

Hornsea Project Four

Key Documents Regarding The Crown Estate Leasing Round 4 Record of the Habitats Regulations Assessment

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15 July 2022

Dear Dan,

The Crown Estate's Fourth Seabed Leasing Round: Habitats Regulation Assessment

I refer to The Crown Estate's letter of 20 April 2022 on the Plan Level Habitats Regulations Assessment for the Fourth Seabed Leasing Round. I am content that The Crown Estate has fulfilled its obligations under regulation 64 of the Habitats Regulations 2017, and regulations 29 and 30 of the Conservation of Offshore Marine Habitats and Species Regulations 2017. I am content that The Crown Estate has appropriately assessed the impacts of the plan on the protected sites within the National Site Network that may be affected and am content for the plan to proceed subject to the condition set out in this letter.

I am satisfied that an appropriate evaluation of alternative solutions has been carried out and we accept that there are no alternative solutions to the preferred options that would have a lesser effect on the integrity of the sites in our National Site Network, whilst meeting our decarbonisation and renewables ambitions under the British Energy Security Strategy (BESS).

There is also a strong case to justify the anticipated damage to sites within the National Site Network on grounds of imperative reasons of overriding public interest, based on the importance of dealing with climate change and meeting our decarbonisation and renewables ambitions, and more recently the need for energy security.

I note that it has been difficult to provide the level of detail necessary to identify all potential impacts and that where this is the case, further assessment has been deferred to the project level HRAs, where further assessment, and consultation will take place with Government, Statutory Nature Conservation Bodies (SNCBs) and environmental NGOs.

I understand that impacts on the Dogger Bank SAC and Flamborough and Filey Coast SPA will be compensated through developing compensation plans for each of the affected sites. However, I note that a lack of certainty on the efficacy and longevity of certain measures was raised by some respondents to The Crown Estate's consultation. I am encouraged that you will be exploring a suite of potential compensation measures to ensure there is the flexibility needed to develop effective compensation. I am also supportive of the steering groups being set up for each

compensation plan, with a condition added to developer's Agreement for Lease (AfL) that agreement of the compensation plan within each steering group is required before submission of DCO applications. I note that both BEIS and Defra will be invited to participate on the steering group for each compensation plan. This is essential so Government understands future compensation needs, potential opportunities and allow us to ensure that the compensation packages can learn from ongoing research programmes such as OWEC (Offshore Wind Evidence and Change Programme) and align with the new policies and arrangements being developed under the British Energy Security Strategy, such as the Offshore Wind Environmental Improvement Programme.

Given the uncertainty in the efficacy and longevity of certain compensation measures, monitoring will be essential to ensure the measures are working, and adaptive monitoring will be required if the initial measures do not work as planned. A condition of my approval is:

- The Terms of Reference for each steering group require the steering group to monitor each measure and the compensation plan as a whole, at intervals that experts within the steering group consider appropriate,
- Require the steering group to put in place adaptive management if necessary,
- Require the steering group to take into account any recommendations from the advisory group, and
- Require the steering group to take into account wider Government policies (such as requirements within the BESS) when monitoring and adapting.

My Department is happy to work with The Crown Estate on the practicalities of undertaking this monitoring review as part of our membership on each steering group.

On the basis of the condition proposed above, I am content that appropriate steps have been taken to ensure that compensatory measures will be in place to offset predicted losses to the Dogger Bank SAC and the Flamborough and Filey Coast SPA. Consequently, I can confirm that BEIS has no objections to The Crown Estate's approval of the Strategy.

Yours sincerely,



RT HON KWASI KWARTENG MP
Secretary of State for Business, Energy & Industrial Strategy



THE CROWN ESTATE

Offshore Wind **Leasing Round 4**

April 2022
38255-TCE-DOC-103

Record of the Habitats Regulations Assessment

Undertaken under Regulation 63 of The Conservation of Habitats and Species Regulations 2017 and Regulation 28 of The Conservation of Offshore Marine Habitats and Species Regulations 2017

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1. Summary of the Conclusions of the Assessment

1.1.1. The Offshore Wind Leasing Round 4 Plan ("the Round 4 Plan") has been considered by The Crown Estate Commissioners ("The Crown Estate") in light of the assessment requirements of Regulation 63 of the Conservation of Habitats and Species Regulations 2017 (as amended) and Regulation 28 of The Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended).

1.1.2. Having carried out a screening assessment of the Plan, The Crown Estate concluded that a likely significant effect ("LSE") could not be discounted for a number of European Sites and European Offshore Marine Sites (together referred to as "European Sites" within the context of the UK's National Site Network) and their qualifying features (NIRAS, 2021) [that is to say, adopting the approach set out in the '*Waddenzee*' ruling of the European Court of Justice Case C – 127/02, it was not possible to exclude, on the basis of objective information, the likelihood of significant effects on those European Sites without reasonable scientific doubt]. Consequently, an Appropriate Assessment ("AA") was required of the implications of the plan for the qualifying features of those sites in view of their conservation objectives.

1.1.3. Following the production of a Report to Inform an Appropriate Assessment ("RIAA") and the completion of an AA in accordance with the Regulations, The Crown Estate has ascertained that an adverse effect on site integrity ("AEOSI") cannot be ruled out on two European Sites as a result of the plan.

1.1.4. Natural England, Natural Resources Wales, the Joint Nature Conservation Committee, Department of Agriculture, Environment and Rural Affairs ("DAERA"), and other selected organisations have been consulted throughout the HRA process, and their submissions taken into account by The Crown Estate.

2. Introduction

2.1. Background

2.1.1. This is a record of the Habitats Regulation Assessment ("HRA") that The Crown Estate has undertaken under the Conservation of Habitats and Species Regulations 2017 (SI No. 2017/1012) ("the Habitats Regulations"), and The Offshore Marine Habitats and Species Regulations 2017 (SI No. 2017/1013) ("the Offshore Habitats Regulations"), in respect of the plan for seabed leasing of the Offshore Wind Leasing Round 4 Plan, referred to as "the Round 4 Plan".

2.1.2. In spring 2020, The Crown Estate initiated a two-stage tender process for the possible award of a minimum of 7GW and maximum of 8.5GW for offshore wind development across four seabed areas within the seas around England and Wales. Six "Preferred Projects" were accepted by The Crown Estate subject to the outcome of the HRA; an Agreement for Lease would secure a location for offshore wind development and represent the adoption of the Round 4 plan and provide security with regards to a lease for the export cable asset subject to project development. Subsequent award of seabed rights would permit offshore wind development as applied for through the tender process, subject to all necessary statutory consents being obtained by the applicant.

2.1.3. This Record of AA contains The Crown Estate's analysis and assessment of the potential impacts of the Round 4 Plan upon European Sites screened into this assessment.

2.1.4. It should be noted that the outcome of this plan does not authorise development; development consent and other key project consents must be obtained for each project in the normal manner under the existing regulatory regime.

2.1.5. For reference, The Crown Estate has also undertaken a Marine Conservation Zone assessment considering the features of sites designated under Part 5 of The Marine and Coastal Access Act 2008 separate to this HRA.

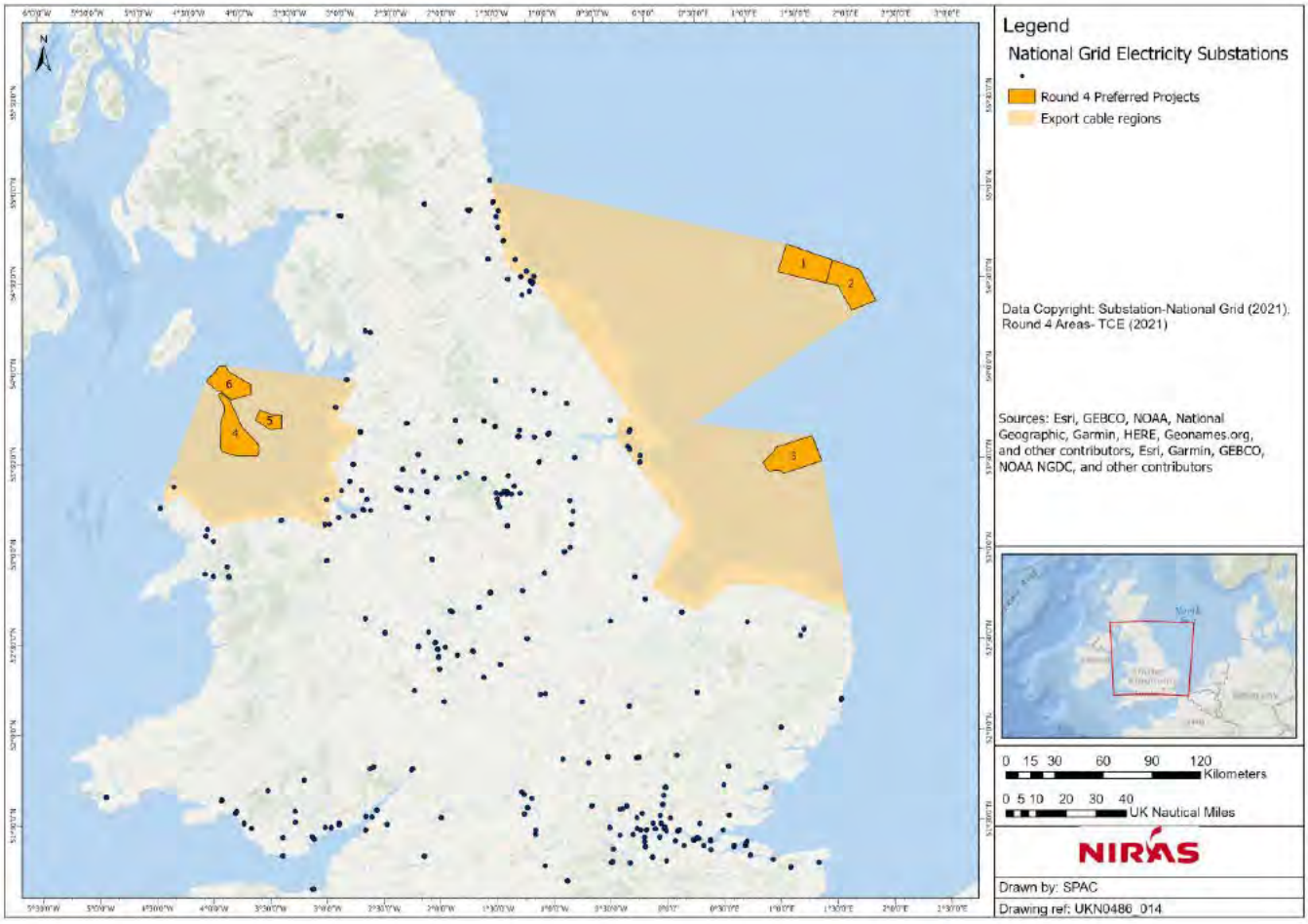


Figure 1 – Location of the Round 4 Plan Preferred Project Areas

2.2. Habitats Regulations Assessment (HRA)

2.2.1. Council Directive 92/43/EC on the conservation of natural habitats and of wild fauna and flora ("the Habitats Directive") and Council Directive 2009/147/EC on the conservation of wild birds ("the Birds Directive") aim to maintain or restore certain species and habitats to a favourable conservation status. Article 6(3) of the Habitats Directive makes specific provisions to protect sites from adverse effects associated with proposed plans and projects.

2.2.2. The Habitats Directive provides for the designation of sites for the protection of habitats and species of European importance, known as Special Areas of Conservation ("SACs"). The Birds Directive provides for the classification of sites for the protection of rare and vulnerable birds and for regularly occurring migratory species, known as Special Protection Areas ("SPAs"). SACs and SPAs, and as a matter of Government Policy

Ramsar Sites (wetlands of international importance designated under the Ramsar Convention 1971) are collectively termed European Sites and form part of a network of European Sites across Europe designated under the Bern Convention 1989 known as the Emerald Network. Prior to the UK's withdrawal from the European Union and subsequent transition period, these sites were part of the European Union's Natura 2000 network of European Sites. They now form part of a National Site Network.

2.2.3. In the UK, the Habitats Regulations transposed the Habitats and Birds Directives into national law as far as the 12nm limit of territorial waters. Beyond territorial waters, the Offshore Habitats Regulations serve the same function for the UK's offshore marine area. Following the UK's withdrawal from the European Union and subsequent transition period The Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019 ensure that the Habitats Regulations continue to operate effectively in the UK. The Round 4 Plan covers areas within and outside the 12nm limit so both sets of Regulations apply. They are collectively referred to as the Habitats Regulations for the purposes of this Record of AA.

2.2.4. Regulation 63 of the Habitats Regulations states that:

> *A competent authority….before deciding to undertake, or give any consent, permission or other authorisation for, a plan or project which (a) is likely to have a significant effect on a European site or a European offshore marine site (either alone or in combination with other plans or projects), and (b) is not directly connected with or necessary to the management of that site, must make an Appropriate Assessment of the implications for that site in view of that site's conservation objectives.*

2.2.5. Regulation 28 of the Offshore Habitats Regulations incorporates the equivalent provision.

2.2.6. The Round 4 Plan is not directly connected with, or necessary to, the management of European Sites. The Habitats Regulations require that, where it appears to The Crown Estate as a competent authority that the Round 4 Plan is likely to have a significant effect on any such European Site, either alone or in combination with other plans and projects, an AA is carried out in order to determine if it is possible to ascertain that it will not adversely affect the integrity of any European Site in view of that site's conservation objectives.

2.2.7. Through a competitive tendering process, The Crown Estate appointed NIRAS as HRA consultant. NIRAS are renowned experts, with a wealth of HRA and technical experience, particularly for the offshore wind sector. NIRAS have undertaken a shadow assessment and provided the information required to enable The Crown Estate to undertake an AA for the Round 4 Plan.

2.2.8. In outline, the approach to the HRA undertaken by The Crown Estate centres around three reports produced as part of the NIRAS shadow assessment:

- **Principles Document –** this sets out the criteria that were used in scoping European Sites into the assessment and the assessment methodology.
- **Screening Report –** this report assesses the potential impact of the plan and screens sites in or out of the AA based on the possibility that the plan will have a LSE on them.
- **Report to Inform Appropriate Assessment (RIAA) –** for those sites screened in, this report assesses the possibility of the plan having an AEOSI.

2.2.9. To inform the HRA, The Crown Estate has undertaken statutory consultation with the relevant UK statutory nature conservation bodies ("SNCBs") and with select government departments and non-departmental public bodies, as well as environmental non-governmental organisations ("NGOs"), which have relevant expertise in

relation to the Round 4 Plan (namely the Royal Society for Protection of Birds ("RSPB"), the Whale and Dolphin Conservation Society, and The Wildlife Trusts).

2.2.10. Natural England, Natural Resources Wales, the Joint Nature Conservation Committee, DAERA, and other selected organisations have therefore been consulted throughout the HRA process. The Crown Estate has given significant weight to the views of the SNCBs.

2.2.11. In accordance with the Habitat Regulations, European Sites comprise: designated Special Areas of Conservation ("SAC"), Sites of Community Importance ("SCI") included on the list of such sites compiled by the European Commission, candidate SAC ("cSAC") submitted to the European Commission for possible inclusion as an SCI, and classified Special Protection Areas ("SPA"). As a matter of Government policy, the following should be given the same protection as European Sites: potential SPA ("pSPA"); possible/proposed SAC ("pSAC"); and listed Ramsar sites. This protection is extended to proposed Ramsar sites in England and Wales (NPPF 2021; PPW, 2021). In England only, sites identified or required as compensatory habitat are also afforded the same protection in policy (NPPF 2021).

2.2.12. The RIAA drafted by NIRAS included non-UK European sites within the assessment, these are:

- Bray Head SPA
- Doggersbank Dutch SAC
- Duinen en Lage Land Texel SPA
- Duinen Vlieland SPA
- Howth Head Coast SPA
- Inishtrahull SPA
- Ireland's Eye SPA
- Klaverbank Dutch SAC
- Lambay Island SPA
- North Inishowen Coast SPA
- Rockabill SPA
- Saltee Islands SPA
- Waddenzee SPA
- Wicklow Head SPA

2.2.13. Of the above SACs, protected for marine mammals, NIRAS (2022) did not identify any significant effects from the Round 4 Plan given the distance from the European Sites and the nearest Preferred Project (over 26km); but on a precautionary basis assumed there was the potential for individual animals ranging from these European Sites to be present and subject to risk of injury or death. NIRAS noted that this risk can reduced to negligible levels by implementation of standard best practice guidance (JNCC, 2010a&b). NIRAS concluded that there is negligible risk from disturbance and that any additional impact from the Round 4 Plan alone would not make an appreciable difference to any in-combination impact for Doggersbank Dutch SAC and Klaverbank Dutch SAC SACs.

2.2.14. The Crown Estate has considered the assessment of Doggersbank Dutch SAC and Klaverbank Dutch SAC carefully and agrees with the conclusions from NIRAS.

2.2.15. Of the above SPAs, NIRAS (2022) did not identify any significant effects from the Round 4 plan. Some features at the above SPAs (Bray Head: guillemot; Howth Head: guillemot; Inishtrahull: kittiwake; Ireland's Eye: guillemot and puffin; Lambay Island: lesser black-backed gull; Wicklow Head: guillemot) were identified as having a relatively high increase in mortality rate; however, the estimated number of mortalities from birds displaced/collisions was considered to be negligible and more likely indistinguishable from background mortality and it was considered that these effects would not undermine the site Conservation Objectives. NIRAS concluded that Round 4 Plan alone is not expected to make an appreciable difference to any in-combination impact for these SPAs.

2.2.16. The Crown Estate has considered the assessment of Bray Head SPA, Duinen en Lage Land Texel SPA, Duinen Vlieland SPA, Howth Head Coast SPA, Inishtrahull SPA, Ireland's Eye SPA, Lambay Island SPA, North Inishowen Coast SPA Rockabill SPA, Saltee Islands SPA, Waddenzee SPA and Wicklow Head SPA carefully and agrees with the conclusions from NIRAS.

2.2.17. The Crown Estate has considered the assessment of transboundary impacts carefully and agrees with the conclusions from NIRAS. To inform The Crown Estate's assessment of these sites the Department of Housing, Local Government and Heritage in Ireland and the Ministry of Infrastructure and the Environment in the Netherlands were contacted. The departments of Ireland and the Netherlands did not raise any concerns in relation to transboundary effects from the Round 4 Plan and implications for the European Sites highlighted above (2.2.12 to 2.2.16). As a result, this AA does not consider these sites further.

2.2.18. In undertaking HRA it is open to a competent authority to consider implementing mitigation measures or amending its plan to avoid or reduce potentially damaging effects on European Sites. As part of the HRA process, the plan-making authority may agree to a plan only if the authority has ascertained that it will not adversely affect the integrity of a European Site. The only exception to this is where there are no alternative solutions and the plan must be carried out for imperative reasons of overriding public interest, in which case the authority must take all necessary compensatory measures.

2.2.19. This Record of AA should be read in conjunction with the following documents:

- NIRAS. 2020. Principles: Offshore Wind Leasing Round 4. Plan Level HRA. 38255_REP_100. Report prepared for The Crown Estate. 28 August 2020.
- NIRAS. 2021. Offshore Wind Leasing Round 4 Plan Level HRA. Screening Report. July 2021.
- NIRAS. 2022. Offshore Wind Leasing Round 4 Plan Level HRA. Report to Inform Appropriate Assessment. March 2022

2.2.20. The key information from these documents and the representations of the SNCBs is summarised and referenced in the subsequent sections of this document.

3. Screening

3.1. The Likely Significant Effects Test

3.1.1. Under Regulation 63 of the Habitats Regulations and Regulation 28 of the Offshore Habitats Regulations, a competent authority must consider whether a plan or project may result in a LSE on a European Site, either alone or in combination with other plans or projects. A LSE is, in this context, any effect that may be reasonably predicted as a consequence of a plan that may undermine the conservation objectives of the features for which the site was designated, but excluding trivial or inconsequential effects. An AA is required if a plan is likely to have a significant effect on a European site, either alone or in combination with other plans or projects.

