available?: No
Should random seeds be matched for impact scenarios?: Yes
Are impacts specified as a relative value or absolute harvest?: relative
Years in which impacts are assumed to begin and end: 2025 to 2065

Impact scenario outputs

Scenario 1

All subpopulations

Impact on productivity rate mean: 0, se: N/A

Impact on adult survival rate mean: 0.001893, se: N/A

Razorbill Ireland’s Eye SPA

Basic information

Run had reference name “RA_IrelandsEye”

PVA model run type: simplescenarios

Model to use for environmental stochasticity: betagamma.

Model for density dependence: nodd. I

nclude demographic stochasticity in model?: Yes.

Number of simulations: 5,000. Random seed: 0.

Years for burn-in: 0.

Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Razorbill.

Region type to use for breeding success data: Global.

Available colony-specific survival rate: National.

Sector to use within breeding success region: Global.

Age at first breeding: 5.

Is there an upper constraint on productivity in the model?: Yes, constrained to 3 per pair.

Number of subpopulations: 1.

Are demographic rates applied separately to each subpopulation?: No.

Units for initial population size: breeding.adults

Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 1600 in 2015

Productivity rate per pair: mean: 0.57 , sd: 0.247

Adult survival rate: mean: 0.895 , sd: 0.067

Immatures survival rates:

Age class 0 to 1 - mean: 0.794 , sd: 0.209 , DD: NA

Age class 1 to 2 - mean: 0.794 , sd: 0.209 , DD: NA

Age class 2 to 3 - mean: 0.895 , sd: 0.067 , DD: NA

Age class 3 to 4 - mean: 0.895 , sd: 0.067 , DD: NA

Age class 4 to 5 - mean: 0.895 , sd: 0.067 , DD: NA

Impact scenario inputs

Number of impact scenarios: 1.

Are impacts applied separately to each subpopulation?: No

Are impacts of scenarios specified separately for immatures?: No

Are standard errors of impacts available?: No

Should random seeds be matched for impact scenarios?: Yes

Are impacts specified as a relative value or absolute harvest?: relative

Years in which impacts are assumed to begin and end: 2025 to 2065

Impact scenario outputs
Scenario 1
All subpopulations
Impact on productivity rate mean: 0, se: N/A
Impact on adult survival rate mean: 0.002819, se: N/A

Herring Gull Ireland's Eye SPA

Basic information
Run had reference name "Herring Gull Ireland's Eye SPA"
PVA model run type: simplescenarios
Model to use for environmental stochasticity: betagamma.
Model for density dependence: nodd. I
nclude demographic stochasticity in model?: Yes.
Number of simulations: 5,000. Random seed: 0.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates
Species chosen to set initial values: Herring Gull.
Region type to use for breeding success data: Global.
Available colony-specific survival rate: National.
Sector to use within breeding success region: Global.
Age at first breeding: 5.
Is there an upper constraint on productivity in the model?: Yes, constrained to 3 per pair.
Number of subpopulations: 1.
Are demographic rates applied separately to each subpopulation?: No.
Units for initial population size: breeding.adults
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1
Initial population values: Initial population 636 in 2015
Productivity rate per pair: mean: 0.615 , sd: 0.476
Adult survival rate: mean: 0.834 , sd: 0.079
Immatures survival rates:
Age class 0 to 1 - mean: 0.794 , sd: 0.079 , DD: NA
Age class 1 to 2 - mean: 0.834 , sd: 0.079 , DD: NA
Age class 2 to 3 - mean: 0.834 , sd: 0.079 , DD: NA
Age class 3 to 4 - mean: 0.834 , sd: 0.079 , DD: NA
Age class 4 to 5 - mean: 0.834 , sd: 0.079 , DD: NA

Impact scenario inputs
Number of impact scenarios: 1.
Are impacts applied separately to each subpopulation?: No
Are impacts of scenarios specified separately for immatures?: No
Are standard errors of impacts available?: No
Should random seeds be matched for impact scenarios?: No
Are impacts specified as a relative value or absolute harvest?: relative
Years in which impacts are assumed to begin and end: 2025 to 2065

Impact scenario outputs
Scenario 1
All subpopulations
Impact on productivity rate mean: 0, se: N/A
Impact on adult survival rate mean: 0.007356, se: N/A

Herring Gull Lambay Island SPA

Basic information
Run had reference name “Herring Gull Lambay Island SPA”
PVA model run type: simplescenarios
Model to use for environmental stochasticity: betagamma.
Model for density dependence: nodd.
Include demographic stochasticity in model?: Yes.
Number of simulations: 5,000. Random seed: 0.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates
Species chosen to set initial values: Herring Gull.
Region type to use for breeding success data: Global.
Available colony-specific survival rate: National.
Sector to use within breeding success region: Global.
Age at first breeding: 5.
Is there an upper constraint on productivity in the model?: Yes, constrained to 3 per pair.
Number of subpopulations: 1.
Are demographic rates applied separately to each subpopulation?: No.
Units for initial population size: breeding.adults
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1
Initial population values: Initial population 1812 in 2015
Productivity rate per pair: mean: 0.615 , sd: 0.476
Adult survival rate: mean: 0.834 , sd: 0.079
Immatures survival rates:
Age class 0 to 1 - mean: 0.794 , sd: 0.079 , DD: NA
Age class 1 to 2 - mean: 0.834 , sd: 0.079 , DD: NA
Age class 2 to 3 - mean: 0.834 , sd: 0.079 , DD: NA
Age class 3 to 4 - mean: 0.834 , sd: 0.079 , DD: NA
Age class 4 to 5 - mean: 0.834 , sd: 0.079 , DD: NA

Impact scenario inputs
Number of impact scenarios: 1.
Are impacts applied separately to each subpopulation?: No
Are impacts of scenarios specified separately for immatures?: No
Are standard errors of impacts available?: No
Should random seeds be matched for impact scenarios?: No
Are impacts specified as a relative value or absolute harvest?: relative
Years in which impacts are assumed to begin and end: 2025 to 2065

Impact scenario outputs
Scenario 1
All subpopulations
Impact on productivity rate mean: 0, se: N/A
Impact on adult survival rate mean: 0.005502, se: N/A

Kittiwake Howth Head Coast SPA

Basic information
This run had reference name “Kitti_Howth”.
PVA model run type: simplescenarios.
Model to use for environmental stochasticity: betagamma.
Model for density dependence: nodd.
Include demographic stochasticity in model?: Yes.
Number of simulations: 5000.
Random seed: 0.
Years for burn-in: 5.
Case study selected: None.

Baseline demographic rates
Species chosen to set initial values: Black-Legged Kittiwake.
Region type to use for breeding success data: Global.
Available colony-specific survival rate: National. Sector to use within breeding success region: Global.
Age at first breeding: 4.
Is there an upper constraint on productivity in the model?: Yes, constrained to 2 per pair.
Number of subpopulations: 1.
Are demographic rates applied separately to each subpopulation?: No.
Units for initial population size: breeding.adults
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1
Initial population values: Initial population 3546 in 2015
Productivity rate per pair: mean: 0.604 , sd: 0.326
Adult survival rate: mean: 0.854 , sd: 0.077
Immatures survival rates:
Age class 0 to 1 - mean: 0.79 , sd: 0.077 , DD: NA
Age class 1 to 2 - mean: 0.854 , sd: 0.077 , DD: NA
Age class 2 to 3 - mean: 0.854 , sd: 0.077 , DD: NA
Age class 3 to 4 - mean: 0.854 , sd: 0.077 , DD: NA

Impacts
Number of impact scenarios: 1.
Are impacts applied separately to each subpopulation?: No
Are impacts of scenarios specified separately for immatures?: No
Are standard errors of impacts available?: No
Should random seeds be matched for impact scenarios?: No
Are impacts specified as a relative value or absolute harvest?: relative
Years in which impacts are assumed to begin and end: 2025 to 2065

Impact on Demographic Rates
Scenario A - Name:
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.002155 , se: NA

Kittiwake Ireland's Eye SPA

Basic information
This run had reference name "Kitti_Ireland".
PVA model run type: simplescenarios.
Model to use for environmental stochasticity: betagamma.
Model for density dependence: nodd.
Include demographic stochasticity in model?: Yes.
Number of simulations: 5000.
Random seed: 0.
Years for burn-in: 5.
Case study selected: None.

Baseline demographic rates
Species chosen to set initial values: Black-Legged Kittiwake.
Region type to use for breeding success data: Global.
Available colony-specific survival rate: National. Sector to use within breeding success region: Global.
Age at first breeding: 4.
Is there an upper constraint on productivity in the model?: Yes, constrained to 2 per pair.
Number of subpopulations: 1.
Are demographic rates applied separately to each subpopulation?: No.
Units for initial population size: breeding.adults
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1
Initial population values: Initial population 910 in 2015
Productivity rate per pair: mean: 0.604 , sd: 0.326
Adult survival rate: mean: 0.854 , sd: 0.077
Immatures survival rates:
Age class 0 to 1 - mean: 0.79 , sd: 0.077 , DD: NA
Age class 1 to 2 - mean: 0.854 , sd: 0.077 , DD: NA
Age class 2 to 3 - mean: 0.854 , sd: 0.077 , DD: NA
Age class 3 to 4 - mean: 0.854 , sd: 0.077 , DD: NA

Impacts
Number of impact scenarios: 1.
Are impacts applied separately to each subpopulation?: No
Are impacts of scenarios specified separately for immatures?: No
Are standard errors of impacts available?: No
Should random seeds be matched for impact scenarios?: No
Are impacts specified as a relative value or absolute harvest?: relative
Years in which impacts are assumed to begin and end: 2025 to 2065

Impact on Demographic Rates
Scenario A - Name:
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.002552 , se: NA

Kittiwake Lambay Island SPA

Basic information
This run had reference name "Kitti_Lambay".
PVA model run type: simplescenarios.
Model to use for environmental stochasticity: betagamma.
Model for density dependence: nodd.
Include demographic stochasticity in model?: Yes.
Number of simulations: 5000.
Random seed: 0.
Years for burn-in: 5.
Case study selected: None.

Baseline demographic rates
Species chosen to set initial values: Black-Legged Kittiwake.
Region type to use for breeding success data: Global.
Available colony-specific survival rate: National. Sector to use within breeding success region: Global.
Age at first breeding: 4.
Is there an upper constraint on productivity in the model?: Yes, constrained to 2 per pair.
Number of subpopulations: 1.
Are demographic rates applied separately to each subpopulation?: No.
Units for initial population size: breeding.adults
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1
Initial population values: Initial population 6640 in 2015
Productivity rate per pair: mean: 0.604 , sd: 0.326
Adult survival rate: mean: 0.854 , sd: 0.077
Immatures survival rates:
Age class 0 to 1 - mean: 0.79 , sd: 0.077 , DD: NA
Age class 1 to 2 - mean: 0.854 , sd: 0.077 , DD: NA
Age class 2 to 3 - mean: 0.854 , sd: 0.077 , DD: NA
Age class 3 to 4 - mean: 0.854 , sd: 0.077 , DD: NA

Impacts
Number of impact scenarios: 1.
Are impacts applied separately to each subpopulation?: No
Are impacts of scenarios specified separately for immatures?: No
Are standard errors of impacts available?: No
Should random seeds be matched for impact scenarios?: No
Are impacts specified as a relative value or absolute harvest?: relative
Years in which impacts are assumed to begin and end: 2025 to 2065

Impact on Demographic Rates

Scenario A - Name:
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.001787 , se: NA

Gannet Salteee Island SPA

Basic information

Run had reference name "GX_SalteeIsland"
PVA model run type: simplescenarios
Model to use for environmental stochasticity: betagamma.
Model for density dependence: nodd. I
nclude demographic stochasticity in model?: Yes.
Number of simulations: 5,000. Random seed: 0.
Years for burn-in: 5.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Gannet.
Region type to use for breeding success data: Global.
Available colony-specific survival rate: National.
Sector to use within breeding success region: Global.
Age at first breeding: 5.
Is there an upper constraint on productivity in the model?: Yes, constrained to 3 per pair.
Number of subpopulations: 1.
Are demographic rates applied separately to each subpopulation?: No.
Units for initial population size: breeding.adults
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 4722 in 2013
Productivity rate per pair: mean: 0.766 , sd: 0.051
Adult survival rate: mean: 0.919 , sd: 0.042
Immatures survival rates:
Age class 0 to 1 - mean: 0.424 , sd: 0.045 , DD: NA
Age class 1 to 2 - mean: 0.829 , sd: 0.026 , DD: NA
Age class 2 to 3 - mean: 0.891 , sd: 0.019 , DD: NA
Age class 3 to 4 - mean: 0.895 , sd: 0.019 , DD: NA
Age class 4 to 5 - mean: 0.919 , sd: 0.042 , DD: NA

Impact scenario inputs

Number of impact scenarios: 1.
Are impacts applied separately to each subpopulation?: No
Are impacts of scenarios specified separately for immatures?: No
Are standard errors of impacts available?: No
Should random seeds be matched for impact scenarios?: Yes
Are impacts specified as a relative value or absolute harvest?: relative
Years in which impacts are assumed to begin and end: 2025 to 2065

Impact scenario outputs

Scenario 1

All subpopulations

Impact on productivity rate mean: 0, se: N/A

Impact on adult survival rate mean: 0.004641, se: N/A

ANNEX 9: MIGRATORY COLLISION RISK MODELLING: PHASE ONE PROJECTS CUMULATIVE ASSESSMENT

North Irish Sea Array Windfarm Ltd

Offshore Ornithology Migratory Collision Risk Modelling: Irish East Coast Phase One Offshore Wind Projects Cumulative Assessment

Irish East Coast Phase One Offshore Wind Projects

Confidentiality

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Revision	Date	Status	Author:	Checked by:	Approved by:
1.0	December 2025	Draft 1	JS/RI	SS/JM	CC
3.0	December 2025	Draft 4	JS/MR	JM/MT/ES	CC
FINAL	December 2025	Draft 5	JS/MR	JM/MT/WH	CC

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Acronyms

Term	Definition
ABP	An Bord Pleanála
AR	Avoidance rates
CRM	Collision risk modelling
EIA	Environmental impact assessment
EIAR	Environmental impact assessment report
GIS	Geographical information system
JNCC	Joint Nature Conservation Committee
km	Kilometre
NPWS	National Parks and Wildlife Service
OWF	Offshore wind farm
RFI	Request for further information
RWE	RWE Renewables Ireland Ltd (a wholly owned subsidiary of RWE AG)
SD	Standard deviation
SPA	Special Protection Area
UK	United Kingdom
WTG	Wind turbine generator
ZOI	Zone of Influence

1 Introduction

1.1 Project Background

1.1.1 This document has been prepared by GoBe Consultants Limited (GoBe) on behalf of North Irish Sea Array Limited (NISA Ltd) to address specific concerns raised through submissions in response to the Irish East Coast Phase One Offshore Wind Projects planning applications. The two overarching issues raised in submissions, which this report aims to address are:

(1) differences in Developer approaches to a migratory collision risk assessment; and

(2) the absence of a cumulative assessment.

1.1.2 Other requests within submissions, for example, the request for further monitoring etc., are not addressed within this report.

1.1.3 There are five Irish East Coast Phase One Offshore Wind Projects, which have submitted planning applications, these include Oriel Windfarm (hereafter 'Oriel'), North Irish Sea Array (hereafter 'NISA'), Dublin Array (hereafter 'Dublin'), Codling Wind Park (hereafter 'Codling'), and Arklow Bank Wind Park 2 (hereafter 'Arklow'). The locations of these projects are presented in Figure 1 and each have been included within the assessments contained within this report.

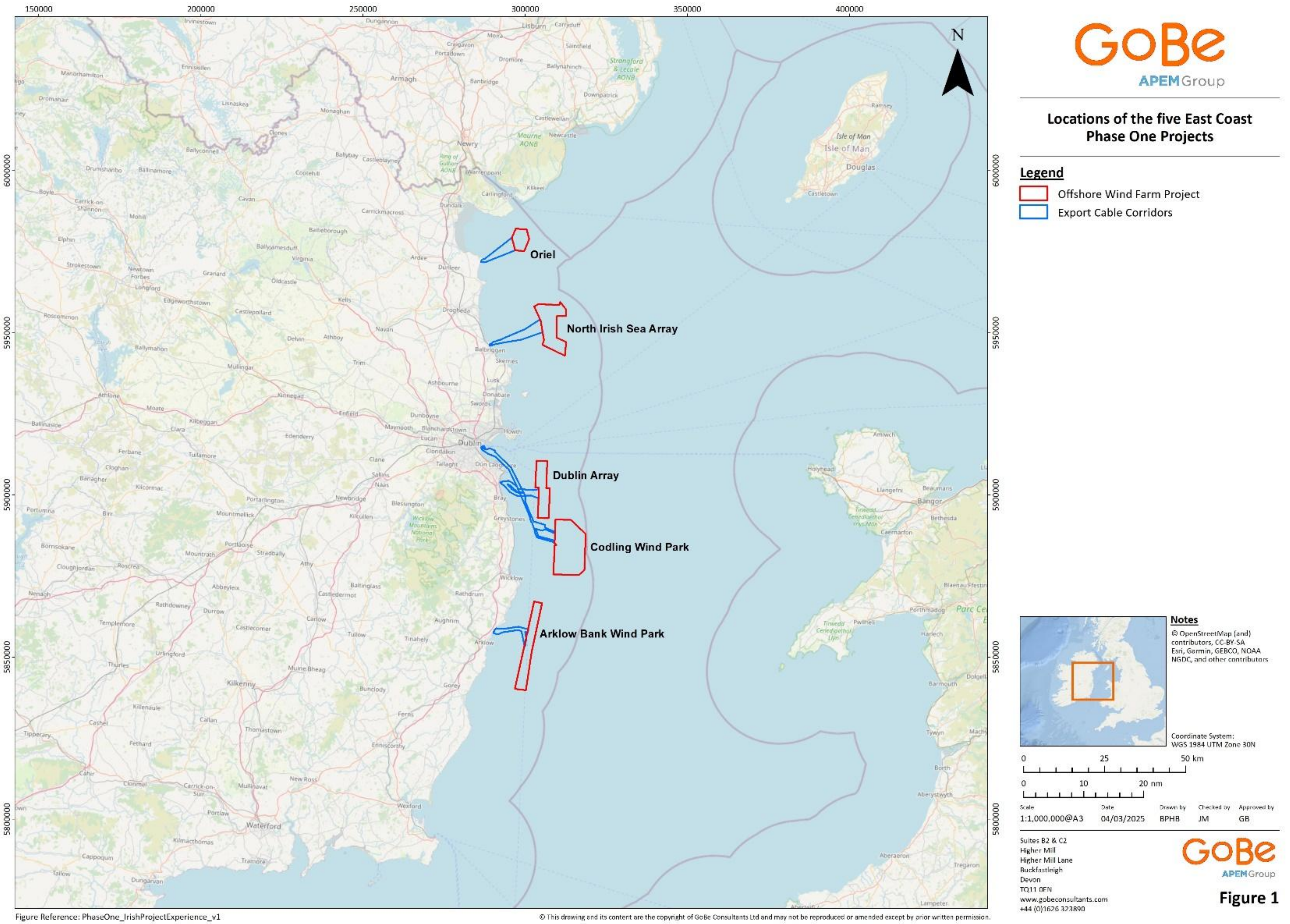


Figure 1. Locations of the Irish East Coast Phase One Offshore Wind Projects.

1.2 Migratory Collision Risk Modelling

1.2.1 This technical appendix has been prepared to support the Request for Further Information (RFI), from An Bord Pleanála (ABP). It examines the potential project-specific and cumulative impacts of all Irish East Coast Phase One Offshore Wind Projects on migratory bird species. These migratory species are often not recorded in site-specific monthly surveys due to their movements occurring over short periods that may be missed by snap-shot survey methods, and movements may occur at night with limited methods to detect them or during weather conditions that do not allow for any surveys to collect data in (Woodward *et al.*, 2023; Wright *et al.*, 2012).

1.2.2 The Irish Sea experiences significant passage of migratory birds travelling between the United Kingdom (UK), Europe and other distant regions (Stienen *et al.*, 2007). This includes the movements of non-seabird species such as waders, wildfowl, other non-passerines, and passerines and non-passerines. As part of the environmental impact assessment (EIA) process, evaluating the potential impact of collision risk mortality with wind turbine generators (WTGs) is critical. Collision risk modelling (CRM) is used to estimate the level of bird strikes that lead to mortality events for different migratory bird species. The resultant mortality rates can then be used to estimate the impact on particular species in relation to their overall populations at varying levels from specific assemblages of interest to wider regional, national and international populations.

1.2.3 To model the movements of migratory birds within the proposed development areas, a modified version of the Marine Scotland Avian Migration Collision Risk Model Shiny Application, hereafter referred to as the mCRM tool (HiDef Aerial Surveying Ltd., 2024), was employed. Throughout this report, 'mCRM tool' refers specifically to the software application, whereas 'migratory CRM' refers to the collision risk modelling methodology.