3.1.2. The purpose of this test is to identify LSEs on any European Sites that may result from the implementation of the Round 4 Plan, and to record The Crown Estate's conclusions on the need for an AA. For those features where a LSE cannot be ruled out, these must be subject to an AA. This review of potential implications can be described as a 'two-tier process' with the LSE test as the first tier and the AA of effects on integrity as the second tier.

3.1.3. This section addresses this first step of the HRA process, for which The Crown Estate has considered the potential impacts of the Round 4 Plan either alone or in combination with other plans and projects on European Sites to determine whether there is a risk of LSEs.

3.2. Screening – Identification of Likely Significant Effects

3.2.1. A screening exercise was undertaken to identify European Sites where there may be a LSE arising from the Round 4 Plan, based on impact pathways and criteria as set out in the Principles Report (NIRAS, 2020). For the purposes of undertaking the screening, a worst-case scenario has been adopted based on the project envelope provided by preferred bidders in their response to the first Invitation to Tender (ITT1) in June 2020.

3.2.2. For the screening exercise both the Preferred Project areas and cable regions identified were utilised to ensure any uncertainty around project design did not impact upon the assessment of potential risk of LSE. All European Sites (including pSPAs, pSACs and Ramsar sites) were included in the HRA screening exercise (excluding European Sites supporting terrestrial and freshwater habitats and species, and migratory birds where there is no pathway of connectivity with the plan).

3.2.3. The criteria outlined in the Principles Document were applied to the qualifying features of European Sites, based on the impact pathways (as defined in the Principles Document) within the Preferred Project areas and the cable route regions. For the purposes of this plan-level HRA, a LSE was assumed to arise where there is the potential presence of an impact pathway resulting from all phases of development that may comprise part of the Round 4 Plan, including pre-construction, construction, operation, maintenance and decommissioning. Each pathway identified can potentially lead to a variety of impacts, which can affect receptors in different ways. Further analysis was undertaken to identify the 'pressures' that could arise through these pathways. The use of pressures in this way matches the approach adopted for the 2017 Project Extensions HRA (NIRAS, 2019).

3.2.4. To ensure compliance with recent case law, no mitigation measures to avoid or reduce any potential harmful effects of the plan were assumed or applied at the screening stage (see judgment of 12 April 2018*, People Over Wind and Others*, Case C-323/17, EU:C:2018:244, paragraph 40).

3.2.5. The Screening Report has identified the qualifying sites and features under the Habitat Regulations and the Ramsar Convention that ought to be included for assessment. The qualifying sites and features for which the possibility of LSE (as a result of the plan) could not be excluded are listed in section 3 of the Screening Report. A full list of the sites and qualifying features screened into the assessment is detailed in Appendix C of the Screening Report.

3.2.6. Natural England, Natural Resources Wales, JNCC, DAERA and other selected organisations were consulted on the Principles Document, the Screening Report, and their views taken into account.

3.2.7. The Crown Estate has reviewed the Screening Report, and the feedback provided by the SNCBs and is satisfied that the screening exercise has been conducted in an appropriate manner. The Crown Estate are further satisfied that an appropriate list of European Sites and their qualifying features (as detailed in Appendix C of the Screening Report (based on the potential for LSE)) has been taken forward for assessment.

3.2.8. Given the findings of the screening assessment, and the fact that the Round 4 Plan is not directly connected with or necessary to the management of a European Site, The Crown Estate has made an AA of the implications of the Round 4 Plan for these sites in view of the sites' conservation objectives. The AA has been informed by the detail of the Screening Report (NIRAS, 2021) and the RIAA produced by NIRAS, (2022).

4. Appropriate Assessment

4.1. Test for Adverse Effect on Site Integrity

4.1.1. The requirement to undertake an AA is triggered when a competent authority, in this case The Crown Estate Commissioners, determines that a plan or project may have a likely significant effect on a European Site either alone or in combination with other plans or projects. Guidance issued by the European Commission states that the purpose of an AA is to enable a competent authority to ascertain that the plan or project will not adversely affect the integrity of any European Site, either alone or in combination with other plans and projects, and in view of the site's conservation objectives (European Commission, 2018).

4.1.2. If the competent authority cannot ascertain the absence of an AEOSI beyond reasonable scientific doubt, then under the Habitats Regulations it may not agree to the plan or project unless it can pass further legal tests and be granted a 'derogation.' Such a derogation allows a plan or project to proceed notwithstanding the risk of an AEOSI but only if there is no alternative solution, the plan or project must be carried out for imperative reasons of overriding public interest ("IROPI") and compensatory measures necessary to ensure the overall coherence of the National Site Network are secured.

4.1.3. Guidance from the European Commission confirms that disturbance to a species or deterioration of habitats, for which a European Site has been designated, must be considered in relation to the integrity of that site and its conservation objectives (European Commission, 2018 para 4.6.3):

"The appropriate assessment focuses on assessing the implications for the site of the plan or project, individually or in combination with other plans or projects, in view of the site's conservation objectives. Article 6(3) must therefore be read in close conjunction with Article 6(1) and 6(2) since the conservation objectives to be used in the appropriate assessment are linked also to these two earlier paragraphs."

Section 4.6.4 of the guidance defines site integrity as:

> *"…the coherent sum of the site's ecological structure, function and ecological processes, across its whole area, which enables it to sustain the habitats, complex of habitats and/or populations of species for which the site is or will be classified."*

4.1.4. Conservation objectives outline the desired state for a European Site, in terms of the interest features for which it has been designated.

4.1.5. There are no set thresholds at which impacts on site integrity are considered to be adverse. This is a matter for interpretation on a site-by-site basis, depending on the designated feature and nature, scale and significance of the impact.

4.1.6. Conservation objectives have been used by The Crown Estate to consider whether the Round 4 Plan has the potential to result in an AEOSI, either alone or in combination.

4.2. RIAA Methodology

4.2.1. The assessment undertaken by NIRAS sought to determine whether the potential for LSEs identified during the Stage 1 Screening exercise could result (either alone or in-combination with other plans or projects) in an adverse effect on European Site integrity. For all European Sites/features that were screened in, an assessment was made of whether it could be ascertained that the Round 4 Plan would not lead to an adverse effect on the integrity of a European Site.

4.2.2. The RIAA was undertaken in three assessment stages to account for the different pressures associated with the Export Cable Regions and the Preferred Project arrays. However, the final conclusions on the risk of the Preferred Projects having an AEOSI of any European Sites were reached based on a comprehensive view of all three assessment stages.

4.2.3. The methodology of all three assessment stages follows the key assessment principles as described previously in the Round 4 Plan Level HRA Principles Report (NIRAS, 2020). A fundamental principle of the RIAA is the commitment to undertake a reasonable and meaningful assessment where possible. This allows The Crown Estate to determine which of the assessments can be concluded at the plan level, and which can only be meaningfully assessed at the project level HRA stage.

4.2.4. Stage one of the assessment assesses the risk of the Export Cable Regions (the Export Cable Region Assessment ("ECRA")) having an AEOSI of the European Sites and associated features screened in for pressures associated with cable infrastructure.

4.2.5. Stages two and three of the assessment together make up the Array Assessment, which assess the risk of the Preferred Project arrays having an AEOSI on the European Sites and associated features that were screened in for pressures associated with the array areas, including inter array cabling.

- Stage two assesses if the risk of an AEOSI can be excluded at a number of SPAs in view of the characteristics associated with three categories of seabird features (foraging range over land, SPAs designated as foraging areas and species with large foraging ranges). These characteristics were previously considered within the Screening Report, but the associated level of impact is assessed.
- Stage three provides additional quantitative and qualitative analysis to assess the risk of an AEOSI for all other European Sites and associated features screened in for pressures associated with the array.

4.2.6. The Crown Estate is satisfied that this is an appropriate approach to undertaking the assessment.

4.3. In Combination Assessment

4.3.1. The approach to the in-combination assessment undertaken by NIRAS builds upon the assessments undertaken for each European Site with respect to Round 4 Plan-related effects acting alone. An initial search was undertaken to capture broad plan or project categories with the following criteria:

- applications for a new permission;
- applications to change an existing permission;
- granted permissions that have not begun or been completed;
- granted permissions that need renewing; and
- plans that have been drafted but not yet adopted.

4.3.2. Specific plans and projects were then identified for inclusion in the in-combination assessment (RIAA Appendix B), by means of a quantitative exercise involving interrogation of a number of data sources in addition to a manual search.

4.3.3. The project data sources were interrogated using spatial criteria against the European Sites which were identified in the Screening Report. For most receptors the criteria chosen are specific to the type of activity and reflects the furthest distance within which the pressures associated with that activity can cause an effect. In addition to the use of spatial criteria, a final search was carried out to identify any plans and projects not captured in the data sources. This involved a search of the websites of the key UK and devolved Governments (and their agencies) with statutory responsibilities for projects in UK territorial waters and the Exclusive Economic Zone.

4.3.4. Following the identification of specific plans and projects, the SNCB tiering system for offshore windfarms was applied (RIAA Appendix A, Table 2.2). The plans and projects included in the tiers were then further categorised to determine how they would be treated in the in-combination assessment. There are three categories taken into account in the SNCB tiering system, and that logic has been applied to other types of development and activity as part of the in-combination assessment. See RIAA Appendix A for further detail.

4.3.5. Following the completion of the RIAA, East Anglia One North Offshore Wind Farm and East Anglia Two Offshore Wind Farm were both granted development consent under the Planning Act 2008 on 31 March 2022. The Crown Estate has undertaken a review of the RIAA in light of these decision and considers that these projects should be moved from Tier 4 (projects that have an application submitted to the appropriate regulatory body that have not yet been determined) to Tier 3 (projects that have been consented (but construction has not yet commenced). However, this change in status does not materially alter the in combination assessment as the treatment of Tier 3 and Tier 4 projects is the same.

4.3.6. The Crown Estate is satisfied that a suitable approach has been taken to consideration and assessment of in-combination effects.

4.4. Uncertainties

4.4.1. A precautionary approach has been taken to assumptions about Round 4 Plan activities based on information supplied by the Preferred Projects, with a 'worst-case' for various Round 4 Plan activities and potential impact pathways used for the assessment. The RIAA utilised the best available information at the time of

assessment, to make a determination of whether it can be concluded that the plan will not have an AEOSI. In cases where uncertainties about the magnitude of likely effects arose (e.g. based on uncertainty about the scale, design, configuration or precise location of the Preferred Projects, or limitations in the available data), it was not always possible to undertake a meaningful, quantitative assessment of the effects that are likely to arise.

4.4.2. Because the integrity test incorporates the application of the precautionary principle as a matter of law, and because plan assessments are, by their nature, less precise than project assessments, it is important for the assessment process to eliminate the prospect of adverse effects on site integrity in so far as that is possible at the level of specificity inherent in the nature and purpose of the particular plan. This can be achieved through the incorporation of plan specific mitigation or incorporation of specific restriction with regard to plan delivery, or the addition of further mitigation measures in lower plans or projects.

4.4.3. The Crown Estate is satisfied that the approach to uncertainties adopted by the RIAA is appropriate, namely that where meaningful assessment cannot be undertaken at plan level (owing to this absence of key information), reliance can be placed on the project-level assessment (specifically at the lower the project-level HRA). This is on the basis that project-level HRA:

- Will be required as a matter of law at that stage;
- Will need to identify and assess the magnitude of all LSEs including those effects identified at plan level which are affected by uncertainty;
- Will be able to determine and secure, where necessary, appropriate and feasible mitigation measures;
- Will be able to more precisely identify the nature timing, duration, scale or location of development, based on further detailed information and data, and therefore will be able to ascertain with more certainty the magnitude of the effects of each project to enable an AEOSI to be avoided.

4.4.4. The Crown Estate also agrees that there will be sufficient flexibility and scope for avoidance and appropriate mitigation to be implemented at project level to avoid AEOSI in respect of European Sites in relation to certain elements of the Round 4 Plan. The Crown Estate notes to the Advocate General's opinion in the European Court of Justice case C-6/04 European Commission v United Kingdom confirming that the progression of assessment that must take place as a plan become more specific whereby 'adverse effects on areas of conservation must be assessed at every relevant stage of the procedure to the extent possible on the basis of the precision of the plan. This assessment is to be updated with increasing specificity in subsequent stages of the procedure.'

4.4.5. The ECRA was undertaken for European Sites and features for which the Screening Report identified a risk of LSE from an Export Cable Region. The export cable routes for Preferred Projects have not yet been defined, and consequently there is considerable uncertainty associated with the spatial parameters required for detailed assessment. The ECRA was used to evaluate the overall risk of an AEOSI from each Export Cable Region (and the Export Cable Regions collectively), alone and in-combination with other plans and projects.

4.4.6. The Crown Estate has reviewed the consultation responses submitted by members of the HRA Expert Working Group ("EWG"), which was established enable effective technical engagement and includes the statutory nature conservation bodies (SNCBs as well as NGOs that have relevant expertise in relation to the Round 4 Plan), and is satisfied that the assessment has been conducted in an appropriate manner.

5. Assessment Findings

5.1.1. The following sections provide a summary of the key findings of the assessment in relation to the European Sites and features screened into the assessment, and a summary of any relevant feedback provided by the SNCBs and other consultees.

5.1.2. As highlighted previously the RIAA included non-UK European Sites within the assessment. Having reviewed the assessment on those non-UK sites (see 2.2.12 - 2.2.15), The Crown Estate agrees with the conclusions from NIRAS on these sites and this AA does not consider these sites further.

5.2. Annex I Habitats

5.2.1. **Dogger Bank SAC**

5.2.1.1. The Dogger Bank SAC is designated for the conservation of the protection of sandbanks which are slightly covered by sea water all the time. The feature is currently in unfavourable condition with a restore conservation objective.

5.2.1.2. Section 4.10.2 to 4.10.8 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying feature of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical damage, indirect physical damage, toxic contaminants, temperature, suspended sediments and invasive species both alone, and in combination with other reasonably foreseeable plans and projects.

5.2.1.3. NIRAS (2022) concluded that an AEOSI due to habitat loss/gain and direct physical damage cannot be excluded beyond reasonable scientific doubt as it is not possible to state with certainty that the impacts would not lead to a significant change in the extent and distribution, ecological function and/or the supporting processes of the sandbanks feature.

5.2.1.4. The Primary Assessment (RIAA Appendix J) found that, with the exception of habitat loss and direct damage, all screened in pressures would lead to a negligible impact on this feature at any scale. The Secondary Assessment (RIAA Appendix J) took account of feature sensitivity, the scale of the impact (to the attribute, extent and distribution of the feature) and ecological function and supporting processes.

5.2.1.5. The Secondary Assessment calculated for habitat loss the impact from the Round 4 Plan alone is 2.035km^2, which equates to 0.016% of this features distribution within this European Site. Impacts would delay restoration, which is contrary to the conservation objectives of this SAC. Options to mitigate such impacts at the plan-level are limited, but consideration has been given to reduction of infrastructure within the SAC.

5.2.1.6. The Secondary Assessment calculated for habitat damage (P2 –direct physical damage) that the impact from the Round 4 Plan alone is 32.209km^2, which equates to 0.261% of the feature's distribution within this European Site. Such impacts would delay restoration, which is contrary to the conservation objectives of this SAC. Options to mitigate such an impact are limited to the removal of Preferred Projects 1 and 2 from the Round 4 Plan. However, this is not an acceptable mitigation measure as it would not meet the renewable energy generation targets of the Round 4 Plan. Further consideration of mitigation for Dogger Bank SAC is within the Mitigation Measures Section.

5.2.1.7. The unfavourable condition of the site is believed to relate (at least in part) to the current impacts on the site from the presence of large-scale and widespread infrastructure associated with offshore oil and gas and cabling activities (JNCC, 2018). As such, there is also the potential for existing plans and projects to act in combination with the proposed Round 4 Plan, and specifically Preferred Projects 1 and 2 to prevent or impede the achievement of the conservation objectives to restore the extent and distribution and the structure and function of the qualifying sandbank habitat and return the site to a favourable condition.

5.2.1.8. The Crown Estate has reviewed the detail of the RIAA with respect to the Dogger Bank SAC. It has been possible to undertake a meaningful assessment of the potential impacts arising from the Dogger Bank SAC site owing to the ability to make an estimation of potential habitat loss and direct physical damage based on worst-case project parameters and the direct spatial overlap with the Dogger Bank SAC. The Crown Estate has also reviewed submissions made by Preferred Projects 1 and 2 in relation to 'as-built' headroom considerations resulting from the difference between what was consented for the four Round 3 projects (8.2km^2, 0.05% of SAC area) and what will be built out. The build scenarios for the four consented wind farms (Dogger Bank A, Dogger Bank B, Dogger Bank C and Sofia) results in an at least threefold reduction in their seabed footprint such that at least 3.95km² (0.032% of SAC area) within the Dogger Bank SAC will not be impacted.

5.2.1.9. Natural England, JNCC and The Wildlife Trusts agreed with the findings of the RIAA in relation to AEOSI on Dogger Bank SAC. The Crown Estate agrees with the conclusions of the RIAA relating to the likely magnitude of potential impact on the sandbank feature of the Dogger Bank SAC.

5.2.1.10. The Crown Estate has considered the ability to mitigate the impact on the Dogger Bank SAC and has concluded that, based on the evidence currently available, it is possible to mitigate impacts but not to an acceptable level (see Mitigation Measures Section). The Crown Estate has therefore decided that it is unable to conclude that the Plan will not adversely affect the integrity of the Dogger Bank SAC and that the further tests set out in the Habitats Regulations must be applied. These include an assessment of alternatives, IROPI and compensatory measures.

5.2.2. **North Norfolk Sandbanks and Saturn Reef SAC**

5.2.2.1. The North Norfolk Sandbanks and Saturn Reef SAC is a SAC designated for the conservation of reef and sandbanks which are slightly covered by sea water all the time. The features are currently in unfavourable condition with restore conservation objectives.

5.2.2.2. Section 4.17.2 to 4.17.12 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to indirect physical damage, toxic contaminants, suspended sediments and invasive species both alone, and in combination with other reasonably foreseeable plans and projects.

5.2.2.3. NIRAS (2022) concluded that there will be no adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.2.2.4. The Primary Assessment (RIAA Appendix J) found that, with the exception of indirect damage, all screened in pressures would lead to a negligible impact on this feature at any scale. The Secondary

Assessment (RIAA Appendix J) took account of feature sensitivity, the scale of the impact and ecological function and supporting processes. The Secondary Assessment has found that due to the distance between the Round 4 Plan and this European Site (more than 5km for reef and sandbanks which are slightly covered by sea water all the time), it would be unrealistic to expect any detectable impact from indirect damage. Other plans or projects have the potential to exert the same pressures described above. However, in view of the above assessment, any additional impact from the Round 4 Plan alone would not make an appreciable difference to any in-combination impact. The assessment does not replace the information requirements of project level HRA and does not attempt to pre-empt their conclusions.

5.2.2.5. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to North Norfolk Sandbanks and Saturn Reef SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of the North Norfolk Sandbanks and Saturn Reef SAC, alone or in-combination with other plans and projects.

5.2.3. **Shell Flat and Lune Deep SAC**

5.2.3.1. The Shell Flat and Lune Deep SAC is a SAC designated for the conservation of reef and sandbanks which are slightly covered by sea water all the time. The condition of features of the site are currently unavailable but the site has maintain or restore conservation objectives.

5.2.3.2. Section 4.44.2 to 4.44.12 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to indirect physical damage, toxic contaminants, suspended sediments and invasive species both alone, and in combination with other reasonably foreseeable plans and projects.

5.2.3.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.2.3.4. The Primary Assessment (RIAA Appendix J) found that, with the exception of indirect damage, all screened in pressures would lead to a negligible impact on this feature at any scale. The Secondary Assessment (RIAA Appendix J) took account of feature sensitivity, the scale of the impact and ecological function and supporting processes. The Secondary Assessment has found that due to the distance between the Round 4 Plan and this European Site (more than 20km – reefs and 5km sandbanks slightly covered by seawater all the time), it would be unrealistic to expect any detectable impact from indirect damage. Other plans or projects have the potential to exert the same pressures described above. However, in view of the above assessment, any additional impact from the Round 4 Plan alone would not make an appreciable difference to any in-combination impact. The assessment does not replace the information requirements of project level HRAs and does not attempt to pre-empt their conclusions.

5.2.3.5. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Shell Flat and Lune Deep SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of the Shell Flat and Lune Deep SAC, alone or in-combination with other plans and projects.

5.3. Annex II Species

5.3.1. **Afon Eden – Cors Goch Trawsfynydd SAC**

5.3.1.1. The Afon Eden - Cors Goch Trawsfynydd SAC is a SAC designated for the conservation of Atlantic salmon and freshwater pearl mussel. The features are currently in unfavourable condition with restore conservation objectives.

5.3.1.2. Section 4.2.2 to 4.2.7 of the RIAA provides detailed assessment of the potential risk of AEOSI of the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.1.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.1.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Afon Eden - Cors Goch Trawsfynydd SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of the Afon Eden - Cors Goch Trawsfynydd SAC, alone or in-combination with other plans and projects.

5.3.2. **Afon Gwyfai a Llyn Cwellyn SAC**

5.3.2.1. The Afon Gwyfai a Llyn Cwellyn SAC is a SAC designated for the conservation of Atlantic salmon. The feature is currently in unfavourable (unclassified) condition with a maintain or restore conservation objective.

5.3.2.2. Section 4.3.2 to 4.3.5 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.2.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.2.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Afon Gwyfai a Llyn Cwellyn SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of the Afon Gwyfai a Llyn Cwellyn SAC, alone or in-combination with other plans and projects.

5.3.3. **Afon Teifi/River Teifi SAC**

5.3.3.1. The Afon Teifi/River Teifi SAC is a SAC designated for the conservation of Atlantic salmon. The feature is currently in unfavourable (unclassified) condition with a maintain or restore conservation objective.

5.3.3.2. Section 4.4.2 to 4.4.5 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified

relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.3.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.3.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Afon Teifi/River Teifi SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of the Afon Teifi/River Teifi SAC, alone or in-combination with other plans and projects.

5.3.4. **Berriedale and Langwell Waters SAC**

5.3.4.1. The Berriedale and Langwell Waters SAC is a SAC designated for the conservation of Atlantic salmon. The feature is currently in favourable (maintained) condition with a maintain conservation objective.

5.3.4.2. Section 4.5.2 to 4.5.6 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.4.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.4.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Berriedale and Langwell Waters SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of the Berriedale and Langwell Waters SAC, alone or in-combination with other plans and projects.

5.3.5. **Bristol Channel Approaches SAC**

5.3.5.1. The Bristol Channel Approaches SAC is a SAC designated for the conservation of harbour porpoise. The feature is currently in favourable condition with a maintain conservation objective.

5.3.5.2. Section 4.6.2 to 4.6.10 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.5.3. The Primary Assessment (RIAA Appendix I) found that, with the exception of underwater noise, all screened in pressures would lead to a negligible impact on this species at any population scale. The Secondary Assessment (RIAA Appendix I) included an estimate of the number of individuals likely to be present within a 500m injury radius of any location within each of the Preferred Projects. This did not exceed 1 animal at any of the Preferred Projects. The Secondary Assessment also found that the impact

associated with disturbance would be negligible for harbour porpoise because the European Site lies more than 26km from the closest Preferred Project.

5.3.5.4. No in-combination impact is expected in relation to injury or disturbance due to the location of this European Site (more than 26km from any of the Preferred Project) and use of standard best practice guidance (JNCC, 2010a&b).

5.3.5.5. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.5.6. Natural England advised the Bristol Channel Approaches SAC should have a European Site in-combination score of 'medium' rather than 'low'. Following a review of the assessment, NIRAS updated this European Site in-combination score to 'medium' however this does not affect the conclusions in respect of this European Site and its features. The Crown Estate considers that the in-combination assessment has been undertaken appropriately within the RIAA.

5.3.5.7. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Bristol Channel Approaches SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of the Bristol Channel Approaches SAC, alone or in-combination with other plans and projects.

5.3.6. **Cardigan Bay/Bae SAC**

5.3.6.1. The Cardigan Bay/Bae SAC is a SAC designated for the conservation of grey seal and bottlenose dolphin, as well as other Annex II species (Screening Report, Appendix C) not considered within this AA. The features are currently in favourable condition with maintain conservation objectives.

5.3.6.2. Section 4.7.2 to 4.7.17 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, physical presence, underwater noise, above water noise, toxic contaminants, electromagnetic fields, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.6.3. The Primary Assessment (RIAA Appendix I) found that, with the exception of underwater noise, all screened in pressures would lead to a negligible impact on these species at any population scale. The Secondary Assessment (RIAA Appendix I) included an estimate of the number of individuals likely to be present within a 500m injury radius of any location within each of the Preferred Projects. This did not exceed 1 animal at any of the Preferred Projects. The Secondary Assessment also found that the impact associated with disturbance would be negligible for both features because the European Site lies more than 26km from the closest Preferred Project.

5.3.6.4. No in-combination impact is expected in relation to injury or disturbance due to the location of this European Site (more than 26km from any of the Preferred Project) and use of standard best practice guidance (JNCC, 2010a&b).

5.3.6.5. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.6.6. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Cardigan Bay/Bae SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of the Cardigan Bay/Bae SAC, alone or in-combination with other plans and projects.

5.3.7. **Cladagh (Swanlinbar) River SAC**

5.3.7.1. The Cladagh (Swanlinbar) River SAC is a SAC designated for the conservation of freshwater pearl mussel. The condition of the feature is not currently available but has a maintain or restore conservation objective.

5.3.7.2. Section 4.8.2 to 4.8.5 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying feature of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.7.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.7.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Cladagh (Swanlinbar) River SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of of Cladagh (Swanlinbar) River SAC, alone or in-combination with other plans and projects.

5.3.8. **Dee Estuary/Aber Dyfrdwy SAC**

5.3.8.1. The Dee Estuary/Aber Dyfrdwy SAC is a SAC designated for the conservation of river lamprey and sea lamprey. The features are currently in unfavourable condition with maintain or restore conservation objectives.

5.3.8.2. Section 4.9.2 to 4.9.7 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.8.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.8.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Dee Estuary/Aber Dyfrdwy SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of the Dee Estuary/Aber Dyfrdwy SAC, alone or in-combination with other plans and projects.

5.3.9. **Humber Estuary SAC**

5.3.9.1. The Humber Estuary SAC is a SAC designated for the conservation of the Annex II species river lamprey and sea lamprey as well as grey seal. The condition of the fish features is currently unavailable but they have a maintain or restore conservation objective, whilst grey seal is in favourable condition with a maintain conservation objective.

5.3.9.2. Section 4.12.2 to 4.12.14 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical damage, indirect physical damage, collision, physical presence, underwater noise, above water noise, toxic contaminants, electromagnetic fields, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.9.3. For grey seal the Primary Assessment (RIAA Appendix I) found that, with the exception of underwater noise, all screened in pressures would lead to a negligible impact on these species at any population scale. The Secondary Assessment (RIAA Appendix I) included an estimate of the number of individuals likely to be present within a 500m injury radius of any location within each of the Preferred Projects. This did not exceed 1 animal at any of the Preferred Projects. The Secondary Assessment also found that the impact associated with disturbance would be negligible for both features because the European Site lies more than 26km from the closest Preferred Project.

5.3.9.4. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.9.5. The Wildlife Trusts raised concerns regarding foraging behaviour of grey seal within the Humber Estuary and the requirement for the RIAA to consider the impacts of Preferred Projects 1-3 on foraging range. Subsequently NIRAS has provided additional information within paragraphs 5.1.9 of the RIAA Appendix I to confirm that functionally linked habitat has been considered, consequently this does not affect the conclusions in respect of this European Site and its features. The Crown Estate considers that the assessment has been undertaken appropriately.

5.3.9.6. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Humber Estuary SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of the Humber Estuary SAC, alone or in-combination with other plans and projects.

5.3.10. **Lough Melvin SAC**

5.3.10.1. The Lough Melvin SAC is a SAC designated for the conservation of Atlantic salmon. The condition of the feature is currently unavailable but it has a maintain conservation objective.

5.3.10.2. Section 4.14.2 to 4.14.5 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.10.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.10.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Lough Melvin SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of Lough Melvin SAC, alone or in-combination with other plans and projects.

5.3.11. **North Anglesey Marine/Gogledd Môn Forol SAC**

5.3.11.1. The North Anglesey Marine/Gogledd Môn Forol SAC is a SAC designated for the conservation of harbour porpoise. The feature has a maintain conservation objective and is currently in favourable condition.

5.3.11.2. Section 4.16.2 to 4.16.10 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.11.3. The Primary Assessment (RIAA Appendix I) found that, with the exception of underwater noise, all screened in pressures would lead to a negligible impact on this species at any population scale. The Secondary Assessment (RIAA Appendix I) included an estimate of the number of individuals likely to be present within a 500m injury radius of any location within each of the Preferred Projects. This did not exceed 1 animal at any of the Preferred Projects. The Secondary Assessment also found that a small proportion of Preferred Project 4 overlaps with a 26 km radius (2.05%), but that the majority of potential piling or UXO locations within Preferred Project 4 lie beyond 26km.

5.3.11.4. No in-combination impact is expected in relation to injury due to the use of standard best practice guidance (JNCC, 2010a&b). For disturbance the Round 4 Plan will not make an appreciable difference to any in-combination impact.

5.3.11.5. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the European Site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.11.6. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to North Anglesey Marine/Gogledd Môn Forol SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of North Anglesey Marine/Gogledd Môn Forol SAC, alone or in-combination with other plans and projects.

5.3.12. **North Channel SAC**

5.3.12.1. The North Channel SAC is a SAC designated for the conservation of harbour porpoise. The feature has a maintain conservation objective and is currently in favourable condition.

5.3.12.2. Section 4.15.2 to 4.15.10 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan.

This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.12.3. The Primary Assessment (RIAA Appendix I) found that, with the exception of underwater noise, all screened in pressures would lead to a negligible impact on this species at any population scale. The Secondary Assessment (RIAA Appendix I) included an estimate of the number of individuals likely to be present within a 500m injury radius of any location within each of the Preferred Projects. This did not exceed 1 animal at any of the Preferred Projects. The Secondary Assessment also found that the impact associated with disturbance would be negligible for harbour porpoise because the European Site lies more than 26km from the closest Preferred Project.

5.3.12.4. No in-combination impact is expected in relation to injury or disturbance due to the location of this European Site (more than 26km from any of the Preferred Project) and use of standard best practice guidance (JNCC, 2010a&b).

5.3.12.5. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.12.6. The Wildlife Trusts disagreed with the in-combination assessment conclusions due to the uncertainty of in-combination impacts. No concerns were raised by the SNCBs for this feature at this European Site. The Crown Estate considers the best available evidence has been used by NIRAS and that the in-combination assessment has been undertaken appropriately.

5.3.12.7. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to North Channel SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of North Channel SAC, alone or in-combination with other plans and projects.

5.3.13. **Owenkillew River SAC**

5.3.13.1. The Owenkillew River SAC is a SAC designated for the conservation of Atlantic salmon and freshwater pearl mussel. The condition of the features is currently unavailable but their conservation objectives are to maintain (salmon) and maintain or restore (freshwater pearl mussel).

5.3.13.2. Section 4.18.2 to 4.18.7 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.13.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.13.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Owenkillew River SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not

adversely affect the integrity of to Owenkillew River SAC, alone or in-combination with other plans and projects.

5.3.14. **Pembrokeshire Marine/Sir SAC**

5.3.14.1. The Pembrokeshire Marine/Sir SAC is a SAC designated for the conservation of grey seal. The feature has a maintain or restore conservation objective and is currently in favourable condition.

5.3.14.2. Section 4.19.2 to 4.19.10 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, physical presence, underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.14.3. The Primary Assessment (RIAA Appendix I) found that, with the exception of underwater noise, all screened in pressures would lead to a negligible impact on this species at any population scale. The Secondary Assessment (RIAA Appendix I) included an estimate of the number of individuals likely to be present within a 500m injury radius of any location within each of the Preferred Projects. This did not exceed 1 animal at any of the Preferred Projects. The Secondary Assessment also found that the impact associated with disturbance would be negligible for grey seal because the European Site lies more than 26km from the closest Preferred Project.

5.3.14.4. No in-combination impact is expected in relation to injury or disturbance due to the location of this European Site (more than 26km from any of the Preferred Project) and use of standard best practice guidance (JNCC, 2010a&b).

5.3.14.5. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.14.6. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Pembrokeshire Marine/Sir SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of Pembrokeshire Marine/Sir SAC, alone or in-combination with other plans and projects.

5.3.15. **Pen Llyn a`r Sarnau/Lleyn Peninsula and the Sarnau SAC**

5.3.15.1. The Pen Llyn a`r Sarnau/Lleyn Peninsula and the Sarnau SAC is a SAC designated for the conservation of grey seal and bottlenose dolphin. The features have maintain conservation objectives and are currently in favourable condition.

5.3.15.2. Section 4.20.2 to 4.20.17 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, physical presence, underwater noise, above water noise, toxic contaminants, electromagnetic fields, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.15.3. The Primary Assessment (RIAA Appendix I) found that, with the exception of underwater noise, all screened in pressures would lead to a negligible impact on these species at any population scale. The Secondary Assessment (RIAA Appendix I) included an estimate of the number of individuals likely to be present within a 500m injury radius of any location within each of the Preferred Projects. This did not exceed 1 animal at any of the Preferred Projects. The Secondary Assessment also found that the impact associated with disturbance would be negligible for both features because the European Site lies more than 26km from the closest Preferred Project.

5.3.15.4. No in-combination impact is expected in relation to injury or disturbance due to the location of this European Site (more than 26km from any of the Preferred Project) and use of standard best practice guidance (JNCC, 2010a&b).

5.3.15.5. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.15.6. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Pen Llyn a`r Sarnau/Lleyn Peninsula and the Sarnau SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of Pen Llyn a`r Sarnau/Lleyn Peninsula and the Sarnau SAC, alone or in-combination with other plans and projects.

5.3.16. **Rannoch Moor SAC**

5.3.16.1. The Rannoch Moor SAC is a SAC designated for the conservation of freshwater pearl mussel. The feature has a maintain or restore conservation objective and is currently in unfavourable condition.

5.3.16.2. Section 4.21.2 to 4.21.5 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying feature of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.16.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects as all screened pressures would have a negligible impact on the species at any population scale

5.3.16.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Rannoch Moor SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of Rannoch Moor SAC, alone or in-combination with other plans and projects.

5.3.17. **River Avon SAC**

5.3.17.1. The River Avon SAC is a SAC designated for the conservation of Atlantic salmon. The feature has a maintain or restore conservation objective and is currently in unfavourable recovering/favourable condition.

5.3.17.2. Section 4.22.2 to 4.22.5 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan.

This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.17.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.17.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to River Avon SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of River Avon SAC, alone or in-combination with other plans and projects.

5.3.18. **River Bladnoch SAC**

5.3.18.1. The River Bladnoch SAC is a SAC designated for the conservation Atlantic salmon. The feature has a restore conservation objective and is currently in unfavourable recovering condition.

5.3.18.2. Section 4.23.2 to 4.23.5 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.18.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.18.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect River Bladnoch SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of River Bladnoch SAC, alone or in-combination with other plans and projects.

5.3.19. **River Camel SAC**

5.3.19.1. The River Camel SAC is a SAC designated for the conservation of Atlantic salmon. The feature has a maintain or restore conservation objective and is currently in unfavourable no change/ unfavourable recovering condition.

5.3.19.2. Section 4.24.2 to 4.24.5 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.19.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.19.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect River Camel SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of River Camel SAC, alone or in-combination with other plans and projects.

5.3.20. **River Clun SAC**

5.3.20.1. The River Clun SAC is a SAC designated for the conservation of freshwater pearl mussel. The feature has a maintain or restore conservation objective and is currently in unfavourable condition.

5.3.20.2. Section 4.25.2 to 4.25.5 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying feature of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.20.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.20.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to River Clun SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of River Clun SAC, alone or in-combination with other plans and projects.

5.3.21. **River Dee and Bala Lake SAC / Afon Dyfrdwy a Lyn Tegid SAC**

5.3.21.1. The River Dee and Bala Lake SAC / Afon Dyfrdwy a Lyn Tegid SAC is a SAC designated for the conservation of river lamprey, sea lamprey, Atlantic salmon, as well as other Annex II species (Screening Report, Appendix C) not considered within this AA. The features are currently in unfavourable condition with maintain or restore conservation objectives.

5.3.21.2. Section 4.26.2 to 4.26.9 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.21.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.21.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to River Dee and Bala Lake SAC / Afon Dyfrdwy a Lyn Tegid SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of River Dee and Bala Lake SAC / Afon Dyfrdwy a Lyn Tegid SAC, alone or in-combination with other plans and projects.

5.3.22. **River Dee SAC**

5.3.22.1. The River Dee SAC is a SAC designated for the conservation of Atlantic salmon and freshwater pearl mussel. The condition of the features is favourable maintained (salmon) and unfavourable declining

(freshwater pearl mussel) and their conservation objectives are to maintain (salmon) and restore (freshwater pearl mussel).

5.3.22.2. Section 4.27.2 to 4.27.7 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.22.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.22.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to River Dee SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of the River Dee SAC, alone or in-combination with other plans and projects.

5.3.23. **River Derwent and Bassenthwaite Lake SAC**

5.3.23.1. The River Derwent and Bassenthwaite Lake SAC is a SAC designated for the conservation of river lamprey, sea lamprey, Atlantic salmon, as well as other Annex II species (Screening Report, Appendix C) not considered within this AA. The features are currently in unfavourable recovering/ unfavourable no change / favourable condition with maintain or restore conservation objectives.

5.3.23.2. Section 4.28.2 to 4.28.9 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.23.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.23.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to River Derwent and Bassenthwaite Lake SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of the River Derwent and Bassenthwaite Lake SAC, alone or in-combination with other plans and projects.

5.3.24. **River Eden SAC**

5.3.24.1. River Eden SAC is a SAC designated for the conservation of river lamprey, sea lamprey and Atlantic salmon. The features are currently in unfavourable recovering/ unfavourable no change / favourable condition with maintain or restore conservation objectives.

5.3.24.2. Section 4.29.2 to 4.29.9 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were

identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.24.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.24.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to River Eden SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of the River Eden SAC, alone or in-combination with other plans and projects.

5.3.25. **River Ehen SAC**

5.3.25.1. The River Ehen SAC is a SAC designated for the conservation of Atlantic salmon and freshwater pearl mussel. The condition of the features is unfavourable no change (salmon) and unfavourable declining (freshwater pearl mussel) both with a restore conservation objective.

5.3.25.2. Section 4.30.2 to 4.30.7 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.25.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.25.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to River Ehen SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of the River Ehen SAC, alone or in-combination with other plans and projects.

5.3.26. **River Evelix SAC**

5.3.26.1. The River Evelix SAC is a SAC designated for the conservation of freshwater pearl mussel. The feature has a maintain conservation objective and is currently in unfavourable declining condition.

5.3.26.2. Section 4.31.2 to 4.31.5 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying feature of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.26.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.26.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to River Evelix SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of the River Evelix SAC, alone or in-combination with other plans and projects.

5.3.27. **River Faughan and Tributaries SAC**

5.3.27.1. The River Faughan and Tributaries SAC is a SAC designated for the conservation of Atlantic salmon. The feature has a maintain conservation objective and but no condition assessment is available.