1.2.4 This Marine Scotland mCRM tool is a stochastic adaption of the Band (2012) migration collision risk worksheet that allows for a precautionary way to quantify impacts to migratory species by making several assumptions about flight paths and species avoidance rates (AR). The mCRM tool generates robust population estimates, of birds passing through the array area, using a bootstrapping technique which randomly samples 1,000 potential flight lines. These flight lines are generated from 10,000 random lines that comprise a birds' potential migration pathway to and from Ireland. Furthermore, the default AR values set within the mCRM tool are used for each species. These values have been checked by an ornithological expert (Cook per comms, 2023) and closely align with NatureScot guidance which is based on several literature sources that incorporate collision data from all suitable terrestrial, coastal and marine offshore wind farms.

1.2.5 The mCRM tool is not suitable for modelling all bird species, particularly those that do not follow point-to-point migration patterns (Newton, 2023). Some species, such as seabirds, adopt longer routes that follow coastlines instead of direct overland paths. This analysis focused solely on migratory birds that tend to migrate over land and are considered within the mCRM tool for the evaluation of potential Phase One project-specific and cumulative impacts.

1.3 Bespoke mCRM tool

1.3.1 A bespoke version of the mCRM tool was developed in order to tailor the flight lines within the tool to suit an Irish assessment, which in turn allowed known Irish populations to be used as model inputs. The alternative, i.e. maintaining the UK-centric flightlines would necessitate the allocation of an arbitrary proportion of the UK population to the Irish Sea, in addition to the Irish population. It was considered that a more appropriate and accurate assessment could be carried out through the use of the Irish populations alone (where these are available).

1.3.2 The modified version of the tool provides an assessment using Irish populations and uses an Ireland-centric version of the model where flight lines converge on Ireland (rather than the UK) (Figure 2). The rationale for this approach is that by adapting the model to focus on flights into and out of Ireland, Irish population estimates can be used to inform the model. This provides a potentially more realistic presentation of the volume of passage over Irish waters and the populations of the birds involved.

1.3.3 A key benefit of this approach therefore is that an estimate of the UK population overflying Irish waters may not be necessary. Birds moving from the UK to Ireland are very likely to be recorded in Ireland and therefore included within the Irish population estimates that underpin these assessments. Movement of birds between the two countries is therefore already accounted for.

1.3.4 For migratory species that rely on terrestrial, estuarine or inshore habitats (such as the species considered by the mCRM tool), it is considered highly unlikely that birds would undertake long, indirect sea crossings that brought them close to an abundance of suitable habitat on the Irish east coast without utilising these habitats. The Irish coastline adjacent to the Irish East Coast Phase One Offshore Wind Projects hosts a number of special protection areas (SPAs) that are estuaries or wetlands designated for passage populations of many of the species considered herein, demonstrating that these species utilise Irish SPAs (and therefore contribute to the Irish population) while migrating. Finally, given that the Phase One developments are positioned relatively close inshore to the Irish east coast means that the likelihood of UK birds passing through these development areas, but without contributing to the Irish population, is very small.

2 Species selection and screening process

2.1 Screening methodology

2.1.1 All species that are presented in the latest version of the mCRM tool (v1.0.0) were considered for assessment within this technical appendix. The modified tool uses robust migratory routes updated from Wright *et al.* (2012) and Woodward *et al.* (2023). Species were then screened out based upon the likelihood that there would be connectivity between migratory populations and the Irish East Coast Phase One Offshore Wind Projects. Where species have been screened out, justifications have been presented in section 2.2. Likelihood of connectivity has been based upon the species population and distribution in Ireland, the location of the Phase One developments, and data presented within the BTO Migration Atlas (which covers movements of Irish birds and movements from Great Britain to Ireland) and The Eurasian African Bird Migration Atlas https://migrationatlas.org/.

2.1.2 Seabird species, for which CRM can be informed by site-specific survey data are also screened out.

2.2 Screening results

2.2.1 The migratory species considered for CRM analysis, with regards to potential Phase One project-specific and cumulative impacts, are presented in (Table 1). The scientific names for each bird species are presented in Appendix A. Justifications for species that have been screened out are presented in section 2.2.3 to 2.2.29.

Table 1: Species considered for migratory CRM assessment.

Migratory Species		
Bar-tailed godwit	Black-tailed godwit (islandica)	Canadian light-bellied brent goose
Common scoter	Corncrake	Curlew
Dunlin	Eider	Golden plover
Goldeneye	Great crested grebe	Great northern diver
Greenland white-fronted goose	Greenshank	Grey plover
Hen harrier	Knot	Lapwing
Long-tailed duck	Mallard	Merlin
Oystercatcher	Pintail	Pochard
Purple sandpiper	Red-breasted merganser	Redshank
Red-throated diver	Ringed plover	Ruff
Sanderling	Scaup	Shelduck
Short-eared owl	Shoveler	Slavonian grebe
Snipe	Teal	Tufted duck
Turnstone	Whimbrel	Whooper swan
Wigeon		

Species screened out of assessment

2.2.2 The following species or taxa can be assessed using the mCRM tool but have not been considered further due to a lack of connectivity.

Avocet

2.2.3 Maps from the latest Bird Atlas (Balmer et al., 2013) show no breeding birds and one wintering record in Ireland. The species is not common enough in Ireland as a non-breeding species to have been covered by Burke et al (2018). The Migration Atlas (Wernham et al.,2002) shows no ring recoveries in Ireland from the UK. The Eurasian African Bird Migration Atlas (accessed November 2025) Shows no movement of UK (or any other) avocet into Ireland and all movements relating to UK birds appear to avoid Ireland and Irish waters. As such, avocet has been screened out of this assessment due to its scarcity in Ireland meaning that connectivity is unlikely.

Bewick's swan

2.2.4 This species has traditionally wintered in Ireland in relatively large numbers, for example in 1984, the wintering population was 1,224 birds. Since then the species has declined rapidly, with 101 counted during the 2010 International Swan Census (ISC) and 21 during the 2015 ISC (Burke et al., 2021). During the winter of 2024/25, no birds were reported in Ireland (Birdguides 2025), and to date no birds have been reported during the winter of 2025/26. Declines in Bewick's swan are considered highly unlikely to recover given the flyway level population declines, and that an increasing proportion of the western European wintering population is short stopping due to milder continental winters (Burke et al., 2021). Given the likelihood that future occurrences of Bewick's swan in Ireland are likely to represent overshooting or vagrancy, rather than a genuine, recurring, non-breeding population and that there is no guarantee that any birds will occur within the existing Irish SPA for this species, this species has been screened out of this assessment.

Black-throated diver

2.2.5 The black-throated diver is a rare visitor to Ireland during the non-breeding season and it was deemed uncommon enough not to be treated in Burke et al., 2018. Irish WeBS data suggest that fewer than 12 birds occur per year, with many of these wintering on the west coast, and thus unlikely to interact with the Phase One developments. As such, this species has been screened out of this assessment.

European white-fronted goose

2.2.6 This taxon is a sufficiently rare visitor to Ireland that Burke et al. (2018) did not estimate a non-breeding population, and it does not feature on BirdWatch Ireland's 'List of Ireland's Birds'. Balmer et al., (2013) shows only two wintering locations in Ireland for the period of 2007 to 2011, which may only refer to two individual records. With this taxon only wintering in the UK in relatively small numbers (2,400 birds, Musgrove et al., 2011) and so few making it as far west as Ireland, this taxon has been screened out of the assessment.

Pink-footed goose

2.2.7 This species is a rare winter visitor to Ireland (Balmer et al., 2013) and Burke et al., (2018) consider it sufficiently uncommon to not estimate an Irish population. Birdwatch Irelands list the species as a scarce winter visitor. As such, this species is unlikely to interact with the Phase One developments and has therefore been screened out of the assessment.

Nightjar

2.2.8 The nightjar is an extremely rare breeding bird in Ireland, with birds on territory at only two sites and breeding at only one site during dedicated survey work in 2024 (Irish Rare Bird Breeding Panel (IRBBP), 2024). Movements informed by ringing and tracking, presented in Wernham et al., (2002) and The Eurasian African Bird Migration Atlas suggest that migration is predominantly north to south. As such, with so few birds potentially crossing the Irish Sea, this species has been screened out of the assessment.

Dotterel

2.2.9 This species does not breed in Ireland (Balmer et al., 2013) and there is just one ringing recovery, of a bird controlled in Russia. Irish Birding (2025) lists 143 observations since 2007 of birds passing through while on spring or autumn migration. Even if the potential for some of these records to relate to multiple reports of long staying birds is not considered, dotterel records in Ireland average approximately eight records per year. As such, it is considered that the potential for interaction between this species and the Phase One developments is very low. Therefore, this species has been screened out of the assessment.

Red-necked phalarope

2.2.10 This species is an extremely rare breeding bird in Ireland, with no confirmed breeding records during the most recent breeding atlas period (2007 – 2011, Balmer et al., 2013). The IRBBP lists it as a rare breeder occasionally nesting in the west of Ireland. The species is also a very rare breeder in the UK, mostly confined to the Outer Hebrides and Shetland (Balmer et al., 2013). Birds breeding in Shetland have been tracked migrating west across the Atlantic (towards tropical Pacific wintering grounds) rather than heading south (van Bemellen et al., 2019). As such, the potential for birds to move between the UK and Ireland or to migrate through the Irish Sea is considered to be extremely low, and therefore this species is screened out of this assessment.

White-tailed eagle

2.2.11 This species was recently re-introduced to Ireland and is listed as a rare resident breeder (although it is not covered by the IRBPP to date). The scarcity of this species in Ireland, coupled with tracking data that show that birds crossing the Irish Sea is infrequent (and has not occurred within the area covered by the Phase One developments) suggest that the likelihood of interaction between this species and the Phase One projects is very low. As such this species has been screened out of the assessment.

Honey buzzard

2.2.12 This species does not breed in Ireland (Balmer et al., 2013) and it appears to be extremely uncommon during spring and autumn passage, with just 15 records listed on Irish Birding (2025) since 2008. As such, it is considered that the potential for interaction between this species and the Phase One developments is very low. Therefore, this species has been screened out of the assessment.

Marsh harrier

2.2.13 This species is an irregular and extremely uncommon breeder in Ireland, with just one confirmed breeding record during the most recent Breeding Atlas period (Balmer et al., 2013). The Eurasian African Bird Migration Atlas shows just three recoveries of UK ringed marsh harriers from Ireland, and describes a predominantly NE-SW migration route, both of which suggest that, for a species mainly found in southern England, interaction with the Phase One developments is very unlikely. As such this species has been screened out of this assessment.

Northern gannet

2.2.14 CRM for this species will be based upon site-specific data, and therefore it is not considered in this assessment.

Spotted crake

2.2.15 This species does not breed in Ireland and is an extremely rare breeder in the UK (Balmer et al., 2013). There are no ringing records from Ireland. Irish Birding lists 23 records since 2009, although 11 of these records are likely to relate to the same long staying bird. As such, it can be considered to be a very scarce visitor to Ireland and therefore it has been screened out of this assessment.

Bittern

2.2.16 This species does not breed in Ireland and there were only four non-breeding season records during the latest Breeding Atlas period (2007 to 2011). The Eurasian African Bird Migration Atlas shows just one ringing recovery of a UK bird from Ireland. Irish Birding lists 94 records since 2008, suggesting on average between five and six bittern occur in Ireland each year (although many of the 94 records will not refer to unique birds so the actual level of occurrence is likely to be somewhat below this number). As such, interaction with the Phase One developments is very unlikely, and this species has been screened out of this assessment

Goosander

2.2.17 This is a rare breeding bird in Ireland with fewer than ten breeding pairs. Winter records are more frequent however it is still classed as a rare winter visitor throughout Ireland by Birdwatch Ireland (Birdwatch Ireland 2025). Ringing data presented on The Eurasian African Bird Migration Atlas show that UK birds predominantly make movements towards the east, and as such, it is considered that the potential for interaction with the Phase One developments is very low. Therefore, this species is screened out of this assessment.

Gadwall

2.2.18 This species is a scarce breeding bird in Ireland with approximately 250 breeding pairs (IRBBP 2025). The wintering population is 890 birds (Burke et al., 2018). With a breeding population of 500 birds (and not considering the presence of Irish bred juveniles within the wintering population) it appears that flux of gadwall into Ireland during the non-breeding season happens at a relatively small scale. Ringing data informing the source locations of birds migrating to Ireland, and the locations where recoveries were made in Ireland, suggests that the potential for interaction with the Phase One developments is low. As such this species has been screened out of the assessment.

Greenland barnacle goose

2.2.19 This taxon does not breed in Ireland. During the winter Greenland barnacle geese winter in small numbers on Irelands west coast, with very few records of any barnacle geese on the Irish Sea coast of Ireland (Balmer et al., 2013). As such, it is considered that the potential for interaction with the Phase One developments is very low. Therefore, this taxon is screened out of this assessment.

Svalbard light-bellied brent goose

2.2.20 This taxon in not known to occur in Ireland, with the non-breeding population centred around Lindisfarne, in Northumberland. As such, it is considered that the potential for interaction with the Phase One developments is very low. Therefore, this taxon is screened out of this assessment.

Dark-bellied brent goose

2.2.21 This taxon is a rare winter visitor to Ireland, with the non-breeding population centred around the south and east coasts of England. As such, it is considered that the potential for interaction with the Phase One developments is very low. Therefore, this taxon is screened out of this assessment.

Icelandic greylag goose

2.2.22 There appears to be little difference between the breeding and non-breeding populations of greylag goose in Ireland, in terms of size and distribution. As such, the majority of Irelands greylag geese in the non-breeding season should be considered resident feral birds rather than migrants from Iceland. A census of greylag geese between 2017 and 2020 (Burke et al., 2022) counted a maximum of just 670 Icelandic greylag geese using coastal sites on the Irish Sea coast (2018 data). With a small population arriving from the north-west, and limited scope for birds to journey offshore (e.g. birds have not been recorded on Lambay Island since 2008 (Burke et al., 2022)) it is considered that the potential for interaction with the Phase One developments is very low. As such this taxon is screened out of this assessment.

Stone curlew

2.2.23 This species does not breed in Ireland and Irish Birding lists just nine records since 2009. As such, with fewer than one record per year in Ireland, potential for interaction with the Phase One developments is very low. As such this taxon is screened out of this assessment.

Velvet scoter

2.2.24 This species is listed as a rare winter visitor to Ireland by Birdwatch Ireland with less than ten records annually across the whole of Ireland (Birdwatch Ireland 2025). Balmer et al., (2013) present very few records from Irish Sea coasts during the most recent atlas period (2007 – 2011). As such it is considered that potential for interaction with the Phase One developments is very low, and therefore velvet scoter is screened out of this assessment.

Bean Goose

2.2.25 Bean geese of either taxon (tundra bean goose and taiga bean goose) are rare winter visitors to Ireland, with most records referring to the tundra bean goose (Irish Birding 2025). Balmer et al., 2013 presented just three records for the atlas period 2007 to 2011, and Ennis et al, (2021) describe both taxa as less than annual. As such it is considered that potential for interaction with the Phase One developments is very low, and therefore both taxa of bean geese are screened out of this assessment.

Montagu's harrier

2.2.26 Montagu's harrier does not breed in Ireland and there were no breeding season records during the most recent atlas period (2007 to 2011). Given the recent declines in this species in the UK, with breeding now less than annual, and the species rarity in Ireland, interaction with the Phase One developments is considered highly unlikely. As such the Montagu's harrier is screened out of this assessment.

Osprey

2.2.27 This species does not breed in Ireland and occurs solely as a scarce passage migrant. As raptors tend to avoid long sea crossings, it is considered that the potential for interaction with the Phase One developments is very low. As such this species has been screened out of the assessment.

Svalbard barnacle goose

2.2.28 Barnacle geese from the Svalbard breeding population winter almost exclusively on the Solway, in the UK. As such, interaction with the Phase One developments is highly unlikely. For this reason, this taxon has been screened out of this assessment.

Wood sandpiper

2.2.29 This species does not breed in Ireland and occurs solely as a scarce passage migrant. Irish WeBS data suggest that fewer than ten birds occur per year. As such, interaction with the Phase One developments is highly unlikely. For this reason, this species has been screened out of this assessment.

3 Migratory CRM

3.1 Migratory CRM methodology

3.1.1 There is potential for migratory birds to be subjected to collision risk mortalities whilst on seasonal migrations through the Irish Phase One project array areas. The potential mortality rates can be estimated using CRM. The modified version of the mCRM tool (HiDef Aerial Surveying Ltd., 2024[1]), was used to undertake migratory collision risk modelling.

3.1.2 The migratory CRM was accessed through the mCRM tool's graphical interface, which is user-friendly and available via a standard web browser or within the R programming environment (R Core Team, 2021). The tool uses R code to estimate migratory collision risks (Donovan, 2018). For this assessment, the latest version of the mCRM tool (v1.0.1) at the time was downloaded and run locally within R (v4.3.3). The bespoke modifications to the tool (i.e. the converging of flight lines onto Ireland rather than the UK) were made locally within the R environment. This is a different version of the tool than that used by Phase One Projects in their submission. Previous mCRM estimates were calculated in an unmodified version of the tool and did not use the same reference populations as those presented herein. Therefore, the estimated number of birds passing through the array, and subsequent collisions, presented within this report differ to those within the application.

3.1.3 One key advantage of the mCRM tool over the Band (2012) model is its ability to provide a clear and transparent audit trail for all modelling runs. This ensures that regulators and other stakeholders can readily access and reproduce the results of any modelling scenario, enhancing transparency and accountability.

3.1.4 The mCRM tool provides two main functions to estimate collision risk mortality:

- The creation of population estimates for bird species moving through selected offshore wind farms (OWFs) by sampling migratory pathways via straight lines drawn between Ireland, the UK and European countries of interest; and
- The implementation of a stochastic version of the migratory CRM (Band, 2012) based on generated population estimates, OWF and WTG parameters and species-specific information (e.g. wingspan and avoidance rate).

3.2 Migratory CRM inputs

Turbine parameters

3.2.1 A geographical information system (GIS) shapefile of the Phase One OWF footprints was added to the mCRM tool. The OWF and WTG parameters used in the migratory CRM are presented in Table 2 and Table 3. These values are based on the worst-case scenario with regards to bird collisions from the project options. A 'Large Array Correction' factor was applied to the migratory CRM.

[1] Accessed via https://blackbawks.shinyapps.io/mCRM/ [Last accessed January 2025].

Table 2: Project WTG parameters used for the migratory CRM assessment.

Parameter	Arklow	Dublin	Codling	NISA	Oriel
Latitude (deg)	52.81	53.23	53.10	53.70	54.06
Mean array width (km)	18.87	8.98	9.60	8.18	5.05
Percentage of upwind flights (%)	50	50	50	50	50
Number of turbines	56	45	75	49	25
Number of blades	3	3	3	3	3
Rotor radius (m)	118	125	125	125	118
Blade width (m)	6.8	9.0	7.0	7.0	7.0
Average Rotation speed (rpm)	5.73 (SD 0.00)	4.70 (SD 0.00)	6.80 (SD 1.25)	8.30 (SD 1.45)	8.10 (SD 0.30)
Average Blade pitch (deg)	10.00 (SD 0.00)	2.40 (SD 0.00)	6.74 (SD 5.04)	5.60 (SD 0.50)	10.00 (SD 0.00)

Table 3: Project predicted mean wind availability and downtime for cumulative CRM scenario.

Project	Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Arklow	Wind availability (%)	95.8	99.4	95.9	92.1	90.6	91.6	86.3	91.8	93.1	98	95.9	96.9
	Mean downtime (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dublin	Wind availability (%)	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0
	Mean downtime (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Codling	Wind availability (%)	89.4	89.8	86.5	83.6	82.5	81.5	81.1	82.7	85.3	88.7	89.5	90.6
	Mean downtime (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NISA	Wind availability (%)	95.7	95.7	95.7	95.7	95.7	93	93	93	95.7	95.7	95.7	95.7
	Mean downtime (%)	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3
Oriel	Wind availability (%)	95.0	96.0	95.0	93.0	92.0	90.0	90.0	90.0	93.0	95.0	95.0	95.0
	Mean downtime (%)	1.0	1.0	2.0	1.0	2.0	2.0	3.0	4.0	4.0	3.0	1.0	1.0

Bird parameters

Migration periods and population size

3.2.2 The defined pre-breeding and post-breeding migration seasons that are default within the mCRM tool, and which were used for migratory CRM, are presented in Table 4.

3.2.3 The populations used in the mCRM tool are primarily drawn from Burke et al. (2018). The Irish populations were considered the most appropriate for this assessment because the Phase One developments are located relatively close inshore to Ireland, within the Irish Sea. It is highly unlikely that significant migration through the development area would involve birds other than those contributing to the Irish population.

3.2.4 Although it is not possible to completely rule out the presence of individual UK-origin birds during migration periods, the likelihood of a significant proportion of UK populations occurring within the Zone of Influence (ZOI) is considered very low. This conclusion is based on species-specific migration patterns and the absence of evidence for regular or substantial cross-border movements into the assessment area during relevant seasons. Where movements between the UK and Ireland do occur, those birds are already accounted for within the Irish population definitions. Consequently, UK populations have not been included in this assessment. This approach aligns with the requirements of the EIA Directive and EPA guidelines, which stipulate that population-level assessments should focus on the relevant national population (in this case, the Irish population) because transboundary contributions that are negligible do not materially affect significance determinations. Furthermore, this methodology is consistent with standard practice in Irish environmental impact assessment reports (EIARs), where only populations with a demonstrable ecological or conservation relevance to the project area are considered for impact evaluation.