5.3.27.2. Section 4.32.2 to 4.32.5 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.27.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.27.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to River Faughan and Tributaries SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of the River Faughan and Tributaries SAC, alone or in-combination with other plans and projects.

5.3.28. **River Foyle and Tributaries SAC**

5.3.28.1. The River Foyle and Tributaries SAC is a SAC designated for the conservation of Atlantic salmon. The feature has a maintain conservation objective and but no condition assessment is available.

5.3.28.2. Section 4.33.2 to 4.33.5 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.28.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.28.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to River Foyle and Tributaries SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of the River Foyle and Tributaries SAC, alone or in-combination with other plans and projects.

5.3.29. **River Kent SAC**

5.3.29.1. The River Kent SAC is a SAC designated for the conservation of freshwater pearl mussel. The feature has a maintain or restore conservation objective and is currently in unfavourable condition.

5.3.29.2. Section 4.34.2 to 4.34.5 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying feature of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.29.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.29.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to River Kent SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of the River Kent SAC, alone or in-combination with other plans and projects.

5.3.30. **River Oykel SAC**

5.3.30.1. The River Oykel SAC is a SAC designated for the conservation of Atlantic salmon and freshwater pearl mussel. The condition of the features is unfavourable no change (freshwater pearl mussel) and favourable recovered (salmon) with a restore (freshwater pearl mussel) and maintain (salmon) conservation objectives.

5.3.30.2. Section 4.35.2 to 4.35.7 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.30.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.30.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to River Oykel SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of the River Oykel SAC, alone or in-combination with other plans and projects.

5.3.31. **River Roe and Tributaries SAC**

5.3.31.1. The River Roe and Tributaries SAC is a SAC designated for the conservation of Atlantic salmon. The feature has a maintain conservation objective but no condition assessment is available.

5.3.31.2. Section 4.36.2 to 4.36.5 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.31.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.31.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to River Roe and Tributaries SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of the River Roe and Tributaries SAC, alone or in-combination with other plans and projects.

5.3.32. **River South Esk SAC**

5.3.32.1. The River South Esk SAC is a SAC designated for the conservation of Atlantic salmon and freshwater pearl mussel. The condition of the features is unfavourable recovering (salmon) and unfavourable no change (freshwater pearl mussel), both have a restore conservation objective.

5.3.32.2. Section 4.37.2 to 4.37.6 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.32.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.32.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to River South Esk SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of River South Esk SAC, alone or in-combination with other plans and projects.

5.3.33. **River Spey SAC**

5.3.33.1. The River Spey SAC is a SAC designated for the conservation of Atlantic salmon and freshwater pearl mussel. The condition of the features is unfavourable recovering (salmon) and unfavourable declining (freshwater pearl mussel), both have a restore conservation objective.

5.3.33.2. Section 4.38.2 to 4.38.7 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.33.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.33.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to River Spey SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of River Spey SAC, alone or in-combination with other plans and projects.

5.3.34. **River Tay SAC**

5.3.34.1. The River Tay SAC is a SAC designated for the conservation of Atlantic salmon. The condition of the feature is favourable maintained with a maintain conservation objective.

5.3.34.2. Section 4.39.2 to 4.39.5 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.34.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.34.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to River Tay SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of River Tay SAC, alone or in-combination with other plans and projects.

5.3.35. **River Teith SAC**

5.3.35.1. The River Teith SAC is a SAC designated for the conservation of Atlantic salmon. The condition of the feature is unfavourable recovering with a maintain conservation objective.

5.3.35.2. Section 4.40.2 to 4.40.5 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.35.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.35.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to River Teith SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of River Teith SAC, alone or in-combination with other plans and projects.

5.3.36. **River Tweed SAC**

5.3.36.1. The River Tweed SAC is a SAC designated for the conservation of Atlantic salmon, as well as other Annex II species (Screening Report, Appendix C) not considered within this AA. The condition of the feature is favourable with a maintain conservation objective.

5.3.36.2. Section 4.41.2 to 4.41.5 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.36.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.36.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to River Tweed SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of River Tweed SAC, alone or in-combination with other plans and projects.

5.3.37. **River Usk SAC/Afon Wysg SAC**

5.3.37.1. The River Usk SAC/Afon Wysg is a SAC designated for the conservation of Atlantic salmon. The condition of the feature is unfavourable (unclassified) with a maintain or restore conservation objective.

5.3.37.2. Section 4.42.2 to 4.42.5 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.37.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.37.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to River Usk SAC/Afon Wysg SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of the River Usk SAC/Afon Wysg SAC, alone or in-combination with other plans and projects.

5.3.38. **River Wye/ Afon Gwy SAC**

5.3.38.1. The River Wye/ Afon Gwy SAC is a SAC designated for the conservation of Atlantic salmon, as well as other Annex II species (Screening Report, Appendix C) not considered within this AA. The condition of the feature is unfavourable (unclassified) with a restore conservation objective.

5.3.38.2. Section 4.43.2 to 4.43.5 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.38.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.38.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to River Wye/ Afon Gwy SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of the River Wye/ Afon Gwy SAC alone or in-combination with other plans and projects.

5.3.39. **Solway Firth SAC**

5.3.39.1. Solway Firth SAC is a SAC designated for the conservation of river lamprey and sea lamprey. The condition of the features are not recorded with a maintain or restore conservation objective.

5.3.39.2. Section 4.45.2 to 4.45.7 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.39.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.39.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Solway Firth SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of Solway Firth SAC alone or in-combination with other plans and projects.

5.3.40. **Southern North Sea SAC**

5.3.40.1. The Southern North Sea SAC is a SAC designated for the conservation of harbour porpoise. The feature has a maintain conservation objective and is currently in favourable condition.

5.3.40.2. Section 4.46.2 to 4.46.10 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.40.3. The Primary Assessment (RIAA Appendix I) found that, with the exception of underwater noise, all screened in pressures would lead to a negligible impact on this species at any population scale. The Secondary Assessment (RIAA Appendix I) included an estimate of the number of individuals likely to be present within a 500m injury radius of any location within each of the Preferred Projects. This did not exceed 1 animal at any of the Preferred Projects. The Secondary Assessment found that impacts associated with disturbance could be detrimental under certain scenarios, as such Preferred Bidders (1-3) must produce and implement a Site Integrity Plan ("SIP"). The SIP must contain suitable measures to stay within the noise disturbance thresholds which are defined within JNCC (2020) guidance as 20% of the relevant area of the site in any given day or an average of 10% of the relevant area of the site over a season.

5.3.40.4. No in-combination impact is expected in relation to injury due to the use of standard best practice guidance (JNCC, 2010a&b). However as outlined above for noise disturbance, an impact of this order is also possible with the addition of impacts from other plans and projects. Such an impact could be reduced to acceptable levels with coordination of piling location and timing. However, The Crown Estate is not able to make such an assessment without detailed project specific information on construction programming. Therefore, Preferred Bidders (1-3) will be required to produce and implement a SIP.

5.3.40.5. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.40.6. Natural England and The Wildlife Trusts raised significant concerns regarding the suitability of SIPs from multiple projects without a robust procedure in place to manage the SIPs and reduce in-combination impacts to ensure a conclusion of no adverse effect on integrity can be made for the Southern North Sea SAC.

5.3.40.7. The Crown Estate considers the SIP to be an appropriate mechanism to provide a framework to ensure there is no adverse effect on the integrity of the Southern North Sea SAC. As a result of the concern

expressed by Natural England and The Wildlife Trusts around the robustness of the procedure at project level, The Crown Estate considers it appropriate for a Round 4 Strategic Site Integrity Plan ("SSIP") to be established for Preferred Projects 1, 2 and 3. The purpose of the Round 4 Strategic Site Integrity Plan is to set out the approach to be taken by Preferred Projects 1, 2 and 3 to provide certainty as to the conclusion of this AA's conclusion of no AEOSI in relation to the Southern North Sea SAC. The Round 4 SSIP will be secured through Agreements for Lease and must be agreed with The Crown Estate in consultation with the HRA EWG.

5.3.40.8. Natural England, BEIS and NRW disagreed with the use of 1km injury ranges for UXO detonation. NIRAS noted that recent modelling for clearance of various sized UXO does indicate potentially larger ranges and that text has been added to reference the recently published position statement on UXO clearance (Gov.uk, 2022). Guidance from Southall et al (2019) highlights injury ranges can be up to 15 km however it is acknowledged within the same guidance that 'The radius of the mitigation zone may be reduced, or increased, from the default 1 km if evidence supporting this change is accepted by the regulators following consultation with the appropriate nature conservation agency'. Such ranges would be informed by project specific modelling, once the type, size and location of UXO (if any) are known. The Round 4 SSIP will consider noise UXO detonation activities. Additionally, during the consenting process as a matter of law each project will be required to undertake an impact assessment, including project level HRA, where a LSE on a European site cannot be excluded beyond reasonable scientific doubt. This assessment will be used by the consenting body, as the competent authority, to undertake a statutory HRA, the outcome of which will ensure that the integrity of the European site will be safeguarded. Therefore, the uncertainties as to the level of effect (i.e. due to the lack of site-specific modelling data) will be addressed through the project level assessment. Notwithstanding this and after careful consideration of the issue, The Crown Estate considers the best available evidence has been used by NIRAS, that the assessment has been undertaken appropriately and that the remaining uncertainty will be addressed at project level (the approach to which is described in the paragraphs under heading 4.4), which will ensure that the integrity of the European site will be safeguarded.

5.3.40.9. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Southern North Sea SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of Southern North Sea SAC alone or in-combination with other plans and projects.

5.3.41. **The Wash and North Norfolk Coast SAC**

5.3.41.1. The Wash and North Norfolk Coast SAC is a SAC designated for the conservation of harbour seal. The feature has a maintain conservation objective and is currently in favourable condition.

5.3.41.2. Section 4.47.2 to 4.47.10 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, physical presence, underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.41.3. The Primary Assessment (RIAA Appendix I) found that, with the exception of underwater noise, all screened in pressures would lead to a negligible impact on this species at any population scale. The Secondary Assessment (RIAA Appendix I) included an estimate of the number of individuals likely to be present within a 500m injury radius of any location within each of the Preferred Projects. This did not

exceed 1 animal at any of the Preferred Projects. The Secondary Assessment also found that the impact associated with disturbance would be negligible for harbour seal because the European Site lies more than 26km from the closest Preferred Project.

5.3.41.4. No in-combination impact is expected in relation to injury or disturbance due to the location of this European Site (more than 26km from any of the Preferred Project) and use of standard best practice guidance (JNCC, 2010a&b).

5.3.41.5. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.41.6. Natural England, JNCC and BEIS raised concerns with the declining condition of harbour seal feature at The Wash and North Norfolk Coast SAC. Natural England noted the feature has recently become unfavourable, due to the observed 20-30% decline in harbour seal numbers in the Wash in 2019-2020 and are in the process of updating conservation advice for this site. Following a review and consideration of the feedback from Natural England, JNCC and BEIS, NIRAS updated the European Site condition to 'medium', however individual sensitivity to disturbance and at sea density data remains unchanged and therefore the conclusion of no AEOSI remains valid. The Crown Estate considers that the assessment has used the best available evidence and has been undertaken appropriately.

5.3.41.7. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to The Wash and North Norfolk Coast SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of The Wash and North Norfolk Coast SAC alone or in-combination with other plans and projects.

5.3.42. **Upper Ballinderry River SAC**

5.3.42.1. The Upper Ballinderry River SAC is a SAC designated for the conservation of freshwater pearl mussel. The condition of the feature is not currently available however the feature has a maintain or restore conservation objective.

5.3.42.2. Section 4.48.2 to 4.84.5 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying feature of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.42.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.42.4. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Upper Ballinderry River SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of Upper Ballinderry River SAC alone or in-combination with other plans and projects.

5.3.43. **West Wales / Gorllewin Cymru Forol SAC**

5.3.43.1. The West Wales / Gorllewin Cymru Forol SAC is a SAC designated for the conservation of harbour porpoise. The feature has a maintain conservation objective and is currently in favourable condition.

5.3.43.2. Section 4.49.2 to 4.49.10 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SAC screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, physical presence, underwater noise, toxic contaminants, electromagnetic fields and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.3.43.3. The Primary Assessment (RIAA Appendix I) found that, with the exception of underwater noise, all screened in pressures would lead to a negligible impact on this species at any population scale. The Secondary Assessment (RIAA Appendix I) included an estimate of the number of individuals likely to be present within a 500m injury radius of any location within each of the Preferred Projects. This did not exceed 1 animal at any of the Preferred Projects. The Secondary Assessment also found that the impact associated with disturbance would be negligible for harbour porpoise because the European Site lies more than 26km from the closest Preferred Project.

5.3.43.4. No in-combination impact is expected in relation to injury or disturbance due to the location of this European Site (more than 26km from any of the Preferred Project) and use of standard best practice guidance (JNCC, 2010a&b).

5.3.43.5. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.3.43.6. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to West Wales / Gorllewin Cymru Forol SAC. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of West Wales / Gorllewin Cymru Forol SAC alone or in-combination with other plans and projects.

5.4. Birds

5.4.1. Within this section, for features screened in, The Crown Estate has undertaken a detailed review of the RIAA and where it has concluded that the actual number of collisions is less than 0.5% baseline mortality The Crown Estate agrees with the finding of the RIAA, that any impact will be negligible and that adverse effect on the integrity of the site as a result of the impact can be ruled out alone, or in-combination with other plans or projects.

5.4.2. The Crown Estate has taken this view as the effect on the feature is not likely to be significant, since 0.5% of baseline mortality represents a proportion of a population that it is so small that it is considered to be practically unmeasurable with any accuracy and, therefore, also considers there will be no in-combination effect. It is, therefore, judged that an impact of this magnitude is negligible by definition and can be discounted from requiring further assessment; consequently in these instances, no assessment is provided other than where specified for extenuating reasons in the assessment below. Below is a list of European Sites filtered out by this threshold:

- Alde-Ore Estuary SPA
- Farne Islands SPA
- Northumberland Marine SPA
- Northumbria Coast Ramsar
- Outer Firth of Forth and St. Andrews Bay Complex SPA
- St Abb's Head to Fast Castle SPA
- Strangford Lough Ramsar
- Upper Solway Flats & Marshes Ramsar

5.4.3. **Ailsa Craig SPA**

5.4.3.1. Alisa Craig SPA is classified for the protection of gannet, lesser black-backed gull and kittiwake, as well as other Annex II species (Screening Report, Appendix C) not considered within this AA. The features have a maintain conservation objective and is currently in favourable (gannet), unfavourable no change (lesser black-backed gull) and unfavourable declining (kittiwake) condition. For lesser black-backed gull and kittiwake the predicted impacts are under the 0.5 % baseline mortality threshold and as such are not considered further – for further detail refer to the caveat in paragraphs 5.4.1 to 5.4.2 for consideration of baseline mortality.

5.4.3.2. Section 4.50.2 to 4.50.16 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SPA screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, physical presence, underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.4.3.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.4.3.4. For gannet the Primary Assessment (RIAA Appendix H) has found that, with the exception of collision risk and physical presence, all screened in pressures would lead to a negligible impact on this species at any population scale. The findings of the Secondary Assessment were that the combined impact of displacement and collision represents 0.21-1.06% of the baseline mortality at this European Site. NIRAS (2022) noted that Marine Scotland Science and NatureScot have previously advised that consideration of displacement impacts for gannet is not required as such impacts are not considered likely to result in an adverse effect on the site integrity of an SPA based on the findings of Searle et al (2014). NIRAS further concluded that for gannet the impact from the Round 4 Plan alone is considered to be negligible, and that the change in baseline mortality predicted from the Round 4 Plan alone is not expected to make an appreciable difference to any in-combination impact.

5.4.3.5. The Primary Assessment (RIAA Appendix H) for lesser black-backed gull and kittiwake found that, with the exception of collision risk, all screened in pressures would lead to a negligible impact on these species at any population scale. In the Secondary Assessment (RIAA Appendix H), NIRAS (2022) concluded that the impact in terms of collision risk from the Round 4 Plan alone is considered to be negligible, and that the change in baseline mortality predicted from the Round 4 Plan alone is not expected to make an appreciable difference to any in-combination impact.

5.4.3.6. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Alisa Craig SPA. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of Alisa Craig SPA alone or in-combination with other plans and projects.

5.4.4. **Alde-Ore Estuary SPA**

5.4.4.1. Alde-Ore Estuary SPA is classified for lesser black-backed gull. The condition of the feature is not currently available however the feature has a maintain or restore conservation objective. For lesser black-backed gull the predicted impact is under the 0.5 % baseline mortality threshold and as such is not considered further – for further detail refer to the caveat in paragraphs 5.4.1 to 5.4.2 for consideration of baseline mortality.

5.4.4.2. Section 4.51.2 to 4.51.7 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SPA screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.4.4.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.4.4.4. The Primary Assessment (RIAA Appendix H) for lesser black-backed gull found that, with the exception of collision risk, all screened in pressures would lead to a negligible impact on this species at any population scale. In the Secondary Assessment NIRAS (2022) concluded that the impact in terms of collision risk from the Round 4 Plan alone is considered to be negligible, and that the change in baseline mortality predicted from the Round 4 Plan alone is not expected to make an appreciable difference to any in-combination impact.

5.4.4.5. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Alde-Ore Estuary SPA. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of Alde-Ore Estuary SPA alone or in-combination with other plans and projects.

5.4.5. **Anglesey Terns/Morwenoliaid Ynys Môn SPA**

5.4.5.1. Anglesey Terns/Morwenoliaid Ynys Môn SPA is classified for Sandwich tern and Arctic tern. The features have a maintain conservation objective and are currently in favourable condition.

5.4.5.2. Section 4.52.2 to 4.52.10 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SPA screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.4.5.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.4.5.4. The Primary Assessment (RIAA Appendix H) for Arctic tern and Sandwich tern found that, with the exception of collision risk, all screened in pressures would lead to a negligible impact on these species at any population scale. The Secondary Assessment (RIAA Appendix H) provided evidence to demonstrate that a negligible number of birds are likely to utilise areas within the Round 4 Plan (NIRAS 2022). NIRAS (2022) concluded that the impact from the Round 4 Plan alone is considered to be negligible, and in view of the Primary Assessment any additional impact from the Round 4 Plan alone would not make an appreciable difference to any in-combination impact.

5.4.5.5. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Anglesey Terns/Morwenoliaid Ynys Môn SPA. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity to Anglesey Terns/Morwenoliaid Ynys Môn SPA alone or in-combination with other plans and projects.

5.4.6. **Bowland Fells SPA**

5.4.6.1. Bowland Fells SPA is classified for lesser black-backed gull. The condition of the feature is not currently available however the feature has a maintain or restore conservation objective. For lesser black-backed gull the predicted impact is under the 0.5 % baseline mortality threshold and as such is not considered further – for further detail refer to paragraphs 5.4.1 to 5.4.2 for consideration of baseline mortality.

5.4.6.2. Section 4.53.2 to 4.5.7 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SPA screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.4.6.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.4.6.4. The Primary Assessment (RIAA Appendix H) for lesser black-backed gull found that, with the exception of collision risk, all screened in pressures would lead to a negligible impact on this species at any population scale. In the Secondary Assessment (RIAA Appendix H), NIRAS (2022) concluded that for lesser black-backed gull the impact in terms of collision risk from the Round 4 Plan alone is considered to be negligible, and that the change in baseline mortality predicted from the Round 4 Plan alone is not expected to make an appreciable difference to any in-combination impact.

5.4.6.5. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Bowland Fells SPA. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity to Bowland Fells SPA, alone or in-combination with other plans and projects.

5.4.7. **Coquet Island SPA**

5.4.7.1. Coquet Island SPA is classified for lesser black-backed gull, kittiwake and puffin. The condition of the features is not currently available however they have a maintain / restore conservation objectives as part of a seabird assemblage. For kittiwake and puffin the predicted impacts are under the 0.5 % baseline mortality threshold and as such are not considered further – for further detail refer to paragraphs 5.4.1 to 5.4.2 for consideration of baseline mortality.