3.2.5 Where a species does not have a population defined by Burke et al., (2018), populations have been sourced from Irish Wetland Bird Survey data, or from species specific bespoke monitoring (for example for hen harrier and corncrake).

3.2.6 For the remaining species for which an Irish population could not be derived (merlin, snipe and short-eared owl) the approach adopted by Codling has been implemented (Codling Wind Park Limited, 2024). This approach defines a precautionary proportion of the UK population which may pass through Irish waters and uses this to inform the migratory CRM. In the case of the three species, 50% of the UK population was used.

3.2.7 The final populations being considered within the assessment are presented in Table 4.

Table 4: Defined migration seasons, and considered populations, used within migratory CRM.

Species	Pre-breeding migration	Post-breeding migration	Other migration period	Migratory Irish population
Bar-tailed godwit	Mar - Apr	Jul - Oct	NA	16,530
Black-tailed godwit	Mar - May	Jun - Oct	NA	19,800
Canadian light-bellied brent goose	Mar - May	Aug - Oct	NA	35,150
Corncrake	Apr - May	Jul - Aug	NA	436[2]
Common scoter	Apr - May	Jun - Oct	NA	7,500
Curlew	Mar - May	Jun - Oct	NA	35,240
Dunlin	Mar - May	Jun - Oct	NA	45,760
Eider	Mar - Apr	Oct - Nov	NA	5,660
Golden plover	Feb - May	Jul - Oct	NA	92,060
Goldeneye	Feb - May	Aug - Dec	NA	3,820
Great crested grebe	Mar - Jun	Jul - Nov	Feb - Mar	2,930
Great-northern diver	Dec - Jun	Aug - Nov	NA	2,240
Greenland white-fronted goose	Mar - Apr	Sep - Nov	NA	9,590
Greenshank	Mar - Jun	Aug - Nov	NA	1,320
Grey plover	Mar - May	Jul - Sep	NA	2,940
Hen harrier	Mar - May	Sep - Nov	NA	222[3]
Knot	Feb - May	Jun - Oct	NA	16,270
Lapwing	Jan - May	Oct - Nov	NA	84,690
Long-tailed duck	Mar - May	Sep - Oct	NA	38[4]
Mallard	Apr - Jun	Sep - Oct	Jan - Mar	28,230
Merlin	Mar - May	Aug - Nov	NA	4,128[5]
Oystercatcher	Jan - Mar	Jul - Nov	NA	60,540
Pintail	Mar - May	Aug - Nov	NA	1,570
Pochard	Mar - May	Aug - Nov	NA	11,150
Purple sandpiper	Mar - May	Jul - Nov	NA	660
Red-breasted merganser	Apr - Jul	Aug - Nov	NA	2,430
Redshank	Mar - May	Jul - Sep	NA	23,800

[2] BirdWatchIreland: https://birdwatchireland.ie/corncrake-population-update/

[3] The 2022 National Survey of breeding Hen Harrier in Ireland: https://www.npws.ie/sites/default/files/publications/pdf/IWM147.pdf

[4] Irish Wetland Bird Survey data

[5] Codling approach

Species	Pre-breeding migration	Post-breeding migration	Other migration period	Migratory Irish population
Red-throated diver	Feb – Jun	Jul - Sep	NA	770
Ringed plover	Mar - May	Aug - Oct	NA	11,660
Ruff	Mar - May	Jul - Nov	NA	39[4]
Sanderling	Apr - Jun	Jul - Oct	NA	8,420
Scaup	Feb - May	Sep - Nov	NA	2,485
Shelduck	Jan - Feb	Jun - Jul	Aug - Dec	10,160
Short-eared owl	Mar - May	Jul - Oct	NA	7,440[5]
Shoveler	Mar - Jun	Jul - Aug	Sep - Dec	2,240
Slavonian grebe	Feb - Apr	Aug - Oct	NA	42[4]
Snipe	Mar - May	Aug - Oct	Oct - Dec	3,052,500[5]
Teal	Feb - May	Jul - Dec	NA	35,740
Tufted duck	Apr - Jun	Sep - Oct	NA	27,470
Turnstone	Jan - Jun	Jul - Aug	NA	9,480
Whimbrel	Apr - Jun	Jun - Oct	NA	53[4]
Whooper swan	Feb - Apr	Sep - Nov	NA	15,370
Wigeon	Mar - Apr	Aug - Nov	NA	55,730

Species-specific biometric parameters

3.2.8 The species-specific biometric input parameters used in the migratory CRM are presented in Table 5. The parameters are preloaded using the mCRM tool, which collates biometric information. The biometrics for all species (body length and wingspan) are derived from recently updated biometric data sources (BTO, 2023). Each flight type was set as "flapping".

3.2.9 Species-specific flight speeds used in the migratory CRM assessment are presented in Table 5. Flight speeds presented within the mCRM tool are defined by Aonghais Cook (pers. comms, 2023) and- closely match those presented in Woodward et al. (2023).

3.2.10 AR are a key parameter in the migratory CRM, they take into consideration that birds will undertake avoidance behaviour in response to the presence of an OWF to prevent collision (Ozsanlav-Harris *et al.*, 2023). This can occur at three scales: micro-avoidance (avoiding individual turbine blades); meso-avoidance (avoiding whole WTGs, not just the rotor-swept area) and macro-avoidance (avoiding the whole OWF array area) (Cook *et al.*, 2014). This adjustment is required since baseline survey data are collected before WTGs are present. The AR used in migratory CRM for each species, presented in Table 5, are set in the mCRM tool as recommended by NatureScot and checked by Aonghais Cook (pers. comms, 2023). The AR used in the tool closely match the most recent evidence available (Woodward *et al.,* 2023) (see Appendix B for a comparison).

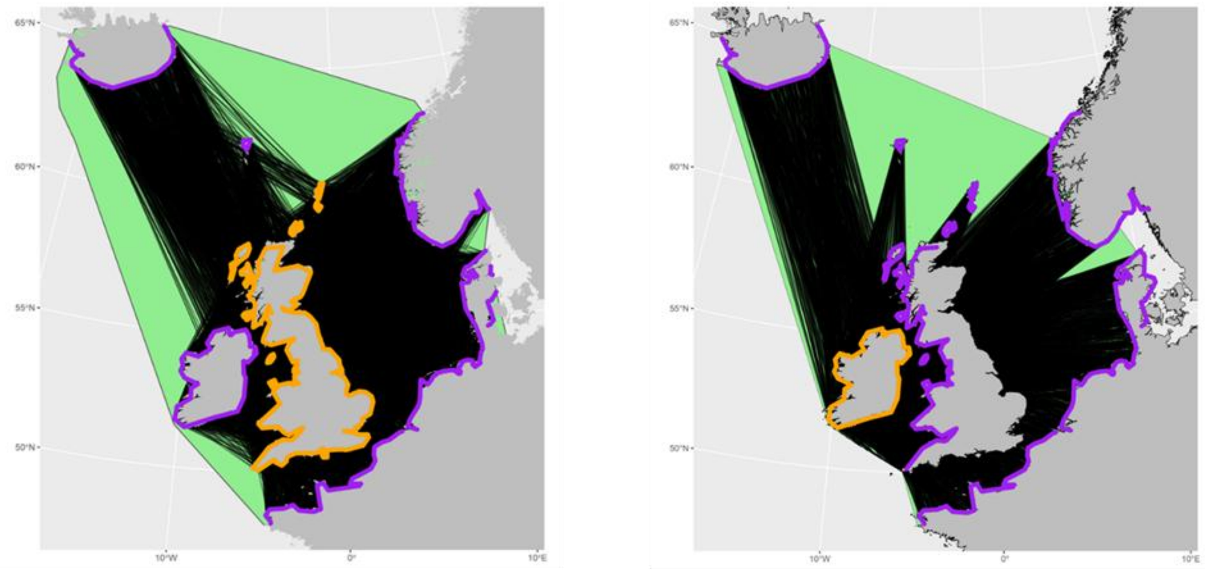
Table 5: Species biometrics used in the mCRM tool.

Species	Body length (m)	Body length SD (m)	Wingspan (m)	Wingspan SD (m)	Flight speed (ms^{-1})	Flight speed SD (ms^{-1})	Proportion at PCH	Avoidance Rate	Avoidance Rate SD
Bar-tailed godwit	0.38	0.02	0.75	0.02	18.3	2.1	1	0.999	0
Black-tailed godwit	0.42	0.02	0.76	0.02	18.1	6.0	1	0.999	0
Canadian light-bellied brent goose	0.58	0.02	1.15	0.02	17.9	6.1	0.5	0.999	0.0001
Corncrake	0.28	0.02	0.50	0.02	13.0	2.0	1	0.995	0.00001
Common scoter	0.49	0.03	0.84	0.03	22.1	4.0	1	0.985	0.0008
Curlew	0.55	0.02	0.90	0.02	15.4	3.3	1	0.999	0
Dunlin	0.18	0.01	0.40	0.01	15.3	1.9	1	0.999	0
Eider	0.60	0.03	0.94	0.03	17.3	2.4	0.25	0.985	0.0008
Golden plover	0.28	0.01	0.72	0.01	16.5	1.8	1	0.999	0
Goldeneye	0.46	0.01	0.72	0.01	20.3	3.8	1	0.985	0.0008
Great crested grebe	0.48	0.02	0.88	0.02	21.1	1.6	1	0.995	0.00001
Great northern diver	0.80	0.02	1.37	0.02	19.5	1.6	0.25	0.995	0.00001
Greenland white-fronted goose	0.72	0.06	1.48	0.06	18.8	7.2	1	0.999	0.0001
Greenshank	0.32	0.01	0.69	0.01	12.3	3.3	1	0.999	0
Grey plover	0.28	0.01	0.77	0.01	16.5	1.8	1	0.999	0
Hen harrier	0.48	0.02	1.10	0.02	11.4	1.1	1	0.995	0.0001
Knot	0.24	0.01	0.59	0.01	24.6	3.3	1	0.999	0
Lapwing	0.30	0.01	0.84	0.01	12.8	1.3	1	0.999	0
Long-tailed duck	0.44	0.01	0.76	0.01	19.7	1.7	1	0.985	0.0008
Mallard	0.58	0.02	0.90	0.02	15.9	2.0	1	0.985	0.0008
Merlin	0.28	0.02	0.56	0.02	12.7	5.8	1	0.989	0.0003
Oystercatcher	0.42	0.02	0.83	0.02	13.0	2.5	1	0.999	0
Pintail	0.58	0.02	0.88	0.02	21.9	2.0	1	0.985	0.0008
Pochard	0.46	0.01	0.77	0.01	23.6	2.0	1	0.985	0.0008
Purple sandpiper	0.21	0.01	0.44	0.01	15.3	1.9	1	0.999	0
Red-breasted merganser	0.55	0.01	0.78	0.01	22.0	2.9	1	0.985	0.0008
Redshank	0.28	0.01	0.62	0.01	15.3	4.1	1	0.999	0