5.4.7.2. Section 4.55.2 to 4.55.15 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SPA screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, physical presence, underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.4.7.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.4.7.4. The Primary Assessment (RIAA Appendix H) for lesser black-backed gull found that, with the exception of collision risk, all screened in pressures would lead to a negligible impact on this species at any population scale. Despite the finding in the Secondary Assessment (RIAA Appendix H) that the predicted collision risk is likely to exceed the 1% baseline mortality threshold of the Coquet Island SPA population (14.8-16.5%), the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account. NIRAS (2022) concluded that for lesser black-backed gull the impact from the Round 4 Plan alone is considered to be negligible, and any additional impact from the Round 4 Plan alone would not make an appreciable difference to any in-combination impact.

5.4.7.5. The Primary Assessment (RIAA Appendix H) also found that, with the exception of collision (kittiwake) and physical presence (puffin), all screened in pressures would lead to a negligible impact on these species at any population scale. In the Secondary Assessment (RIAA Appendix H), NIRAS (2022) concluded that the impact in terms of displacement and collision risk from the Round 4 Plan alone is considered to be negligible, and any additional impact from the Round 4 Plan alone would not make an appreciable difference to any in-combination impact.

5.4.7.6. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Coquet Island SPA. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity to Coquet Island SPA, alone or in-combination with other plans and projects.

5.4.8. **Farne Islands SPA**

5.4.8.1. Farne Islands SPA is classified for kittiwake and puffin. The condition of the features is not currently available however they have a maintain / restore conservation objective as part of a seabird assemblage. For kittiwake and puffin the predicted impacts are under the 0.5 % baseline mortality threshold and as such are not considered further – for further detail refer to the caveat in paragraphs 5.4.1 to 5.4.2 for consideration of baseline mortality.

5.4.8.2. Section 4.58.2 to 4.58.10 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SPA screened into the assessment as a result of the Round 4 Plan. This

includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, physical presence, underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.4.8.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.4.8.4. The Primary Assessment (RIAA Appendix H) has found that, with the exception of collision risk (kittiwake) and physical presence (puffin), all screened in pressures would lead to a negligible impact on these species at any population scale. In the Secondary Assessment (RIAA Appendix H), NIRAS (2022) concluded that the impact in terms of displacement and collision risk from the Round 4 Plan alone is considered to be negligible, and that the change in baseline mortality predicted from the Round 4 Plan alone is not expected to make an appreciable difference to any in-combination impact.

5.4.8.5. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Farne Islands SPA. The Crown Estate is, therefore, satisfied that the Round 4 Plan would not represent an AEOSI in respect of Farne Islands SPA.

5.4.9. **Flamborough & Filey Coast SPA**

5.4.9.1. Flamborough and Filey Coast SPA is classified for gannet, herring gull, kittiwake, common guillemot, razorbill and a breeding seabird assemblage that includes puffin. The condition of the kittiwake feature is classed as unfavourable; the condition of the other features is not currently available. Kittiwake has a 'maintain / restore' conservation objective, whilst the conservation objection is 'maintain' for all other features. For herring gull and razorbill the predicted impacts are under the 0.5 % baseline mortality threshold and as such are not considered further – for further detail refer to paragraphs 5.4.1 to 5.4.2 for consideration of baseline mortality.

5.4.9.2. Section 4.59.2 to 4.59.26 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SPA screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, physical presence, underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.4.9.3. NIRAS (2022) concluded that it was not possible to recommend that The Crown Estate's AA should conclude that the Round 4 Plan in-combination will not have an AEOSI at this European Site. This is due to the impact of collisions from the Round 4 Plan associated with the kittiwake feature, which is considered to make a material contribution to an in combination impact already causing an AEOSI.

5.4.9.4. Further, Natural England advised the risk of AEOSI should not be ruled out for gannet (in-combination), kittiwake (alone and in-combination), guillemot (in-combination), razorbill (in-combination) and puffin (in-combination). RSPB considered that AEOSI should not be ruled out for gannet, guillemot and puffin and that further assessment is needed for razorbill. The Wildlife Trusts advised that AEOSI should not be ruled out with regards to gannet. Natural England also raised concerns around the additional contribution of Hornsea Project Four to in-combination assessments, of which NIRAS have since updated within the RIAA.

5.4.9.5. For kittiwake the Primary Assessment (RIAA Appendix H) has found that, with the exception of collision risk all screened in pressures would lead to a negligible impact on this species at any population scale. The collision risk modelling within the Secondary Assessment (RIAA Appendix H) outlined the number of collisions apportioned to this European Site from the Round 4 Plan is estimated to be 37.9 – 43.4 collisions/annum. This represents 0.25-0.29% of the baseline mortality at this European Site. This figure is below the 0.5% threshold described in paragraphs 5.4.1. and 5.4.2. above. Due to the specific conditions of the colony at this site which is both in unfavourable condition and subject to a significant existing impact from offshore wind installations which have been found have an AEOSI in previous consent decisions, a more conservative approach presented in RIAA Appendix H has been considered and found that this impact could be as much as 94.3-108 collisions/annum, which equates to 0.63-0.72% of the baseline mortality. Population Viability Analysis predicts sustainable population growth of the Flamborough and Filey Coast SPA kittiwake population despite additional mortality from the Round 4 Plan alone. As highlighted in 5.4.9.4 Natural England were unable to conclude that the added kittiwake mortality that may arise from Round 4 alone would not pose any risk of an AEOSI of the European Site.

5.4.9.6. The in-combination assessment for kittiwake predicted the Round 4 Plan in-combination with other plans and projects impact is 557-563 collisions/annum. Population Viability Analysis predicts sustainable population growth of the Flamborough and Filey Coast SPA kittiwake population despite additional mortality from the Round 4 Plan in-combination with other plans and projects; however, after 60 years with this additional mortality the population would be 30.9-31.1% lower than compared to an unimpacted scenario. This impact has the potential to conflict with the conservation objectives of this feature to restore the population. As highlighted in 5.4.9.4 Natural England agreed that the impact calculated for the Round 4 Plan in-combination is considered to be unsustainable.

5.4.9.7. NIRAS (2022) concluded that for kittiwake, on this basis, the impact from the Round 4 Plan is considered to be sustainable alone but conflicting with conservation objectives in-combination with other plans and projects. Additionally in light of advice from Natural England on the most recent offshore windfarm planning applications, and in view of the decision made by the Secretary of State in relation to Hornsea Three's impacts on the kittiwake feature of this European Site, consideration was given to available mitigation options to reduce the impacts associated with the Round 4 Plan. This identified that the predicted impact of the Round 4 Plan can be reduced to an impact representing less than a 0.5% increase in baseline mortality under all scenarios considered by restricting turbine design (such as increasing minimum tip height) at Preferred Projects 1 and 2. It was further concluded that the reduction in collisions expected from mitigation options identified by NIRAS (2022) would still represent an AEOSI in-combination with other plans and projects that is considered to be unsustainable.

5.4.9.8. For gannet the Primary Assessment (RIAA Appendix H) has found that, with the exception of collision risk and physical presence, all screened in pressures would lead to a negligible impact on this species at any population scale. In the Secondary Assessment (RIAA Appendix H) the combined impact of displacement and collision represents 0.69-2.88% of the baseline mortality at this European Site. Population Viability Analysis predicted sustainable population growth of the Flamborough and Filey Coast SPA gannet population despite additional mortality from the Round 4 Plan alone.

5.4.9.9. NIRAS (2022) concluded that for gannet there is no AEOSI from the Round 4 Plan alone, and that the change in baseline mortality from the in-combination contribution from the Round 4 Plan would not be immaterial. The total mortalities from collision and displacement from the Round 4 Plan in-combination

with other plans and projects is 341.3 to 361.1 birds/annum. Population Viability Analysis predicted sustainable population growth of the Flamborough and Filey Coast SPA gannet population despite additional mortality from the Round 4 Plan in-combination with other plans and projects. As highlighted in 5.4.9.4 Natural England, RSPB and The Wildlife Trusts concluded that the risk of an AEOSI could not be ruled out beyond reasonable scientific doubt for gannet in relation to Round 4 plan in combination. Despite the identified sustainable population growth NIRAS (2022) undertook additional assessment on mitigation (linked to kittiwake feature) benefits to gannet from wind turbine design changes including raising the minimum tip height of projects on the east coast which have further reduced levels of impact.

5.4.9.10. The Primary Assessment (RIAA Appendix H) for guillemot found that, with the exception of physical presence, all screened in pressures would lead to a negligible impact on this species at any population scale. The Secondary Assessment (RIAA Appendix H) found that mortality associated with the number of displaced birds apportioned to this European Site from the Round 4 Plan is estimated to be 19.1 birds/annum. This represents 0.4% of the baseline mortality at this European Site. A more conservative approach presented in RIAA Appendix H found that this impact could be as much as 53.4 birds/annum, which represents 1.1% of the baseline mortality. Population Viability Analysis predicts sustainable population growth of the Flamborough and Filey Coast SPA guillemot population despite additional mortality from the Round 4 Plan alone.

5.4.9.11. NIRAS (2022) concluded that for guillemot there is no AEOSI from the Round 4 Plan alone, and that the change in baseline mortality from the in-combination contribution from the Round 4 Plan would not be immaterial. The in-combination assessment for guillemot identified the potential for other plans and projects to displace this feature. The impact predicted for the Round 4 Plan in-combination with other plans and projects is 520 birds/annum. Population Viability Analysis predicts sustainable population growth of the Flamborough and Filey Coast SPA guillemot population despite additional mortality from the Round 4 Plan in-combination with other plans and projects. As highlighted in 5.4.9.4 Natural England were not able to advise on the impact for the Round 4 Plan in-combination – due to Hornsea Four missing from the in-combination assessments. NIRAS have updated the RIAA to include Hornsea Four in the in-combination assessment and outlined that the conclusions have not changed and sustainable population growth of the guillemot population is expected.

5.4.9.12. The primary assessment for herring gull found that all screened in pressures would lead to a negligible impact on this species at any population scale. NIRAS (2022) concluded that for herring gull the impact from the Round 4 Plan alone is considered to be negligible, and that any additional impact from the Round 4 Plan alone is not expected to make an appreciable difference to any in-combination impact.

5.4.9.13. For razorbill the Primary Assessment (RIAA Appendix H) has found that, with the exception of physical presence all screened in pressures would lead to a negligible impact on this species at any population scale. In the Secondary Assessment (RIAA Appendix H), NIRAS (2022) concluded that for razorbill the impact in terms of displacement from the Round 4 Plan alone is considered to be negligible, and that the change in baseline mortality predicted from the Round 4 Plan alone is not expected to make an appreciable difference to any in-combination impact. As highlighted in 5.4.9.4 Natural England agreed that alone that the Round 4 plan alone is unlikely to result in an AEOSI for Flamborough and Filey Coast SPA, however Natural England an adverse effect on site integrity could not be ruled out for razorbill in relation to Round 4 plan in combination.

5.4.9.14. The Primary Assessment (RIAA Appendix H) for puffin, part of the site's assemblage feature, has found that with the exception of physical presence, all screened in pressures would lead to a negligible impact on this species at any population scale. In the Secondary Assessment (RIAA Appendix H), the mortality associated with the number of displaced birds apportioned to this European Site from the Round 4 Plan is estimated to be between 0.5-4.5 birds/annum. This represents between 0.29-2.42% of the baseline mortality at this European Site. However, this is based on population estimates that are highly likely to have been underestimated, comparisons against the baseline mortality of the most recent population estimate suggest an impact of four birds actually represents 0.13-1.11% of the baseline mortality of the puffin population at the SPA. Actual displacement mortality predicted is low and there are considered to be significant assumptions which lead to over-estimation associated with the predicted displacement mortality. Population Viability Analysis predicts population decline of the Flamborough and Filey Coast SPA puffin population, with additional mortality from the Round 4 Plan alone the population would be 0.9-8.8% lower than compared to an unimpacted scenario after 60 years. As highlighted in 5.4.9.4 Natural England concluded that the risk of an adverse effect on site integrity could be ruled out for puffin, in relation to Round 4 plan alone.

5.4.9.15. NIRAS (2022) concluded that for puffin there is no AEOSI from the Round 4 Plan alone, and that the change in baseline mortality from the in-combination contribution from the Round 4 Plan would not be immaterial. The in-combination assessment for puffin identified the potential for other plans and projects to displace this feature. The impact predicted for the Round 4 Plan in-combination with other plans and projects is 6-36 birds/annum. Population Viability Analysis predicts population decline of the Flamborough and Filey Coast SPA puffin population, with additional mortality from the Round 4 Plan in-combination with other plans and projects the population would be 11.6-51.7% lower than compared to an unimpacted scenario after 60 years. Natural England have advised in previous assessments that impacts towards the lower end of the scale presented here should be considered and that impacts of that magnitude would mean that there is no indication of a predicted potential decline in the growth rate of the puffin population. Puffin was assessed on the basis that it is an un-named component of an assemblage feature, and The Crown Estate have sought clarification from Natural England on whether an assessment on this basis is appropriate and it has been confirmed that there is no conclusive evidence that puffin meet any criteria set out in Natural England's Supplementary Advice that would require it to be considered a main component of the breeding bird assemblage. NIRAS (2022) concluded that the magnitude of the impact predicted would not lead to an adverse effect on the assemblage of which it forms a part. This means that neither the abundance nor richness of the breeding seabird assemblage at the Flamborough and Filey Coast SPA would be reduced to the extent that it would cause an adverse effect on site integrity.

5.4.9.16. As highlighted in 5.4.9.4 Natural England concluded that the risk of an AEOSI could not be ruled out for puffin, in relation to Round 4 plan in combination, due to limited information on available evidence and the omission of Hornsea Four from the in-combination assessment. Since then, NIRAS updated the RIAA to include Hornsea Four in the in-combination assessment and outlined that, as Preferred Projects are in areas of low puffin densities, the conclusions have not changed and sustainable population growth of the puffin population is expected.

5.4.9.17. The Crown Estate has given significant weight to the comments made by Natural England, the RSPB and The Wildlife Trusts with respect to the Flamborough and Filey Coast SPA, as detailed above. The addition of Hornsea Four to the in-combination assessment undertaken by NIRAS and resulting conclusions has demonstrated sustainable population growth of guillemot and puffin populations are expected.

5.4.9.18. Concerns were raised over the results of PVA modelling which suggests future population declines could be significant for gannet, kittiwake, guillemot, razorbill (RSPB) and puffin (Natural England and RSPB) however there is sufficient uncertainty associated with PVA modelling. The PVA model is a very crude approximation of the behaviour of each population modelled and built on numerous assumptions and simplifications. It does not take account of any density dependent competition within breeding populations (which almost certainly operates in the large seabird colonies found in Britain). Second, any inaccuracies will compound when extrapolated over a 60 year period. It is considered that the model has low explanatory power over this very long time frame. Finally, there is no agreed method for interpreting the output metrics of the model which is typically done in a subjective way. As a matter of law, each individual project will be required to undertake a project level HRA, where a LSE on a European site cannot be excluded beyond once further detailed project design has been undertaken and more certainty is known about project impacts and appropriate mitigation. Therefore, the uncertainties as to the level of effect (i.e. due to the lack of site-specific data, the increasing knowledge base in relation to parameters used in modelling and the degree of connectivity between the Preferred Projects and the SPA) will be addressed through the project level assessment.

5.4.9.19. The Crown Estate considers that a meaningful assessment has been undertaken to the extent feasible on the best available evidence. The Crown Estate considers that the in combination assessment has been undertaken appropriately within the RIAA and has no remaining concerns for gannet, razorbill and puffin that prevent AEOSI being ruled out in relation to these features at Flamborough and Filey Coast SPA. The Crown Estate takes the view that the use of mitigation (including minimum tip height restrictions for Preferred Projects 1 and 2) will benefit other species (as highlighted within Annex H.6 for gannet) and as such agrees with the conclusions by NIRAS for gannet, razorbill, guillemot and puffin for the Flamborough and Filey Coast SPA that AEOSI can be ruled out for these features at the Flamborough and Filey Coast SPA alone and in-combination.

5.4.9.20. The Crown Estate has considered the ability to mitigate the impact on the Flamborough and Filey Coast SPA and has concluded that, based on the evidence currently available, it is possible to mitigate the impact alone to an acceptable level, but it is not possible to mitigate the in-combination impact to an acceptable level with regards to the kittiwake feature. The Crown Estate has, therefore, decided that it is unable to conclude that the Round 4 Plan will not adversely affect the integrity of the SPA and that the further tests set out in the Habitats Regulations must be considered. These include an assessment of alternative solutions, IROPI and environmental compensation.

5.4.10. **Forth Islands SPA**

5.4.10.1. Forth Islands SPA is classified for gannet and kittiwake. The features have a maintain conservation objective and is currently in favourable maintained (gannet) and unfavourable declining (kittiwake) condition. For kittiwake the predicted impact is under the 0.5 % baseline mortality threshold and as such is not considered further – for further detail refer to the caveat in paragraphs 5.4.1 to 5.4.2 for consideration of baseline mortality.

5.4.10.2. Section 4.60.2 to 4.60.11 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SPA screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, physical presence,

underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.4.10.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.4.10.4. For gannet the Primary Assessment (RIAA Appendix H) has found that, with the exception of collision risk and physical presence, all screened in pressures would lead to a negligible impact on this species at any population scale. In the Secondary Assessment (RIAA Appendix H), the number of collisions apportioned to this European Site from the Round 4 Plan is estimated to be 3.6-4.4 collisions/annum. This represents 0.10-0.13% of the baseline mortality at this European Site. NIRAS (2022) noted that Marine Scotland Science and NatureScot have previously advised that consideration of displacement impacts for gannet is not required as such impacts are not considered likely to result in an adverse effect on the site integrity of an SPA based on the findings of Searle et al (2014). The number of mortalities associated with displaced birds apportioned to this European Site from the Round 4 Plan is estimated to 1.6-22.8 birds/annum. This represents 0.05-0.65% of the baseline mortality at this European Site.

5.4.10.5. JNCC raised in-combination effect concerns for gannet at Forth Islands SPA and outlined previous NatureScot advice regards to in-combination effects on gannet at Forth Islands SPA from Seagreen, Neart na Gaoithe and Inch Cape. NIRAS updated the RIAA to reflect this advice from NatureScot outlining that, the current level of in-combination mortality estimated for this feature at this European Site represents an adverse effect on the integrity of the SPA. NIRAS (2022) noted that the change in baseline mortality predicted from the Round 4 Plan alone is not expected to make an appreciable difference to any in-combination impact.

5.4.10.6. For kittiwake the Primary Assessment (RIAA Appendix H) has found that, with the exception of collision risk, all screened in pressures would lead to a negligible impact on this species at any population scale. NIRAS (2022) concluded that for kittiwake the impact from the Round 4 Plan alone is considered to be negligible, and that the change in baseline mortality predicted from the Round 4 Plan alone is not expected to make an appreciable difference to any in-combination impact.

5.4.10.7. As highlighted above JNCC raised concerns around the in-combination assessment for gannet and outlined the potential usage of Preferred Projects 1 and 2 areas by gannet and that the risk of an AEOSI could not be ruled out in relation to Round 4 plan in combination, due to the combination of the Scottish Sectoral Marine Plan for Offshore Wind, and existing projects in the Forth/Tay area. JNCC highlighted that the HRA for the Sectoral Marine Plan could not rule out further adverse impacts on gannets from this European Site (resulting from development in Development Plan Options E1, E2 and E3 in combination with existing (and planned) projects at the time), based on available evidence. NIRAS (2022) confirmed the assessment assumed usage of the Preferred Project areas by gannet (foraging range) and added the above context to the RIAA however this does not affect the conclusions in respect of this European Site and its features.

5.4.10.8. The Crown Estate has given significant weight to the comments made by JNCC with respect to Forth Islands SPA, as detailed above following an update to the RIAA by NIRAS, The Crown Estate considers that the in combination assessment has been undertaken appropriately and after taking into account the views expressed by JNCC and has no remaining concerns for gannet at Forth Islands SPA.

5.4.10.9. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Forth Islands SPA. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity to Forth Islands SPA, alone or in-combination with other plans and projects.

5.4.11. **Greater Wash SPA**

5.4.11.1. Greater Wash SPA is classified for Sandwich tern. The condition of the feature is not currently available however it has a maintain or restore conservation objective.

5.4.11.2. Section 4.61.2 to 4.61.6 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SPA screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.4.11.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.4.11.4. For Sandwich tern the Primary Assessment (RIAA Appendix H) found that, with the exception of collision risk, all screened in pressures would lead to a negligible impact on this species at any population scale. The Secondary Assessment (RIAA Appendix H) provided evidence to demonstrate that a negligible number of birds are likely to interact, and therefore collide with, any of the Preferred Projects. NIRAS (2022) concluded that for Sandwich tern there is limited potential for the Round 4 Plan alone to contribute to any in-combination impact.

5.4.11.5. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Greater Wash SPA. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity to Greater Wash SPA, alone or in-combination with other plans and projects.

5.4.12. **Liverpool Bay SPA**

5.4.12.1. Liverpool Bay SPA is classified for red-throated diver, cormorant, common scoter, red-breasted merganser and little gull. The features have a maintain or restore conservation objective and are currently in favourable (red-throated diver and common scoter) condition, the remaining features do not have a condition assessment available. For common scoter the predicted impact is under the 0.5 % baseline mortality threshold and as such is not considered further – for further detail refer to paragraphs 5.4.1 to 5.4.2 for consideration of baseline mortality.

5.4.12.2. Section 4.66.2 to 4.66.19 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SPA screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, physical presence, underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.4.12.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.4.12.4. The Primary Assessment (RIAA Appendix H) found that, with the exception of physical presence (red-throated diver and common scoter), all screened in pressures would lead to a negligible impact on these species at any population scale. Natural England have previously advised that for red-throated diver the current level of in-combination mortality estimated for this feature at this European Site represents an AEOSI of the SPA, but that the change in baseline mortality predicted from the Round 4 Plan alone is not expected to make an appreciable difference to any in-combination impact. In the Secondary Assessment (RIAA Appendix H), NIRAS (2022) concluded that the impact in terms of displacement from the Round 4 Plan alone is considered to be negligible, and that the small change in baseline mortality predicted from the Round 4 Plan alone is not expected to make an appreciable difference to any in-combination impact.

5.4.12.5. For cormorant the Primary Assessment (RIAA Appendix H) found that all screened in pressures would lead to a negligible impact on this species at any population scale. NIRAS (2022) concluded that the impact from the Round 4 Plan alone is considered to be negligible, and that in view of the Primary Assessment, any additional impact from the Round 4 Plan alone would not make an appreciable difference to any in-combination impact.

5.4.12.6. The Primary Assessment (RIAA Appendix H) for red-breasted merganser found that, with the exception of physical presence, all screened in pressures would lead to a negligible impact on this species at any population scale. The Secondary Assessment (RIAA Appendix H) provided evidence to demonstrate that a negligible number of birds are likely to utilise areas within the Round 4 Plan. NIRAS (2022) concluded that for red-breasted merganser the impact in terms of displacement from the Round 4 Plan alone is considered to be negligible, and in view of the Primary Assessment any additional impact from the Round 4 Plan alone would not make an appreciable difference to any in-combination impact.

5.4.12.7. The Primary Assessment (RIAA Appendix H) for little gull found that, with the exception of collision risk, all screened in pressures would lead to a negligible impact on this species at any population scale. The collision risk modelling within the Secondary Assessment (RIAA Appendix H) outlined the number of un-apportioned collisions to this European Site from the Round 4 Plan is estimated to be 0.78 collisions/annum. This represents 1.23% of the baseline mortality at this European Site. If the collision risk estimate was apportioned to the European Site, the collision risk estimate would be much lower, and likely indiscernible from background mortality. NIRAS (2022) concluded that for little gull the impact from the Round 4 Plan alone is considered to be negligible, and any additional impact from the Round 4 Plan alone would not make an appreciable difference to any in-combination impact.

5.4.12.8. Natural England and JNCC raised that the RIAA should quantitatively consider the overlap between red-throated diver and indirect habitat loss of the supporting habitat. NIRAS updated the RIAA to consider this and demonstrates minimal overlap of Preferred Project 5 and important habitat for red-throated diver. The Crown Estate considers that the assessment has been undertaken appropriately.

5.4.12.9. Natural England also raised the implications of vessel movement from Preferred Project 5 and interaction with Liverpool Bay SPA and the inability to conclude no appreciable difference to an in-combination impact. There are no details available at this stage of the location or magnitude of these activities. Additional measures will be implemented at project level, secured through the Round 4 Plan

Obligations Document "R4POD" (see 6.2.7 - 6.2.14), in relation to these activities, including, the agreement of an appropriate vessel traffic management plan which would typically include:

- Restricting vessel movements to existing navigation routes (where the densities of divers are typically relatively low);
- Where it is necessary to go outside of established navigational routes, selecting routes that avoid known aggregations of birds;
- Maintaining direct transit routes (to minimise transit distances through areas used by divers);
- Avoidance of over-revving of engines (to minimise noise disturbance); and
- Briefing of vessel crew on the purpose and implications of these vessel management practices (through, for example, toolbox talks).

5.4.12.10. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Liverpool Bay SPA. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity to Liverpool Bay SPA, alone or in-combination with other plans and projects.

5.4.13. **Lough Neagh & Lough Beg Ramsar**

5.4.13.1. Lough Neagh & Lough Beg Ramsar is designated for lesser black-backed gull. The condition of the feature and conservation objectives for the site are not currently available.

5.4.13.2. Section 4.67.2 to 4.67.7 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SPA screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.4.13.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.4.13.4. The Primary Assessment (RIAA Appendix H) for lesser black-backed gull found that, with the exception of collision risk, all screened in pressures would lead to a negligible impact on this species at any population scale. The number of collisions apportioned to this European Site from the Round 4 Plan in the Secondary Assessment (RIAA Appendix H) is estimated to be 0.5-0.6 collisions/annum. This represents 0.52-0.58% of the baseline mortality at this European Site. The estimated number of collisions is considered to be negligible and more likely indiscernible from background mortality. NIRAS (2022) concluded that for lesser black-backed gull the impact from the Round 4 Plan alone is considered to be negligible, and in view of the Primary Assessment any additional impact from the Round 4 Plan alone would not make an appreciable difference to any in-combination impact.

5.4.13.5. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Lough Neagh & Lough Beg Ramsar. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity to Lough Neagh & Lough Beg Ramsar, alone or in-combination with other plans and projects.

5.4.14. **Mersey Narrows and North Wirral Foreshore SPA**

5.4.14.1. Mersey Narrows and North Wirral Foreshore SPA is classified for common tern. The condition of the feature is not currently available however the feature has a maintain conservation objective.

5.4.14.2. Section 4.68.2 to 4.68.5 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SPA screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to indirect physical, underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.4.14.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.4.14.4. For common tern the Primary Assessment (RIAA Appendix H) found that all screened in pressures would lead to a negligible impact on this species at any population scale. NIRAS (2022) concluded that for common tern the impact from the Round 4 Plan alone is considered to be negligible, and that in view of the Primary Assessment, any additional impact from the Round 4 Plan alone would not make an appreciable difference to any in-combination impact.

5.4.14.5. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Mersey Narrows and North Wirral Foreshore SPA. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity to Mersey Narrows and North Wirral Foreshore SPA, alone or in-combination with other plans and projects.

5.4.15. **Morecambe Bay Ramsar, Duddon Estuary Ramsar & Morecambe Bay and Duddon Estuary SPA**

5.4.15.1. Morecambe Bay Ramsar, Duddon Estuary Ramsar & Morecambe Bay and Duddon Estuary SPA are designated or classified for lesser black-backed gull, herring gull, Sandwich tern and black-headed gull. The condition of the features is not currently available however the features have maintain/restore conservation objectives. For herring gull the predicted impact is under the 0.5 % baseline mortality threshold and as such is not considered further – for further detail refer to the caveat in paragraphs 5.4.1 to 5.4.2 for consideration of baseline mortality.

5.4.15.2. Section 4.69.2 to 4.69.17 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the Ramsar & SPA screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.4.15.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.4.15.4. The Primary Assessment (RIAA Appendix H) for lesser black-backed gull found that, with the exception of collision risk, all screened in pressures would lead to a negligible impact on this species at any population scale. The predicted in-combination collision risk estimate in the Secondary Assessment (RIAA Appendix H) represents 6.25-6.27% of the baseline mortality of the lesser black-backed gull population of

the Morecambe Bay and Duddon Estuary SPA. NIRAS (2022) concluded that the impact from the Round 4 Plan alone is considered to be negligible, and that the change in baseline mortality from the in-combination contribution from the Round 4 Plan would not be immaterial. However, the values used to calculate the in-combination total (for both the Round 4 Plan and in-combination projects) reflect collision risk estimates that were made when the breeding population at Morecambe Bay was significantly higher than it is now. Collision rates calculated using current reduced densities will be substantially lower. An impact of this approximate magnitude has not previously been considered to represent an AEOSI (DECC, 2014), and the impact from the Round 4 Plan alone is not considered to represent an appreciable increase to this.

5.4.15.5. The Primary Assessment (RIAA Appendix H) for Sandwich tern found that with the exception of collision risk, all screened in pressures would lead to a negligible impact on these species at any population scale. The Secondary Assessment (RIAA Appendix H) provided evidence to demonstrate that a negligible number of birds are likely to utilise areas within the Round 4 Plan. NIRAS (2022) concluded the impact from the Round 4 Plan alone is considered to be negligible, and any additional impact from the Round 4 Plan alone would not make an appreciable difference to any in-combination impact.

5.4.15.6. The Primary Assessment (RIAA Appendix H) for black-headed gull found that all screened in pressures would lead to a negligible impact on this species at any population scale. NIRAS (2022) concluded that the impact from the Round 4 Plan alone is considered to be negligible, and in view of the Primary Assessment any additional impact from the Round 4 Plan alone would not make an appreciable difference to any in-combination impact.

5.4.15.7. BEIS raised concerns over the conclusion of no AEOSI with regards to lesser black-backed gull (alone and in-combination) for Morecambe Bay Ramsar, Duddon Estuary Ramsar & Morecambe Bay and Duddon Estuary SPA. This conclusion was reached with regard to previous assessments by DECC (2014) where impacts of higher magnitude concluded that the effect would not prevent the site from achieving favourable conservation status in line with the site's published conservation objectives (see paragraph 6.1.558 of RIAA Appendix H). The values used to calculate the in-combination total (for both the Round 4 Plan and in-combination projects) reflect collision risk estimates that were made when the breeding population at Morecambe Bay was significantly higher than it is now. Collision rates calculated using current reduced densities will be substantially lower, with the population size of the Protected Site having an exponential relationship with densities of birds. It was identified that the predicted mortalities were much lower than the population could withstand without experiencing a long term population decline. Similarly NIRAS (2022) outlined that the impact from the Round 4 Plan alone is not considered to represent an appreciable increase to this value. No concerns were raised by the SNCBs for this feature at this European Site. The Crown Estate therefore considers that the assessment has been undertaken appropriately.

5.4.15.8. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Morecambe Bay Ramsar, Duddon Estuary Ramsar & Morecambe Bay and Duddon Estuary SPA. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity to Morecambe Bay Ramsar, Duddon Estuary Ramsar & Morecambe Bay and Duddon Estuary SPA, alone or in-combination with other plans and projects.

5.4.16. **North Norfolk Coast Ramsar & SPA**

5.4.16.1. North Norfolk Coast Ramsar & SPA is classified for Sandwich tern. The condition of the feature is not currently available however it has a maintain or restore conservation objective.

5.4.16.2. Section 4.71.2 to 4.71.6 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the Ramsar & SPA screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.4.16.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.4.16.4. For Sandwich tern the Primary Assessment (RIAA Appendix H) found that, with the exception of collision risk, all screened in pressures would lead to a negligible impact on this species at any population scale. The Secondary Assessment (RIAA Appendix H) provided evidence to demonstrate that a negligible number of birds are likely to interact, and therefore collide with, any of the Preferred Projects. NIRAS (2022) concluded that for Sandwich tern there is limited potential for the Round 4 Plan alone to contribute to any in-combination impact.

5.4.16.5. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to North Norfolk Coast Ramsar & SPA. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity to North Norfolk Coast Ramsar & SPA, alone or in-combination with other plans and projects.

5.4.17. **Northumberland Marine SPA**

5.4.17.1. Northumberland Marine SPA is classified for lesser black-backed gull, kittiwake and puffin. The condition of the features is not currently available however they have a maintain / restore conservation objective. For lesser black-backed gull, kittiwake and puffin the predicted impacts are under the 0.5 % baseline mortality threshold and as such are not considered further – for further detail refer to paragraphs 5.4.1 to 5.4.2 for consideration of baseline mortality

5.4.17.2. Section 4.72.2 to 4.72.6 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SPA screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, physical presence, underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.4.17.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.4.17.4. The Northumberland Marine SPA is classified to protect the sea areas used by the populations of birds designated as part of multiple SPAs (Coquet Island, Farne Islands, Lindisfarne and Northumbria Coast). As a result the predicted impacts and the assessment conclusions drawn for the constituent SPAs are considered equally applicable to the Northumberland Marine SPA. NIRAS (2022) concluded that for lesser black-backed gull, kittiwake and puffin, the impact from the Round 4 Plan alone is considered to be

negligible, and any additional impact from the Round 4 Plan alone would not make an appreciable difference to any in-combination impact.

5.4.17.5. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Northumberland Marine SPA. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity to Northumberland Marine SPA, alone or in-combination with other plans and projects.

5.4.18. **Northumbria Coast Ramsar**

5.4.18.1. Northumbria Coast Ramsar is designated for kittiwake, the predicted impact is under the 0.5 % baseline mortality threshold and as such is not considered further – for further detail refer to paragraphs 5.4.1 to for 5.4.2 consideration of baseline mortality.

5.4.18.2. Section 4.73.2 to 4.73.7 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the Ramsar screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.4.18.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.4.18.4. For kittiwake the Primary Assessment (RIAA Appendix H) has found that, with the exception of collision risk, all screened in pressures would lead to a negligible impact on this species at any population scale. In the Secondary Assessment NIRAS (2022) concluded that for kittiwake the impact in terms of collision risk from the Round 4 Plan alone is considered to be negligible, and that the change in baseline mortality predicted from the Round 4 Plan alone is not expected to make an appreciable difference to any in-combination impact.

5.4.18.5. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Northumbria Coast Ramsar. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of Northumberland Coast Ramsar, alone or in-combination with other plans and projects.

5.4.19. **Outer Firth of Forth and St. Andrews Bay Complex SPA**

5.4.19.1. Outer Firth of Forth and St. Andrews Bay Complex SPA is classified for gannet and kittiwake. The condition of the features is not currently available however they have a maintain / restore conservation objective. For gannet and kittiwake the predicted impacts are under the 0.5 % baseline mortality threshold and as such are not considered further – for further detail refer paragraphs 5.4.1 to 5.4.2 for consideration of baseline mortality

5.4.19.2. Section 4.74.2 to 4.74.5 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SPA screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, physical presence,

underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.4.19.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.4.19.4. The Outer Firth of Forth and St. Andrews Bay Complex SPA is classified to protect the sea areas used by the populations of birds designated as part of multiple SPAs (Forth Islands and St Abbs's to Fast Castle). As a result the predicted impacts and the assessment conclusions drawn for the constituent SPAs are considered equally applicable to the Outer Firth of Forth and St. Andrews Bay Complex SPA. NIRAS (2022) concluded that for gannet and kittiwake, the Round 4 Plan alone is considered to be negligible, and that the change in baseline mortality predicted from the Round 4 Plan alone is not expected to make an appreciable difference to any in-combination impact.

5.4.19.5. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Outer Firth of Forth and St. Andrews Bay Complex SPA. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of Outer Firth of Forth and St. Andrews Bay Complex SPA, alone or in-combination with other plans and projects.

5.4.20. **Rathlin Island SPA**

5.4.20.1. Rathlin Island SPA is classified for lesser black-backed gull, kittiwake and puffin. The features have a maintain or enhance conservation objective and are currently in favourable condition. For kittiwake and puffin the predicted impacts are under the 0.5 % baseline mortality threshold and as such are not considered further – for further detail refer to the caveat in paragraphs 5.4.1 to 5.4.2 for consideration of baseline mortality.

5.4.20.2. Section 4.75.2 to 4.75.15 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SPA screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, physical presence, underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.4.20.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.4.20.4. The Primary Assessment (RIAA Appendix H) for lesser black-backed gull found that, with the exception of collision risk, all screened in pressures would lead to a negligible impact on this species at any population scale. The collision risk modelling within the Secondary Assessment (RIAA Appendix H) outlined the number of collisions apportioned to this European Site from the Round 4 Plan is estimated to be 0.5-0.6 collisions/annum. This represents 1.47-1.64% of the baseline mortality at this European Site. It is considered highly unlikely that a significant proportion of lesser black-backed gull from Rathlin Island SPA will forage in the sea areas in which the Preferred Projects will be located. The value applied (10%) is considered to be highly precautionary with large gulls unlikely to be found foraging at distances offshore commensurate with the distance between Rathlin Island SPA and the Preferred Projects. Despite the

predicted collision risk exceeding the 1% baseline mortality threshold of the Rathlin Island SPA population, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account. NIRAS (2022) concluded that for lesser black-backed gull the impact from the Round 4 Plan alone is considered to be negligible, and due to the low population associated with the site indiscernible from background mortality, and in view of the Primary Assessment any additional impact from the Round 4 Plan alone would not make an appreciable difference to any in-combination impact.

5.4.20.5. The Primary Assessment (RIAA Appendix H) found that, with the exception of collision risk (kittiwake) and physical presence (puffin), all screened in pressures would lead to a negligible impact on these species at any population scale. In the Secondary Assessment NIRAS (2022) concluded that the impact in terms of collision risk and displacement from the Round 4 Plan alone is considered to be negligible, and that the change in baseline mortality predicted from the Round 4 Plan alone is not expected to make an appreciable difference to any in-combination impact.

5.4.20.6. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Rathlin Island SPA. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of Rathlin Island SPA, alone or in-combination with other plans and projects.

5.4.21. **Ribble & Alt Estuaries Ramsar & SPA**

5.4.21.1. Ribble & Alt Estuaries Ramsar & SPA is classified for black-headed gull, lesser black-backed gull and common tern. The condition of the features is not currently available however the features have maintain/restore conservation objectives. For lesser black-backed gull the predicted impact is under the 0.5 % baseline mortality threshold and as such is not considered further – for further detail refer to paragraphs 5.4.1 to 5.4.2 for consideration of baseline mortality.

5.4.21.2. Section 4.76.3 to 4.76.11 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the Ramsar & SPA screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.4.21.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.4.21.4. The Primary Assessment (RIAA Appendix H) for lesser black-backed gull found that, with the exception of collision risk, all screened in pressures would lead to a negligible impact on this species at any population scale. In the Secondary Assessment (RIAA Appendix H), NIRAS (2022) concluded that for lesser black-backed gull the impact in terms of collision risk from the Round 4 Plan alone is considered to be negligible, and in view of the Primary Assessment any additional impact from the Round 4 Plan alone would not make an appreciable difference to any in-combination impact.

5.4.21.5. The Primary Assessment (RIAA Appendix H) found that all screened in pressures for black-headed gull and common tern would lead to a negligible impact on these species at any population scale. NIRAS (2022) concluded that the impact from the Round 4 Plan alone is considered to be negligible, and

that any additional impact from the Round 4 Plan alone is not expected to make an appreciable difference to any in-combination impact.