Species	Body length (m)	Body length SD (m)	Wingspan (m)	Wingspan SD (m)	Flight speed (ms^{-1})	Flight speed SD (ms^{-1})	Proportion at PCH	Avoidance Rate	Avoidance Rate SD
Red-throated diver	0.61	0.02	1.11	0.02	18.6	3.9	0.25	0.995	0.00001
Ringed plover	0.19	0.01	0.52	0.01	16.0	1.1	1	0.999	0
Ruff	0.25	0.01	0.53	0.01	16.9	1.8	1	0.999	0
Sanderling	0.20	0.01	0.42	0.01	21.4	1.1	1	0.999	0
Scaup	0.46	0.01	0.78	0.01	21.1	2.0	1	0.985	0.0008
Shelduck	0.62	0.02	1.12	0.02	18.2	4.3	0.5	0.985	0.0008
Short-eared owl	0.38	0.02	1.02	0.02	9.7	2.0	1	0.995	0.0001
Shoveler	0.48	0.02	0.77	0.02	18.3	2.0	1	0.985	0.0008
Slavonian grebe	0.34	0.02	0.62	0.02	21.1	1.6	1	0.995	0.00001
Snipe	0.26	0.01	0.46	0.01	17.1	2.7	1	0.999	0
Teal	0.36	0.02	0.61	0.02	17.4	1.6	1	0.985	0.0008
Tufted duck	0.44	0.01	0.70	0.01	21.1	1.1	1	0.985	0.0008
Turnstone	0.23	0.01	0.54	0.01	10.0	3.3	1	0.999	0
Whimbrel	0.41	0.02	0.82	0.02	13.8	0.4	1	0.999	0
Whooper swan	1.52	0.04	2.30	0.04	17.5	4.2	0.5	0.988	0.0009
Wigeon	0.48	0.02	0.80	0.02	18.5	2.0	1	0.985	0.0008

Migratory pathways

3.2.11 The default mCRM tool (v1.01) generates migratory pathways between UK and non-UK points within a species-specific migratory corridor (Marine Scotland Science, 2025). In order to create a more representative approach to compliment the use of Irish-specific migratory populations, the default tool was modified to generate pathways between Ireland and non-Ireland points (including the UK). Points on the east coast of the UK were excluded to avoid double-counting migration from the UK to Ireland via both the east and west coasts. A visual comparison of the two approaches is provided below (Figure 2). All other aspects of the methodology were left unchanged.



A B

Figure 2. A comparison of the default mCRM tool (A) and Irish-specific (B) migratory pathways.

4 Migratory CRM results

4.1.1 This section presents the outputs from the migratory CRM analysis for all migratory species present within the mCRM tool. A summary of results on a Phase One project-specific (Table 6) and cumulative (Table 7) level. Within the summary of cumulative migratory CRM impacts, the Irish proportion of the assessed combined population has also been provided for reference.

Table 6: Summary of Phase One project-specific annual collision estimates with standard deviation included.

Species	Arklow			Dublin			Codling			NISA			Oriel		
	Pre-breeding migration	Post-breeding migration	Other migration period	Pre-breeding migration	Post-breeding migration	Other migration period	Pre-breeding migration	Post-breeding migration	Other migration period	Pre-breeding migration	Post-breeding migration	Other migration period	Pre-breeding migration	Post-breeding migration	Other migration period
Bar-tailed godwit	0.019 ± 0.002	0.019 ± 0.002	0.000 ± 0.000	0.037 ± 0.004	0.037 ± 0.004	0.000 ± 0.000	0.037 ± 0.004	0.037 ± 0.004	0.000 ± 0.000	0.025 ± 0.004	0.024 ± 0.003	0.000 ± 0.000	0.007 ± 0.001	0.007 ± 0.001	0.000 ± 0.000
Black-tailed godwit	0.018 ± 0.003	0.017 ± 0.003	0.000 ± 0.000	0.030 ± 0.004	0.030 ± 0.004	0.000 ± 0.000	0.031 ± 0.007	0.031 ± 0.007	0.000 ± 0.000	0.034 ± 0.007	0.033 ± 0.007	0.000 ± 0.000	0.012 ± 0.004	0.011 ± 0.004	0.000 ± 0.000
Canadian light-bellied brent goose	0.015 ± 0.006	0.016 ± 0.006	0.000 ± 0.000	0.026 ± 0.006	0.026 ± 0.006	0.000 ± 0.000	0.034 ± 0.013	0.034 ± 0.013	0.000 ± 0.000	0.031 ± 0.013	0.030 ± 0.013	0.000 ± 0.000	0.013 ± 0.006	0.013 ± 0.006	0.000 ± 0.000
Corncrake	0.002 ± 0.000	0.002 ± 0.000	0.000 ± 0.000	0.004 ± 0.000	0.004 ± 0.000	0.000 ± 0.000	0.005 ± 0.001	0.005 ± 0.001	0.000 ± 0.000	0.004 ± 0.001	0.004 ± 0.001	0.000 ± 0.000	0.002 ± 0.000	0.002 ± 0.000	0.000 ± 0.000
Common scoter	0.112 ± 0.013	0.113 ± 0.013	0.000 ± 0.000	0.186 ± 0.023	0.186 ± 0.023	0.000 ± 0.000	0.189 ± 0.028	0.191 ± 0.028	0.000 ± 0.000	0.000 ± 0.000	0.191 ± 0.027	0.000 ± 0.000	0.064 ± 0.013	0.064 ± 0.013	0.000 ± 0.000
Curlew	0.043 ± 0.005	0.043 ± 0.005	0.000 ± 0.000	0.069 ± 0.007	0.069 ± 0.007	0.000 ± 0.000	0.065 ± 0.011	0.065 ± 0.011	0.000 ± 0.000	0.075 ± 0.011	0.074 ± 0.011	0.000 ± 0.000	0.027 ± 0.005	0.026 ± 0.005	0.000 ± 0.000
Dunlin	0.039 ± 0.004	0.038 ± 0.004	0.000 ± 0.000	0.069 ± 0.008	0.069 ± 0.008	0.000 ± 0.000	0.070 ± 0.009	0.070 ± 0.009	0.000 ± 0.000	0.070 ± 0.009	0.069 ± 0.009	0.000 ± 0.000	0.024 ± 0.005	0.023 ± 0.005	0.000 ± 0.000
Eider	0.025 ± 0.003	0.026 ± 0.003	0.000 ± 0.000	0.042 ± 0.005	0.042 ± 0.005	0.000 ± 0.000	0.044 ± 0.006	0.046 ± 0.007	0.000 ± 0.000	0.049 ± 0.007	0.049 ± 0.007	0.000 ± 0.000	0.016 ± 0.003	0.017 ± 0.003	0.000 ± 0.000
Golden plover	0.09 ± 0.010	0.088 ± 0.009	0.000 ± 0.000	0.147 ± 0.018	0.147 ± 0.018	0.000 ± 0.000	0.167 ± 0.023	0.164 ± 0.022	0.000 ± 0.000	0.133 ± 0.017	0.131 ± 0.017	0.000 ± 0.000	0.045 ± 0.010	0.044 ± 0.010	0.000 ± 0.000
Goldeneye	0.058 ± 0.007	0.058 ± 0.007	0.000 ± 0.000	0.103 ± 0.012	0.103 ± 0.012	0.000 ± 0.000	0.108 ± 0.014	0.110 ± 0.015	0.000 ± 0.000	0.110 ± 0.014	0.110 ± 0.014	0.000 ± 0.000	0.042 ± 0.007	0.041 ± 0.007	0.000 ± 0.000
Great crested grebe	0.020 ± 0.002	0.020 ± 0.002	0.021 ± 0.002	0.032 ± 0.003	0.032 ± 0.003	0.032 ± 0.003	0.033 ± 0.004	0.034 ± 0.004	0.035 ± 0.004	0.033 ± 0.004	0.032 ± 0.004	0.033 ± 0.004	0.013 ± 0.002	0.013 ± 0.002	0.013 ± 0.002
Great-northern diver	0.003 ± 0.000	0.003 ± 0.000	0.000 ± 0.000	0.005 ± 0.001	0.005 ± 0.001	0.000 ± 0.000	0.006 ± 0.001	0.006 ± 0.001	0.000 ± 0.000	0.005 ± 0.001	0.005 ± 0.001	0.000 ± 0.000	0.002 ± 0.000	0.002 ± 0.000	0.000 ± 0.000
Greenland white-fronted goose	0.003 ± 0.002	0.003 ± 0.002	0.000 ± 0.000	0.012 ± 0.005	0.012 ± 0.005	0.000 ± 0.000	0.008 ± 0.005	0.008 ± 0.005	0.000 ± 0.000	0.018 ± 0.011	0.018 ± 0.011	0.000 ± 0.000	0.010 ± 0.007	0.010 ± 0.007	0.000 ± 0.000
Greenshank	0.001 ± 0.000	0.002 ± 0.000	0.000 ± 0.000	0.002 ± 0.000	0.002 ± 0.000	0.000 ± 0.000	0.002 ± 0.001	0.003 ± 0.001	0.000 ± 0.000	0.003 ± 0.001	0.003 ± 0.001	0.000 ± 0.000	0.001 ± 0.000	0.001 ± 0.000	0.000 ± 0.000

Species	Arklow			Dublin			Codling			NISA			Oriel		
	Pre-breeding migration	Post-breeding migration	Other migration period	Pre-breeding migration	Post-breeding migration	Other migration period	Pre-breeding migration	Post-breeding migration	Other migration period	Pre-breeding migration	Post-breeding migration	Other migration period	Pre-breeding migration	Post-breeding migration	Other migration period
Grey plover	0.003 ± 0.000	0.003 ± 0.000	0.000 ± 0.000	0.005 ± 0.001	0.005 ± 0.001	0.000 ± 0.000	0.005 ± 0.001	0.005 ± 0.001	0.000 ± 0.000	0.006 ± 0.001	0.005 ± 0.001	0.000 ± 0.000	0.002 ± 0.000	0.002 ± 0.000	0.000 ± 0.000
Hen harrier	0.001 ± 0.000	0.002 ± 0.000	0.000 ± 0.000	0.002 ± 0.001	0.002 ± 0.001	0.000 ± 0.000	0.003 ± 0.000	0.003 ± 0.000	0.000 ± 0.000	0.003 ± 0.000	0.003 ± 0.000	0.000 ± 0.000	0.001 ± 0.000	0.001 ± 0.000	0.000 ± 0.000
Knot	0.015 ± 0.002	0.014 ± 0.002	0.000 ± 0.000	0.024 ± 0.003	0.024 ± 0.003	0.000 ± 0.000	0.025 ± 0.003	0.025 ± 0.003	0.000 ± 0.000	0.025 ± 0.003	0.025 ± 0.003	0.000 ± 0.000	0.008 ± 0.002	0.008 ± 0.001	0.000 ± 0.000
Lapwing	0.099 ± 0.010	0.101 ± 0.010	0.000 ± 0.000	0.169 ± 0.019	0.169 ± 0.019	0.000 ± 0.000	0.175 ± 0.024	0.181 ± 0.025	0.000 ± 0.000	0.168 ± 0.019	0.168 ± 0.019	0.000 ± 0.000	0.063 ± 0.011	0.063 ± 0.011	0.000 ± 0.000
Long-tailed duck	0.001 ± 0.000	0.001 ± 0.000	0.000 ± 0.000	0.001 ± 0.000	0.001 ± 0.000	0.000 ± 0.000	0.002 ± 0.001	0.002 ± 0.001	0.000 ± 0.000	0.001 ± 0.000	0.001 ± 0.000	0.000 ± 0.000	0.001 ± 0.000	0.001 ± 0.000	0.000 ± 0.000
Mallard	0.517 ± 0.058	0.540 ± 0.060	0.548 ± 0.061	0.784 ± 0.102	0.784 ± 0.102	0.784 ± 0.102	0.864 ± 0.134	0.911 ± 0.141	0.927 ± 0.144	0.893 ± 0.123	0.902 ± 0.124	0.902 ± 0.124	0.358 ± 0.058	0.367 ± 0.059	0.372 ± 0.060
Merlin	0.050 ± 0.054	0.051 ± 0.055	0.000 ± 0.000	0.071 ± 0.063	0.071 ± 0.063	0.000 ± 0.000	0.087 ± 0.097	0.089 ± 0.100	0.000 ± 0.000	0.087 ± 0.098	0.086 ± 0.098	0.000 ± 0.000	0.036 ± 0.036	0.036 ± 0.036	0.000 ± 0.000
Oystercatcher	0.066 ± 0.007	0.064 ± 0.007	0.000 ± 0.000	0.103 ± 0.014	0.103 ± 0.014	0.000 ± 0.000	0.115 ± 0.018	0.111 ± 0.018	0.000 ± 0.000	0.120 ± 0.015	0.119 ± 0.015	0.000 ± 0.000	0.041 ± 0.008	0.040 ± 0.008	0.000 ± 0.000
Pintail	0.025 ± 0.003	0.025 ± 0.003	0.000 ± 0.000	0.039 ± 0.006	0.039 ± 0.006	0.000 ± 0.000	0.042 ± 0.007	0.043 ± 0.007	0.000 ± 0.000	0.042 ± 0.006	0.042 ± 0.006	0.000 ± 0.000	0.015 ± 0.003	0.015 ± 0.003	0.000 ± 0.000
Pochard	0.263 ± 0.024	0.269 ± 0.024	0.000 ± 0.000	0.467 ± 0.057	0.467 ± 0.057	0.000 ± 0.000	0.554 ± 0.059	0.570 ± 0.060	0.000 ± 0.000	0.393 ± 0.046	0.390 ± 0.046	0.000 ± 0.000	0.140 ± 0.023	0.140 ± 0.023	0.000 ± 0.000
Purple sandpiper	0.001 ± 0.000	0.001 ± 0.000	0.000 ± 0.000	0.001 ± 0.000	0.001 ± 0.000	0.000 ± 0.000	0.001 ± 0.000	0.001 ± 0.000	0.000 ± 0.000	0.001 ± 0.000	0.001 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000
Red-breasted merganser	0.034 ± 0.004	0.036 ± 0.004	0.000 ± 0.000	0.061 ± 0.008	0.061 ± 0.008	0.000 ± 0.000	0.055 ± 0.008	0.058 ± 0.009	0.000 ± 0.000	0.068 ± 0.010	0.069 ± 0.010	0.000 ± 0.000	0.026 ± 0.004	0.026 ± 0.004	0.000 ± 0.000
Redshank	0.021 ± 0.003	0.021 ± 0.003	0.000 ± 0.000	0.037 ± 0.004	0.037 ± 0.004	0.000 ± 0.000	0.042 ± 0.007	0.042 ± 0.007	0.000 ± 0.000	0.041 ± 0.007	0.040 ± 0.007	0.000 ± 0.000	0.015 ± 0.003	0.015 ± 0.003	0.000 ± 0.000
Red-throated diver	0.001 ± 0.000	0.001 ± 0.000	0.000 ± 0.000	0.002 ± 0.000	0.002 ± 0.000	0.000 ± 0.000	0.002 ± 0.000	0.002 ± 0.000	0.000 ± 0.000	0.002 ± 0.000	0.002 ± 0.000	0.000 ± 0.000	0.001 ± 0.000	0.001 ± 0.000	0.000 ± 0.000
Ringed plover	0.010 ± 0.001	0.010 ± 0.001	0.000 ± 0.000	0.017 ± 0.002	0.017 ± 0.002	0.000 ± 0.000	0.018 ± 0.002	0.018 ± 0.002	0.000 ± 0.000	0.017 ± 0.002	0.017 ± 0.002	0.000 ± 0.000	0.006 ± 0.001	0.006 ± 0.001	0.000 ± 0.000
Ruff	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000

Species	Arklow			Dublin			Codling			NISA			Oriel		
	Pre-breeding migration	Post-breeding migration	Other migration period	Pre-breeding migration	Post-breeding migration	Other migration period	Pre-breeding migration	Post-breeding migration	Other migration period	Pre-breeding migration	Post-breeding migration	Other migration period	Pre-breeding migration	Post-breeding migration	Other migration period
Sanderling	0.007 ± 0.001	0.007 ± 0.001	0.000 ± 0.000	0.014 ± 0.002	0.014 ± 0.002	0.000 ± 0.000	0.012 ± 0.001	0.013 ± 0.001	0.000 ± 0.000	0.013 ± 0.001	0.013 ± 0.001	0.000 ± 0.000	0.005 ± 0.001	0.005 ± 0.001	0.000 ± 0.000
Scaup	0.035 ± 0.004	0.035 ± 0.004	0.000 ± 0.000	0.050 ± 0.007	0.050 ± 0.007	0.000 ± 0.000	0.053 ± 0.008	0.054 ± 0.009	0.000 ± 0.000	0.066 ± 0.009	0.066 ± 0.009	0.000 ± 0.000	0.022 ± 0.004	0.022 ± 0.004	0.000 ± 0.000
Shelduck	0.087 ± 0.012	0.080 ± 0.011	0.085 ± 0.011	0.132 ± 0.017	0.132 ± 0.017	0.132 ± 0.017	0.161 ± 0.027	0.146 ± 0.024	0.157 ± 0.026	0.145 ± 0.023	0.141 ± 0.022	0.144 ± 0.023	0.054 ± 0.01	0.051 ± 0.010	0.053 ± 0.010
Short-eared owl	0.039 ± 0.006	0.039 ± 0.006	0.000 ± 0.000	0.071 ± 0.009	0.071 ± 0.009	0.000 ± 0.000	0.087 ± 0.016	0.087 ± 0.016	0.000 ± 0.000	0.083 ± 0.013	0.081 ± 0.013	0.000 ± 0.000	0.031 ± 0.007	0.031 ± 0.007	0.000 ± 0.000
Shoveler	0.038 ± 0.004	0.036 ± 0.004	0.039 ± 0.004	0.056 ± 0.007	0.056 ± 0.007	0.056 ± 0.007	0.059 ± 0.009	0.058 ± 0.009	0.063 ± 0.009	0.065 ± 0.008	0.064 ± 0.008	0.066 ± 0.008	0.028 ± 0.004	0.027 ± 0.004	0.029 ± 0.004
Slavonian grebe	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.001 ± 0.000	0.001 ± 0.000	0.000 ± 0.000	0.001 ± 0.000	0.001 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000
Snipe	2.634 ± 0.277	2.675 ± 0.281	2.750 ± 0.289	4.701 ± 0.661	4.701 ± 0.661	4.701 ± 0.661	4.915 ± 0.629	4.995 ± 0.639	5.230 ± 0.669	4.880 ± 0.530	4.834 ± 0.525	4.880 ± 0.530	1.661 ± 0.294	1.649 ± 0.291	1.690 ± 0.299
Teal	0.578 ± 0.064	0.573 ± 0.063	0.000 ± 0.000	1.089 ± 0.125	1.089 ± 0.125	0.000 ± 0.000	1.309 ± 0.153	1.32 ± 0.155	0.000 ± 0.000	1.212 ± 0.135	1.201 ± 0.134	0.000 ± 0.000	0.638 ± 0.079	0.631 ± 0.078	0.000 ± 0.000
Tufted duck	0.372 ± 0.041	0.389 ± 0.043	0.000 ± 0.000	0.628 ± 0.090	0.628 ± 0.090	0.000 ± 0.000	0.638 ± 0.092	0.672 ± 0.097	0.000 ± 0.000	0.685 ± 0.082	0.692 ± 0.082	0.000 ± 0.000	0.238 ± 0.037	0.244 ± 0.038	0.000 ± 0.000
Turnstone	0.011 ± 0.003	0.010 ± 0.003	0.000 ± 0.000	0.015 ± 0.002	0.015 ± 0.002	0.000 ± 0.000	0.017 ± 0.006	0.017 ± 0.006	0.000 ± 0.000	0.018 ± 0.005	0.018 ± 0.005	0.000 ± 0.000	0.007 ± 0.003	0.007 ± 0.003	0.000 ± 0.000
Whimbrel	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000
Whooper swan	0.091 ± 0.018	0.091 ± 0.018	0.000 ± 0.000	0.167 ± 0.030	0.167 ± 0.03	0.000 ± 0.000	0.154 ± 0.039	0.156 ± 0.040	0.000 ± 0.000	0.311 ± 0.07	0.311 ± 0.07	0.000 ± 0.000	0.118 ± 0.027	0.117 ± 0.027	0.000 ± 0.000
Wigeon	0.814 ± 0.099	0.820 ± 0.100	0.000 ± 0.000	1.414 ± 0.181	1.414 ± 0.181	0.000 ± 0.000	1.512 ± 0.216	1.539 ± 0.220	0.000 ± 0.000	1.399 ± 0.216	1.389 ± 0.214	0.000 ± 0.000	0.569 ± 0.094	0.564 ± 0.093	0.000 ± 0.000

Table 7: Summary of Phase One cumulative annual collision estimates with standard deviation included.