5.4.21.6. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Ribble & Alt Estuaries Ramsar & SPA. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of Ribble & Alt Estuaries Ramsar & SPA, alone or in-combination with other plans and projects.

5.4.22. **Skomer, Skokholm and the Seas off Pembrokeshire SPA**

5.4.22.1. Skomer, Skokholm and the Seas off Pembrokeshire SPA is classified for storm petrel, lesser black-backed gull, kittiwake and puffin. The features have a maintain conservation objective and is currently in favourable (kittiwake and puffin), unfavourable (lesser black-backed gull) and unknown (storm petrel) condition. For lesser black-backed gull, kittiwake and puffin the predicted impacts are under the 0.5 % baseline mortality threshold and as such are not considered further – for further detail refer to the caveat in paragraphs 5.4.1 to 5.4.2 for consideration of baseline mortality.

5.4.22.2. Section 4.79.2 to 4.79.17 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SPA screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, physical presence, underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.4.22.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.4.22.4. For storm petrel the Primary Assessment (RIAA Appendix H) found that all screened in pressures would lead to a negligible impact on this species at any population scale. NIRAS (2022) concluded that for storm petrel the impact from the Round 4 Plan alone is considered to be negligible, and that in view of the Primary Assessment, any additional impact from the Round 4 Plan alone would not make an appreciable difference to any in-combination impact.

5.4.22.5. The Primary Assessment (RIAA Appendix H) found that, with the exception of collision risk (lesser black-backed gull and kittiwake) and physical presence (puffin), all screened in pressures would lead to a negligible impact on these species at any population scale. In the Secondary Assessment (RIAA Appendix H), NIRAS (2022) concluded that the impact in terms of collision risk and displacement from the Round 4 Plan alone is considered to be negligible, and that the change in baseline mortality predicted from the Round 4 Plan alone is not expected to make an appreciable difference to any in-combination impact.

5.4.22.6. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Skomer, Skokholm and the Seas off Pembrokeshire SPA. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of Skomer, Skokholm and the Seas off Pembrokeshire SPA, alone or in-combination with other plans and projects.

5.4.23. **St Abb's Head to Fast Castle SPA**

5.4.23.1. St Abb's Head to Fast Castle SPA is classified for kittiwake. The feature has a maintain conservation objective and is currently in unfavourable declining condition. For kittiwake the predicted impact is under the 0.5 % baseline mortality threshold and as such is not considered further – for further detail refer to paragraphs 5.4.1 to 5.4.2 for consideration of baseline mortality.

5.4.23.2. Section 4.80.2 to 4.80.7 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SPA screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.4.23.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.4.23.4. For kittiwake the Primary Assessment (RIAA Appendix H) has found that, with the exception of collision risk, all screened in pressures would lead to a negligible impact on this species at any population scale. In the Secondary Assessment (RIAA Appendix H), NIRAS (2022) concluded that for kittiwake the impact in terms of collision risk from the Round 4 Plan alone is considered to be negligible, and that the change in baseline mortality predicted from the Round 4 Plan alone is not expected to make an appreciable difference to any in-combination impact.

5.4.23.5. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to St Abb's Head to Fast Castle SPA. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of St Abb's Head to Fast Castle SPA, alone or in-combination with other plans and projects.

5.4.24. **Strangford Lough Ramsar**

5.4.24.1. Strangford Lough Ramsar is designated for lesser black-backed gull, the predicted impact is under the 0.5 % baseline mortality threshold and as such is not considered further – for further detail refer to the caveat in paragraphs 5.4.1 to 5.4.2 for consideration of baseline mortality.

5.4.24.2. Section 4.81.2 to 4.81.7 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the Ramsar screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.4.24.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.4.24.4. The Primary Assessment (RIAA Appendix H) for lesser black-backed gull found that, with the exception of collision risk, all screened in pressures would lead to a negligible impact on this species at any population scale. In the Secondary Assessment (RIAA Appendix H), NIRAS (2022) concluded that for

lesser black-backed gull the impact in terms of collision risk from the Round 4 Plan alone is considered to be negligible, and that the change in baseline mortality predicted from the Round 4 Plan alone is not expected to make an appreciable difference to any in-combination impact.

5.4.24.5. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Strangford Lough Ramsar. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of Strangford Lough Ramsar, alone or in-combination with other plans and projects.

5.4.25. **The Wash Ramsar**

5.4.25.1. The Wash Ramsar is designated for lesser black-backed gull. Section 4.82.2 to 4.82.7 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the Ramsar screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.4.25.2. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.4.25.3. The Primary Assessment (RIAA Appendix H) for lesser black-backed gull found that, with the exception of collision risk, all screened in pressures would lead to a negligible impact on this species at any population scale. The collision risk modelling within the Secondary Assessment (RIAA Appendix H) outlined the number of collisions apportioned to this European Site from the Round 4 Plan is estimated to be 1.3-1.5 collisions /annum. This represents 0.41-0.47% of the baseline mortality at this European Site. A more conservative approach presented in RIAA Appendix H has found that this impact could be as much as 2.9-3.2 collisions/annum, which equates to 0.91-1.02 % of the baseline mortality. Despite this relatively high mortality rate, the actual number of collisions is considered to be negligible and more likely indiscernible from background mortality.

5.4.25.4. NIRAS (2022) concluded that for lesser black-backed gull the impact from the Round 4 Plan alone is considered to be negligible, and in view of the Primary Assessment any additional impact from the Round 4 Plan alone would not make an appreciable difference to any in-combination impact.

5.4.25.5. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to The Wash Ramsar. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of The Wash Ramsar, alone or in-combination with other plans and projects.

5.4.26. **Upper Solway Flats & Marshes Ramsar**

5.4.26.1. Upper Solway Flats & Marshes Ramsar is designated for lesser black-backed gull and herring gull. For lesser black-backed gull and herring gull the predicted impacts are under the 0.5 % baseline mortality threshold and as such are not considered further – for further detail refer to the caveat in paragraphs 5.4.1 to 5.4.2 for consideration of baseline mortality.

5.4.26.2. Section 4.83.2 to 4.83.10 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SPA screened into the assessment as a result of the Round 4 Plan.

This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, collision, underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.4.26.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.4.26.4. The Primary Assessment (RIAA Appendix H) for lesser black-backed gull and herring gull found that, with the exception of collision risk, all screened in pressures would lead to a negligible impact on these species at any population scale. In the Secondary Assessment (RIAA Appendix H), NIRAS (2022) concluded that the impact in terms of collision risk from the Round 4 Plan alone is considered to be negligible, and that any additional impact from the Round 4 Plan alone is not expected to make an appreciable difference to any in-combination impact.

5.4.26.5. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Upper Solway Flats & Marshes Ramsar. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of Upper Solway Flats & Marshes Ramsar, alone or in-combination with other plans and projects.

5.4.27. **Ynys Seiriol/ Puffin Island SPA**

5.4.27.1. Ynys Seiriol/ Puffin Island SPA is classified for cormorant. The feature has a maintain or restore conservation objective and is currently in favourable condition.

5.4.27.2. Section 4.86.2 to 4.86.5 of the RIAA provides detailed assessment of the potential risk of AEOSI to the relevant qualifying features of the SPA screened into the assessment as a result of the Round 4 Plan. This includes an assessment of the potential risk of the plan arising from impact pathways that were identified relating to habitat loss/gain, direct physical, indirect physical, physical presence, underwater noise, above water noise, toxic contaminants, light and suspended sediments both alone, and in combination with other reasonably foreseeable plans and projects.

5.4.27.3. NIRAS (2022) concluded that there will be no significant or adverse effect on the ability of the site and its features to achieve its conservation objectives and favourable conservation status from the Round 4 Plan either alone, or in combination with other plans and projects.

5.4.27.4. For cormorant the Primary Assessment (RIAA Appendix H) found that all screened in pressures would lead to a negligible impact on this species at any population scale. NIRAS (2022) concluded that for cormorant the impact from the Round 4 Plan alone is considered to be negligible, and that in view of the Primary Assessment, any additional impact from the Round 4 Plan alone would not make an appreciable difference to any in-combination impact.

5.4.27.5. The Crown Estate agrees with conclusions of the RIAA (NIRAS, 2022) with respect to Ynys Seiriol/ Puffin Island SPA. The Crown Estate has therefore ascertained that the Round 4 Plan would not adversely affect the integrity of Ynys Seiriol/ Puffin Island SPA, alone or in-combination with other plans and projects.

6. Mitigation Measures

6.1.1. The Crown Estate has identified mitigation measures relevant to the Round 4 Plan to mitigate potential adverse effects on specific European Sites. In addition to mitigation measures secured at the plan level, mitigation has been identified in the assessment to be considered and implemented (if required) at the project level, where there is potential for a LSE on a European site from a Round 4 project.

6.1.2. A project level HRA will be required for individual projects arising from the Round 4 Plan as a matter of law. Individual projects must have due regard to the outcomes and recommendations of this AA in determining project specific mitigation measures that may be identified and implemented in the light of detailed project design and greater certainty about the magnitude of the effects that will be available at that stage.

6.2. Plan level mitigation

Export Cable Route

6.2.1. NIRAS (2022) undertook an Export Cable Region Assessment ("ECRA") for European Sites and features for which the Screening Report (NIRAS, 2021) identified a risk of LSE from an Export Cable Region. Due to the considerable uncertainty associated with cable routes for the Preferred Projects (not yet defined) the ECRA has taken a risk- based approach (consideration of both the vulnerability of features and the vulnerability of the Protected Sites) to the potential impacts arising from the installation of offshore wind farm export cables and their associated infrastructure. The Crown Estate has concluded that it is not possible to undertake a reasonable and meaningful assessment of cable route impacts due to this uncertainty.

6.2.2. Feature Vulnerability was determined on the basis of the feature's risk ("Feature risk") to the pressures screened in and the nature of a feature's interaction ("Feature Interaction") with the Export Cable Regions. For all features a risk score has been assigned to each pressure screened into the assessment (see Screening Report). Feature risks were scored as low, medium or high. The nature of a feature's interaction with the Export Cable Regions was also scored as low, medium or high, based on the receptor specific criteria.

6.2.3. For SACs and SPAs Protected Site Vulnerability was determined on the basis of the condition of the Protected Sites ("Protected Site Condition") and any other impacting activities (e.g. from different marine industries) present at each Protected Site that have the potential to interact in-combination ("Protected Site In-combination").

6.2.4. The ECRA has been used to evaluate the overall risk of an AEOSI from each Export Cable Region (and the Export Cable Regions collectively), alone and in-combination with other plans and projects. The assessment does not replace the information requirements of project level HRAs and does not attempt to pre-empt their conclusions.

6.2.5. The ECRA drafted by NIRAS (2022) is useful at the plan level, as it provides indicative forecasts of risk that can be used to identify where interventions are likely to be required at the project level. Outcomes of the ECRA include mitigation measures detailed below.

6.2.6. The ECRA outputs, as drafted by NIRAS (2022), has since been updated by The Crown Estate to account for complete spatial avoidance (a new 'high' catergory) and transitioned into a 'traffic-light system'. With the low risk features now 'green', low-medium and medium now 'amber', high now 'red' and a new 'black' category. The black category splits the previously high category into two categories – driven by review of the

ECRA results and feature vulnerability for habitats. The black category will require complete spatial avoidance of these habitat features.

6.2.7. The mitigation measures identified will be secured through the Agreements for Lease and leaseholders will be required to demonstrate compliance with the mitigation measures in order to obtain an Agreement for Lease for any transmission assets.

6.2.8. The following required will be secured:

- Requirement to consult: regardless of the overall risk score allocated to the features from the ECRA the requirement to consult with the MMO and/or NRW and relevant SNCBs and where appropriate non-statutory consultees (such as The Wildlife Trusts and RSPB) at the following stages;
    - initial Area of Search (AoS); and
    - route selection and refinement.
- Risk assessment results: dependant on the overall risk score allocated to the features from the ECRA there are categories of mitigation to be applied to the features. These include low, low-medium, medium, and high risks.
    - Green (low risk): no specific measures but activities to be undertaken in line with industry best practice (e.g. application of an environmental management plan, pollution control plan and spillage response plan, and adherence to international conventions such as International Convention for the Prevention of Pollution from Ships (MARPOL) and International Regulations for Preventing Collisions at Sea (COLREGS).
    - Amber (low – medium risk): specific detail must be provided to The Crown Estate at the route selection and refinement stage. Cable route selection studies should be undertaken with a detailed evidence document provided outlining the process completed to identify the proposed export cable route(s) as well as feature specific information.
    - Red (high risk): affected developers must avoid irreparable damage (loss of a non-recoverable habitat) to these red risk features. Evidence should be submitted to The Crown Estate at the route selection and refinement stage outlining avoidance measures, mitigation and installation methods to reduce impacts depending on the type of risk.
    - Black (high risk): affected developers must spatially avoid these black risk features. Evidence should be submitted to The Crown Estate at the route selection and refinement stage outlining the avoidance of these features.

<u>Marine Mammal Features</u>

6.2.9. Where mortality or injury associated with underwater noise may occur in relation to all European Sites with marine mammals as features, project developers must adhere to adhere to industry guidelines:

- Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise (JNCC, 2010a); and
- JNCC guidelines for minimising the risk of injury to marine mammals from using explosives. (JNCC, 2010b).

<u>Southern North Sea SAC</u>

6.2.10. A Southern North Sea SAC Round 4 SSIP will be secured through Agreements for Lease, this will include strategic consideration of suitable measures and scheduling to ensure any development as a result of the Round 4 plan stays within the thresholds outlined Statutory Nature Conservations Body guidance (JNCC,

2020). It is expected that should projects gain development consent under the Planning Act 2008 this would then be replaced by a project level Site Integrity Plan.

Dogger Bank SAC

6.2.11. The HRA concludes there is habitat loss and damage from infrastructure on the sandbank habitat at Dogger Bank SAC based on the currently expected project design envelope, it is expected that project parameters would evolve and be refined based on site specific environmental survey data and following detailed engineering and design. To mitigate the impact on Dogger Bank SAC in so far as is possible, to reduce the amount of habitat loss and damage, project design restrictions have been implemented on Preferred Projects 1 and 2 to remove gravity base structures and suction caisson monopole foundations, and minimising rock protection as secondary cable protection within the SAC (RIAA Appendix J, Annex J.1). This will ultimately reduce the footprint of infrastructure for Preferred Projects 1 and 2 within the SAC. This mitigation is appropriate to reduce the level of impact on the sandbank feature within the SAC. Despite this reduction this does not allow AEOSI to be ruled out but reduces the impact on the feature of the site.

Flamborough and Filey Coast SPA

6.2.12. To reduce the collision risk levels of the Round 4 Plan an increase in wind turbine minimum tip height at Preferred Projects 1 and 2 (RIAA Appendix H, Annex H.6) up to a minimum that is technically achievable at the time of application for development consent, but no lower than 34 m is required. It should be noted that Preferred Project 3's project design envelope as submitted included a minimum tip height of 40 m. This mitigation is appropriate as evidence indicates kittiwake primarily fly below 30m and therefore the assessment undertaken by NIRAS (Annex H.6) has indicated this would reduce collisions from 108 collisions to 44.5 - 65.4. As a result of adding a minimum tip height restriction for kittiwake this will also benefit gannet. Assessment undertaken by NIRAS (Annex H.6) has indicated this would reduce collisions from 20.2 collisions to 7.8-11.7.

6.2.13. This mitigation reduces the level of impact on kittiwake so that AEOSI can be ruled out alone and the level of adverse effect in combination with other plans and projects is reduced.

Securing mitigation

6.2.14. The mitigation measures identified in this AA will be secured through Agreements for Lease for relevant Round 4 projects awarded rights as an outcome of this leasing process.

Unmitigable effects

6.2.15. It has not been possible to rule out an AEOSI for kittiwake at Flamborough and Filey Coast SPA in-combination and the sandbank features of Dogger Bank SAC, alone or in-combination.

6.2.16. Only two options remain for Flamborough and Filey Coast SPA and Dogger Bank SAC:

- the consideration of alternatives (including amendment to the plan); or
- explore the derogation provisions of the Habitats Regulations, i.e. if there are no feasible alternative solutions, whether there are IROPI for the plan to proceed, with the necessary compensatory measures secured in agreement with the relevant SNCB.

6.2.17. Therefore further consideration on whether the further tests set out in the Habitat Regulations can be met to allow the Round 4 Plan to proceed are presented in the Derogation Case Section.

6.3. Project specific mitigation

6.3.1. Table 5-1 of the RIAA (NIRAS 2022) identifies a list of impacts which require mitigation. Project level mitigation measures, if required, will be agreed with SNCBs and licensing authorities prior to consent. Any Agreement for Lease from The Crown Estate will stipulate that any future Lease is conditional upon gaining all relevant statutory consents; The Crown Estate will only issue a Lease once all necessary consents have been granted.

6.3.2. The Crown Estate expects developers responsible for Round 4 to undertake project level HRA, and in doing so, assess the effects referred to in the Round 4 Plan RIAA and identify the mitigation measures that are required. The Crown Estate further expects that developers will have due regard to the recommendations of the plan level HRA and the mitigations specified in Table 5-1 of that report. Furthermore, it is considered that whatever mitigation is required to avoid adverse effects can be applied at project level without compromising the viability of the Round 4 Plan.

6.3.3. The project design envelope for Preferred Projects 1 and 2 has been altered as mitigation with the primary objective to avoid or reduce harm. The spatial footprint of the turbines has been reduced (gravity based structures and suction caisson monopile foundations (reducing suction caisson jacket foundations) have been removed through project design restrictions) and minimising rock protection as secondary cable protection to reduce habitat loss and damage to the sandbank feature at Dogger Bank SAC. Additionally the minimum tip height of the turbines for these projects has been increased to what is technically achievable at the time of application for development consent, but no lower than 34 m above sea level to reduce the collision impact on the kittiwake feature at the Flamborough and Filey Coast SPA. These mitigations have the effect of reducing the amount of habitat loss at Dogger Bank SAC and reducing the number of collisions at Flamborough and Filey Coast SPA.

7. Conclusions

7.1.1. The Crown Estate has undertaken an AA of the effects of the proposed Round 4 Plan in respect of a number of European Sites and their qualifying features (as detailed in Appendix C of the Screening Report), and in consideration of their conservation objectives and the condition of the features. The Crown Estate has considered the information and analysis provided by NIRAS in the Principles Document, the Screening Report and the RIAA, and the advice from Natural England, Natural Resources Wales and JNCC and other stakeholders, including but not limited to The Wildlife Trusts and RSPB, provided over the course of the development of this HRA, to inform this Record of AA.

7.1.2. The Crown Estate considered the potential for AEOSI in respect of European Sites that may be affected by the plan, and other than Flamborough and Filey Coast SPA and Dogger Bank SAC, with the adoption of the mitigation measure identified in this AA, there is sufficient scope and flexibility for project specific mitigation measures to be applied at the project level by developers to ensure no AEOSI.

7.1.3. It has not been possible to rule out an AEOSI with regards to kittiwake at Flamborough and Filey Coast SPA in-combination and the sandbank feature of Dogger Bank SAC, alone or in-combination. Despite this a decision to restrict the project design envelope has been made, reducing the infrastructure footprint at the Dogger Bank SAC by restricting the use of gravity base structures, suction caisson monopile foundations and minimising cable protection for Preferred Projects 1 and 2. Mitigation has been applied by increasing the minimum tip height of the turbines at Preferred Projects 1 and 2 and maintaining Preferred Project 3 minimum tip height to reduce collision risk to kittiwake associated with the Flamborough and Filey Coast

SPA. Consideration is given to the further tests set out in the Habitat Regulations in the Derogation Case Section to determine whether the Round 4 Plan can proceed.