Species	Pre-breeding migration	Post-breeding migration	Other migration period	Annual migration
Bar-tailed godwit	0.125 ± 0.007	0.124 ± 0.007	0.000 ± 0.000	0.249 ± 0.010
Black-tailed godwit	0.125 ± 0.012	0.122 ± 0.012	0.000 ± 0.000	0.247 ± 0.017
Canadian light-bellied brent goose	0.119 ± 0.021	0.119 ± 0.021	0.000 ± 0.000	0.238 ± 0.030
Corncrake	0.017 ± 0.001	0.017 ± 0.001	0.000 ± 0.000	0.034 ± 0.002
Common scoter	0.742 ± 0.049	0.741 ± 0.049	0.000 ± 0.000	1.483 ± 0.069
Curlew	0.279 ± 0.018	0.277 ± 0.018	0.000 ± 0.000	0.556 ± 0.026
Dunlin	0.272 ± 0.016	0.269 ± 0.016	0.000 ± 0.000	0.541 ± 0.023
Eider	0.176 ± 0.011	0.180 ± 0.012	0.000 ± 0.000	0.356 ± 0.016
Golden plover	0.582 ± 0.037	0.574 ± 0.036	0.000 ± 0.000	1.156 ± 0.051
Goldeneye	0.421 ± 0.025	0.422 ± 0.026	0.000 ± 0.000	0.843 ± 0.036
Great crested grebe	0.131 ± 0.007	0.131 ± 0.007	0.134 ± 0.007	0.396 ± 0.012
Great northern diver	0.021 ± 0.002	0.021 ± 0.002	0.000 ± 0.000	0.042 ± 0.002
Greenland white-fronted goose	0.051 ± 0.015	0.051 ± 0.015	0.000 ± 0.000	0.102 ± 0.021
Greenshank	0.009 ± 0.001	0.011 ± 0.001	0.000 ± 0.000	0.020 ± 0.002
Grey plover	0.021 ± 0.002	0.020 ± 0.002	0.000 ± 0.000	0.041 ± 0.002
Hen harrier	0.010 ± 0.001	0.011 ± 0.001	0.000 ± 0.000	0.021 ± 0.001
Knot	0.097 ± 0.006	0.096 ± 0.006	0.000 ± 0.000	0.193 ± 0.008
Lapwing	0.674 ± 0.039	0.682 ± 0.040	0.000 ± 0.000	1.356 ± 0.056
Long-tailed duck	0.006 ± 0.001	0.006 ± 0.001	0.000 ± 0.000	0.012 ± 0.001
Mallard	3.416 ± 0.224	3.504 ± 0.230	3.533 ± 0.232	10.453 ± 0.396
Merlin	0.331 ± 0.165	0.333 ± 0.167	0.000 ± 0.000	0.664 ± 0.235
Oystercatcher	0.445 ± 0.029	0.437 ± 0.029	0.000 ± 0.000	0.882 ± 0.041
Pintail	0.163 ± 0.012	0.164 ± 0.012	0.000 ± 0.000	0.327 ± 0.017
Pochard	1.817 ± 0.100	1.836 ± 0.100	0.000 ± 0.000	3.653 ± 0.141
Purple sandpiper	0.004 ± 0.000	0.004 ± 0.000	0.000 ± 0.000	0.008 ± 0.000
Red-breasted merganser	0.244 ± 0.016	0.250 ± 0.017	0.000 ± 0.000	0.494 ± 0.023
Redshank	0.156 ± 0.011	0.155 ± 0.011	0.000 ± 0.000	0.311 ± 0.016
Red-throated diver	0.008 ± 0.000	0.008 ± 0.000	0.000 ± 0.000	0.016 ± 0.000
Ringed plover	0.068 ± 0.004	0.068 ± 0.004	0.000 ± 0.000	0.136 ± 0.005
Ruff	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000
Sanderling	0.051 ± 0.003	0.052 ± 0.003	0.000 ± 0.000	0.103 ± 0.004
Scaup	0.226 ± 0.015	0.227 ± 0.016	0.000 ± 0.000	0.453 ± 0.022

Species	Pre-breeding migration	Post-breeding migration	Other migration period	Annual migration
Shelduck	0.579 ± 0.042	0.550 ± 0.040	0.571 ± 0.041	1.700 ± 0.071
Short-eared owl	0.311 ± 0.024	0.309 ± 0.024	0.000 ± 0.000	0.620 ± 0.034
Shoveler	0.246 ± 0.015	0.241 ± 0.015	0.253 ± 0.015	0.740 ± 0.026
Slavonian grebe	0.002 ± 0.000	0.002 ± 0.000	0.000 ± 0.000	0.004 ± 0.000
Snipe	18.791 ± 1.130	18.854 ± 1.133	19.251 ± 1.157	56.896 ± 1.975
Teal	4.826 ± 0.260	4.814 ± 0.260	0.000 ± 0.000	9.640 ± 0.368
Tufted duck	2.561 ± 0.162	2.625 ± 0.166	0.000 ± 0.000	5.186 ± 0.232
Turnstone	0.068 ± 0.009	0.067 ± 0.009	0.000 ± 0.000	0.135 ± 0.013
Whimbrel	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000
Whooper swan	0.841 ± 0.092	0.842 ± 0.092	0.000 ± 0.000	1.683 ± 0.130
Wigeon	5.708 ± 0.380	5.726 ± 0.382	0.000 ± 0.000	11.434 ± 0.539

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A Species scientific names

Table 8: Scientific names of species considered for migratory CRM assessment.

Species	Scientific name
Bar-tailed godwit	*Limosa lapponica*
Bewick's swan	*Cygnus columbianus*
Black-tailed godwit	*Limosa limosa*
Black-throated diver	*Gavia arctica*
Canadian light-bellied brent goose[6]	*Branta bernicla hrota*
Common scoter	*Melanitta nigra*
Corncrake	*Crex crex*
Curlew	*Numenius arquata*
Dark-bellied brent goose	*Branta bernicla bernicla*
Dunlin	*Calidris alpina*
Eider	*Somateria mollissima*
European white-fronted goose	*Anser erythropus*
Gadwall	*Mareca strepera*
Golden plover	*Pluvialis apricaria*
Goldeneye	*Bucephala clangula*
Great crested grebe	*Podiceps cristatus*
Great northern diver	*Gavia immer*
Greenland white-fronted goose	*Anser albifrons flavirostris*
Greenshank	*Tringa nebularia*
Grey plover	*Pluvialis squatarola*
Hen harrier	*Circus cyaneus*
Knot	*Calidris canutus*
Lapwing	*Vanellus vanellus*
Long-tailed duck	*Clangula hyemalis*
Mallard	*Anas platyrhynchos*
Merlin	*Falco columbarius*
Nightjar	*Caprimulgus europaeus*
Osprey	*Pandion haliaetus*
Oystercatcher	*Haematopus ostralegus*
Pink-footed goose	*Anser brachyrhynchus*
Pintail	*Anas acuta*
Pochard	*Aythya ferina*
Purple sandpiper	*Calidris maritima*
Red-breasted merganser	*Mergus serrator*
Red-necked phalarope	*Phalaropus lobatus*
Redshank	*Tringa totanus*
Red-throated diver	*Gavia stellata*
Ringed plover	*Charadrius hiaticula*
Ruff	*Calidris pugnax*
Sanderling	*Calidris alba*
Scaup	*Aythya marila*
Shelduck	*Tadorna tadorna*

[6] The Canadian light-bellied brent goose is a distinct population which has a unique migratory route.

Species	Scientific name
Short-eared owl	*Asio flammeus*
Shoveler	*Spatula clypeata*
Slavonian grebe	*Podiceps auritus*
Snipe	*Gallinago gallinago*
Teal	*Anas crecca*
Tufted duck	*Aythya fuligula*
Turnstone	*Arenaria interpres*
Whimbrel	*Numenius phaeopus*
White-tailed eagle	*Haliaeetus albicilla*
Whooper swan	*Cygnus cygnus*
Wigeon	*Mareca penelope*
Wood sandpiper	*Tringa glareola*

B Comparison of Avoidance Rates

Table 9: Comparison of avoidance rates used in the mCRM tool and presented in Woodward et al., 2023.

Species	Avoidance rate from model	Avoidance rate from model SD	Avoidance rate from Woodward et al., (2023)	Avoidance rate from Woodward et al., (2023) SD
Bar-tailed godwit	0.999	0	0.9996	0.00002
Black-tailed godwit	0.999	0	0.9996	0.00002
Canadian light-bellied brent goose	0.999	0.0001	0.9998	0.00001
Corncrake	0.995	0.00001	0.9875	0.00174
Common scoter	0.985	0.0008	0.9851	0.00088
Curlew	0.999	0	0.9996	0.00002
Dunlin	0.999	0	0.9996	0.00002
Eider	0.985	0.0008	0.9851	0.00088
Gadwall	0.985	0.0008	0.9851	0.00088
Golden plover	0.999	0	0.9999	0.00004
Goldeneye	0.985	0.0008	0.9851	0.00088
Great crested grebe	0.995	0.00001	0.9954	0.00002
Great northern diver	0.995	0.00001	0.9954	0.00002
Greenland white-fronted goose	0.999	0.0001	0.9998	0.00001
Greenshank	0.999	0	0.9996	0.00002
Grey plover	0.999	0	0.9996	0.00002
Hen harrier	0.995	0.0001	0.9957	0.00006
Knot	0.999	0	0.9996	0.00002
Lapwing	0.999	0	0.9996	0.00002
Long-tailed duck	0.985	0.0008	0.9851	0.00088
Mallard	0.985	0.0008	0.9801	0.00319
Merlin	0.989	0.0003	0.9957	0.00006
Oystercatcher	0.999	0	0.9996	0.00002
Pintail	0.985	0.0008	0.9851	0.00088
Pochard	0.985	0.0008	0.9851	0.00088
Purple sandpiper	0.999	0	0.9996	0.00002
Red-breasted merganser	0.985	0.0008	0.9851	0.00088
Redshank	0.999	0	0.9996	0.00002
Red-throated diver	0.995	0.00001	0.9954	0.00002

Ringed plover	0.999	0	0.9996	0.00002
Ruff	0.999	0	0.9996	0.00002
Sanderling	0.999	0	0.9996	0.00002
Scaup	0.985	0.0008	0.9851	0.00088
Shelduck	0.985	0.0008	0.9851	0.00088
Short-eared owl	0.995	0.0001	0.9957	0.00006
Shoveler	0.985	0.0008	0.9851	0.00088
Slavonian grebe	0.995	0.00001	0.9954	0.00002
Snipe	0.999	0	0.9996	0.00002
Teal	0.985	0.0008	0.9851	0.00088
Tufted duck	0.985	0.0008	0.9851	0.00088
Turnstone	0.999	0	0.9996	0.00002
Whimbrel	0.999	0	0.9996	0.00002
Whooper swan	0.988	0.0009	0.9874	0.00138
Wigeon	0.985	0.0008	0.9851	0.00088

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