7.1.4. The assessment has identified a number of areas where it has not been possible to conduct a meaningful assessment due to the lack of key project specific information. An example UXO where injury ranges vary significantly depending on site specific conditions including location and water depth (as described in paragraph 5.3.40.8). As a matter of law, each project will be required to undertake an impact assessment, including project level HRA, where a LSE on a European Site cannot be excluded beyond reasonable scientific doubt. This assessment will take account of the detailed project design, informed by site-specific information, the distribution of the habitat features and their sensitivity to the proposed works. If necessary, project level HRA may also involve detailed site surveys and modelling work. The integrity of the European Site(s) will be safeguarded because no project will be awarded consent where it is considered that it will lead to an AEOSI in respect of a European Site unless a derogation case is sought on the basis that there are no alternative solutions and with the provision of evidence of IROPI and securing suitable compensation following the application of mitigation measures.

7.1.5. The views of stakeholders on the uncertainties of the Round 4 Plan, and its effects, as well as specific matters to be addressed by developers at project level will be provided to applicants that are awarded rights following the conclusion of the HRA process, and the Preferred Bidders will have regard to these in the development of the Round 4 Plan projects.

7.1.6. As such, The Crown Estate concludes that, with the exception of the Dogger Bank SAC and Flamborough and Filey Coast SPA, there will be no AEOSI in respect of any European Site, or the European Sites ability to achieve its conservation objectives as a result of the Round 4 Plan, both alone and in combination with other reasonably foreseeable plans and projects. With regards to the Dogger Bank SAC and Flamborough and Filey Coast SPA, given that The Crown Estate cannot exclude adverse effects on the integrity of these sites, consideration is given to the further tests set out in the Habitat Regulations in the Derogation Case Section to determine whether the Round 4 Plan can proceed.

7.1.7. The Crown Estate has also undertaken a Marine Conservation Zone assessment considering the features of sites designated under Part 5 of The Marine and Coastal Access Act 2008 separate to this HRA determining that there was no significant risk of hindering the conservation objectives.

8. Derogation Case

The Crown Estate has not found it possible to rule out an AEOSI with regards to kittiwake at Flamborough and Filey Coast SPA in-combination and the sandbank features of Dogger Bank SAC, alone or in-combination. However, The Crown Estate considers that there is a case for the Round 4 plan to proceed by means of a derogation on the basis that, in the absence of an alternative solution, that there are Imperative Reasons of Overriding Public Interest (IROPI) for the Round 4 Plan to proceed and compensatory measures necessary to ensure the overall coherence of the National Site Network can be secured. This is detailed below. As this is a HRA for the Round 4 Plan there are some acknowledged uncertainties that are subject to more detailed information that will not be available until detailed design and site specific surveys have been undertaken. As such, The Crown Estate have taken an approach to identify measures that will be available to compensate for adverse effects once the requirement is fully understood. In order to secure development consent, projects will be required to undergo project-level HRA and this will include assessment of project and site specific information.

8.1. Alternative Solutions

8.1.1. The Habitats Regulations provide that in circumstances where an adverse effect on the integrity of a European Site cannot be ruled out, the plan-making authority may, nevertheless, agree to the plan if it is satisfied that (there being no alternative solutions that would be less damaging to the European Site), the plan must be given effect for IROPI. This is known as a "derogation".

8.1.2. Defra's guide "Habitats regulations assessments: protecting a European site" (Defra, 2021) includes advice on the use of a derogation. In relation to the alternative solutions test, the guidance indicates that alternatives need to meet the original objectives of the proposal (in this case the Round 4 Plan); it goes on to state that an alternative solution is acceptable if it:

- achieves the same overall objective as the original proposal;
- is financially, legally and technically feasible; and
- is less damaging to the European Site and does not have an adverse effect on the integrity of this or any other European Site.

8.1.3. Therefore, the absence of feasible alternative solutions should be demonstrated before moving on to the next test for a derogation (IROPI).

8.1.4. The Crown Estate has considered the alternative solutions test following the established principles set out in The Habitat Regulations Assessment Handbook (Tyldesley and Chapman, 2013) to establish the presence or absence of alternative solutions:

Step 1 – define the objectives or purpose of the plan and the problem it is causing that needs to be solved, i.e. the harm that it would cause to the integrity of a European Site;

Step 2 – understand the need for the plan;

Step 3 – are there financially, legally and technically feasible alternative solutions;

Step 4 – are there alternative solutions with a lesser effect on the integrity of the European Site?

Step 1: Define the objectives or purpose of the plan and the problem it is causing

8.1.5. The key objectives of the Round 4 Plan are as follows:

1. To deliver at least 7 GW of new seabed rights in England and Wales.
2. To support the decarbonisation and security of UK electricity supply.
3. To facilitate the delivery of new offshore wind generation capacity in a timely manner to help meet UK government targets to cut greenhouse gas emissions to net zero by 2050.
4. To deliver greater volumes of low carbon electricity, as established by National Policy Statements EN-1 and EN-3, the UK government's Ten Point Plan for a Green Industrial Revolution[1], the Offshore Wind Sector Deal[2], the 2020 Energy White Paper[3], the Climate Change Act 2008 (as amended).
5. To maximise social and economic opportunities for the UK from energy infrastructure investment and (respond to the Clean Growth Strategy (DBEIS 2017) and the UK "Offshore Wind Sector Deal" (DBEIS 2019).
6. To support the UK's long-term plans for energy security and to increase domestic energy generation.

As noted in the AA, it has not been possible to rule out an AEOSI for kittiwake at Flamborough and Filey Coast SPA in-combination and the sandbank features of Dogger Bank SAC, alone or in-combination.

Step 2: Understand the need for the plan

8.1.6. With reference to the plan objectives above, the Round 4 Plan is needed to contribute to the UK's drive to meet its carbon reduction commitments. The Round 4 Plan supports decarbonisation and security of the UK's energy supply and government targets. Further detail relating to underpinning legislative drivers referred to within the objectives is provided below:

- Significant new offshore wind generation capacity is essential to help the UK meet its legally binding net zero by 2050 commitment (made through the Climate Change Act 2008 (2050 Target Amendment) Order 2019 - brought into force in June 2019 in response to recommendations by the Climate Change Committee (CCC) (CCC, 2019)) and interim carbon budgets.

- Additional new offshore wind generation capacity is required given the urgent need for greater volumes of low carbon electricity, and accelerating the transition from fossil fuels depends critically on how quickly new renewables including offshore wind can be rolled out. It is clear, that Round 4 is consistent with existing national policy in offering the potential of 7,980 MW of additional low carbon generation; it is also consistent with emerging national policy as evident from the consultation drafts of replacement National Policy Statements EN-1 and EN-3[4] and the UK government's intention to strengthen the Renewable National Policy Statements to reflect the importance of energy security and net zero, as set out in the Energy Security Strategy (April 2022).

[1] https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution

[2] https://www.gov.uk/government/publications/offshore-wind-sector-deal

[3] https://www.gov.uk/government/publications/energy-white-paper-powering-our-net-zero-future

[4] https://www.gov.uk/government/consultations/planning-for-new-energy-infrastructure-review-of-energy-national-policy-statements

Steps 3 and 4: Are there financially, legally and technically feasible alternative solutions, and are there alternative solutions with a lesser effect on the integrity of the European Site?

8.1.7. The table below sets out the alternative solutions considered by The Crown Estate and summarises The Crown Estate's assessment of each solution.

Do nothing	Not proceeding with the Round 4 Plan would remove the risk of impacts to the ornithological and benthic features identified to be at risk in the AA but would not meet the key objectives of the Round 4 Plan referred to above and in particular, to enable at least 7GW of new offshore wind rights in England and Wales; it would also hinder the wider need to deploy offshore wind generation at scale (50 GW[5]) before 2030 to help the UK meet its commitments under the Climate Change Act 2008 (as amended) and the UK's Nationally Determined Contribution (NDC) under the Paris Agreement to reduce greenhouse gas emissions by at least 68% from 1990 levels by 2030[6]. Not proceeding with the Round 4 Plan would also hinder the achievement of other aims and objectives of the British Energy Security Strategy (2022), including the ambition that by 2030 over half of the UK's renewable generation capacity will be from wind. Beyond the 2030 time horizon, the Government's Sixth Carbon Budget which was laid in legislation in April 2021 commits to cutting greenhouse gas emissions by 78% by 2035, compared to 1990 level, in line with the CCC recommendation. The sixth carbon budget spans from 2033-2037. As part of this target, the Government's Net Zero Strategy commits to the decarbonisation of power generation by 2035[7] and identifies Round 4 as a high level essential activity (Fig.16). In addition, in its proposed Sixth Carbon Budget, the Committee on Climate Change concluded that offshore wind is expected to become the "backbone" of the whole UK energy system, providing 65-70% of total generation by 2050; generating capacity for offshore wind is expected to be 100GW or more by 2050, with the CCC's five different scenarios ranging from 65GW to 140GW. In summary, there is an urgent need for renewable energy projects within the UK and accelerating the transition from fossil fuels depends critically on how quickly new renewables including offshore wind can be rolled out. The do nothing alternative solution would fail to meet the objectives of the Round 4 Plan and would erode the ability of the UK government to meet its 50GW by 2030 target, achieve its ambition that over half our renewable generation capacity will be from wind by 2030 and decarbonise power generation and reduce greenhouse gas emissions by 78% by 2035.
Amend Round 4 and a Preferred Projects capacity	Amending a Preferred Projects capacity from Round 4 would result in loss of capacity. It could reduce the risk of impacts to the ornithological and benthic features identified to be at risk in the AA but would not meet the objective of the Round 4 Plan to enable at least 7GW of new offshore wind rights in England and Wales (Objective 1); it would also hinder the wider need to deploy offshore wind generation at scale (50 GW) before

[5] https://www.gov.uk/government/publications/british-energy-security-strategy/british-energy-security-strategy#renewables

[6] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/943618/uk-2030-ndc.pdf

[7] https://www.gov.uk/government/publications/net-zero-strategy

	2030 to help the UK meet its commitments under the Climate Change Act 2008 (as amended) and the UK's NDC under the Paris Agreement to reduce greenhouse gas emissions by at least 68% from 1990 levels by 2030 (Objective 4); as indicated above, the Government's objective to decarbonise power generation by 2035 and to reduce greenhouse gas emissions by 78% by 2035 would also be hindered, as well as the Government's aims and objectives in the British Energy Security Strategy (relevant to Objective 6). There is an urgent need for renewable energy projects within the UK and accelerating the transition from fossil fuels depends critically on how quickly new renewables including offshore wind can be rolled out. The objective of 7 GW is considered to be appropriately ambitious given the scale of the need, identified above, and the priority role offshore wind is afforded by national policy and, sense-checked against early Preferred Projects work was judged to be reasonable. Additionally, it is possible that the development process across the Round 4 Preferred Projects could result in capacity attrition for many different and as yet unidentified reasons (environmental, technical or commercial), noting the substantial attrition previously experienced with the loss of projects such as Atlantic Array, Rhiannon (the whole Irish Sea Zone) and the West of the Isle of Wight project. This remains the case notwithstanding the significant reduction in time for the consenting process proposed in the British Energy Security Strategy; currently the detail of this proposal is unknown and attrition occurs for reasons other than the time taken in the consenting process such as financial (too costly), construction (too challenging) or supply chain issues. Given the imperative to decarbonise energy as rapidly as practicable, delays to project developments must also be mitigated against by allowing for a greater than 7GW total capacity for Round 4 to maximise the offshore wind industry potential to realise the Government targets. Amending the capacity of a Preferred Project as an alternative solution would fail to meet the objectives of the Round 4 Plan and would erode the ability of the UK government to meet its greenhouse gas emissions reduction targets (including net zero), achieve its ambition that over half our renewable generation capacity will be from wind by 2030 and achieve its objective to decarbonise power generation by 2035.
Remove Preferred Projects 1, 2 and 3	Removing Preferred Projects 1, 2 and 3 from Round 4 would result in the award of three Preferred Projects with a combined capacity of 3,480MW. It would remove the risk of impacts to the ornithological and benthic features identified to be at risk in the AA but would not meet the objective of the Round 4 Plan to enable at least 7GW of new offshore wind rights in England and Wales (Objective 1); it would also hinder the wider need to deploy offshore wind generation at scale (50 GW) before 2030 to help the UK meet its commitments under the Climate Change Act 2008 (as amended) and the UK's NDC under the Paris Agreement to reduce greenhouse gas emissions by at least 68% from 1990 levels by 2030 (Objective 4); as indicated above, the Government's objective to decarbonise power generation by 2035 and to reduce greenhouse gas emissions by 78% by 2035 would also be hindered. There is an urgent need for renewable energy projects within the UK and accelerating the transition from fossil fuels depends critically on how quickly new renewables including offshore wind can be rolled out. Removal of Preferred Projects 1, 2 and 3 as an alternative solution would fail to meet the objectives of the Round 4 Plan and would erode the ability of

	the UK government to meet its greenhouse gas emissions reduction targets (including net zero), achieve the aims and objectives of the British Energy Security Strategy (including the ambition that over half our renewable generation capacity will be from wind by 2030) and achieve its objective to decarbonise power generation by 2035.
Amend Round 4 and award alternative or different areas of seabed to Preferred Bidders.	The Round 4 leasing process consists of five stages which in summary comprise the following: 1. Pre-qualification Questionnaire (PQQ) which assessed potential Bidders' financial capability, technical experience and legal compliance, with successful Bidders pre-qualifying for the ITT Stage 1 process (becoming a Pre-qualified Bidder). 2. Invitation to Tender Stage 1 (ITT Stage 1) which assessed the financial and technical robustness of projects submitted by Pre-qualified Bidders. Bidder were required to submit projects in defined Bidding Areas. Projects that pass then become eligible to take part in the ITT Stage 2 process (becoming Eligible Bidders with Eligible Projects). 3. Invitation to Tender Stage 2 (ITT Stage 2) which was a multi-cycle bidding process in two phases, with issue of the ITT Stage 2 tender documentation in late 2020, followed by Bidding Cycles in early 2021. Using option fees bid by Eligible Bidders to determine award, one project was awarded per daily Bidding Cycle (working days only), with Bidding Cycles continuing until 7 GW was identified or exceeded (up to 8.5 GW) – in accordance with the rules of the tender. This process was completed in February 2021 and identified the Preferred Bidders and the six Preferred Projects [with a capacity of just under 8GW] that make up the Plan. 4. This Habitats Regulations Assessment – the plan-level HRA is undertaken by The Crown Estate in its role as a Competent Authority. 5. Subject to the outcome of the plan-level HRA, entry into Agreements for Lease with Preferred Bidders for the Preferred Projects. The Round 4 leasing process does not allow for the award of rights in any additional areas of seabed or for the offering of new areas of seabed to Preferred Bidders and to run Offshore Wind Leasing Round 4 again would result in significant delays and result in the failure to meet Objective 3. This would also result in delayed lead-in times for Preferred Bidders hindering the deployment offshore wind generation at scale (50 GW) before 2030 to help the UK meet its commitments. There would be implications in delaying and would result in undermining The Crown Estates reputation for timely leasing. Therefore this alternative solution has a similar outcome to do nothing alternative solution and would fail to meet the objectives of the Round 4 Plan. In the event that alternative areas of seabed could have been offered to Preferred Bidders this does not take into account the detailed and rigorous site identification Preferred Projects took in order to participate in the Round 4. This included assessment of project locations in all Bidding Areas with the express intent to secure the maximum available capacity as a key component of offshore wind growth strategy. The rationale considered for the siting of preferred projects include, but is not limited to, the following considerations:

	• The required size of the bidding area to support the project capacity according to the tender rules; • Environmental Sensitivities; • Distance from shore and length of export cable route; • Ground conditions; • Technical constraints including other infrastructure; and • Levelised Cost of Energy (LCOE) heat map showing substantial value differences.
Abandon Round 4 and re-start	Not proceeding with the Round 4 Plan as it is currently or re-starting the process would remove the risk of impacts to the ornithological and benthic features identified to be at risk in the AA but would cause significant delay to meeting the objectives of the Round 4 Plan; it would also hinder the wider need to deploy offshore wind generation at scale (50 GW) before 2030 to help the UK meet its commitments under the Climate Change Act 2008 (as amended) and the UK's NDC under the Paris Agreement to reduce greenhouse gas emissions by at least 68% from 1990 levels by 2030[8]. Beyond the 2030 time horizon, the Government's Sixth Carbon Budget sets a target to reduce greenhouse gas emissions by 78% from 1990 to 2035 (including international aviation and shipping emissions); as part of this target, the Government's Net Zero Strategy commits to the decarbonisation of power generation by 2035 and identifies Round 4 as a high level essential activity (Fig.16). In addition, in its proposed Sixth Carbon Budget, the Committee on Climate Change concluded that offshore wind is expected to become the "backbone" of the whole UK energy system, providing 65-70% of total generation by 2050; generating capacity for offshore wind is expected to be 100GW or more by 2050, with the CCC's five different scenarios ranging from 65GW to 140GW. There is, therefore, an urgent need for renewable energy projects within the UK, and accelerating the transition from fossil fuels depends critically on how quickly new renewables including offshore wind can be rolled out. The re-start Round 4 alternative solution would erode the ability of the UK government to meet the various targets and objectives which form part of its Net Zero Strategy and achieve the aims of the British Energy Security Strategy (2022), including the ambition that over half our renewable generation capacity will be from wind by 2030. Therefore, this alternative solution has a similar outcome to do nothing alternative solution and would fail to meet Objective 4 and Objective 6 of the Round 4 Plan.
Abandon Round 4 and rely on ScotWind and Floating Wind Leasing	Not proceeding with the Round 4 Plan would remove the risk of impacts to the ornithological and benthic features identified to be at risk in the AA but would not meet the objectives of the Round 4 Plan namely, to enable at least 7GW of new offshore wind rights in England and Wales. It would also hinder the wider need to deploy offshore wind generation at scale (50 GW) before 2030 to help the UK meet its commitments under the Climate Change Act 2008 (as amended) and the UK's NDC under the Paris Agreement to reduce greenhouse gas emissions by at least 68% from 1990 levels by 2030[10]. Beyond the 2030 time horizon, the Government's Sixth Carbon Budget sets a target to reduce greenhouse gas emissions by 78% from 1990 to 2035

[8] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/943618/uk-2030-ndc.pdf

	(including international aviation and shipping emissions); as part of this target, the Government's Net Zero Strategy commits to the decarbonisation of power generation by 2035 and identifies Round 4 as a high level essential activity (Fig.16). In addition, in its proposed Sixth Carbon Budget, the Committee on Climate Change concluded that offshore wind is expected to become the "backbone" of the whole UK energy system, providing 65-70% of total generation by 2050; generating capacity for offshore wind is expected to be 100GW or more by 2050, with the CCC's five different scenarios ranging from 65GW to 140GW. There is, therefore, an urgent need for renewable energy projects within the UK, and accelerating the transition from fossil fuels depends critically on how quickly new renewables including offshore wind can be rolled out. The Floating Wind leasing round in the Celtic Sea will be up to 4GW and the Sectoral Plan has assessed up to 10GW from ScotWind and the remaining 15GW are without further assessment. This alternative solution would fail to meet all of the objectives of the Round 4 Plan.
Alternative Project Design Restrictions	Changes to Preferred Projects 1 and 2 were made to: • Reduce the amount of habitat loss and damage at Dogger Bank SAC on the sandbank feature, project design restrictions have been implemented to remove gravity base structures and suction caisson monopile foundations, and minimising rock protection as secondary cable protection within the SAC. • Mitigate potential adverse effects on kittiwake at Flamborough and Filey Coast SPA by increasing minimum tip height of turbines from 24 m up to a minimum that is technically achievable at the time of application for development consent, but no lower than 34 m as mitigation for adverse effects arising from collision risk. Further alternative project designs were considered, such as layout of turbines within Preferred Project 1 and 2; such a restriction was considered inappropriate for a plan level HRA due to a lack of site specific information being available. The Crown Estate do not consider that a reduction of red line boundary would necessarily offer an reduction in impact as detailed design has not yet been undertaken and the number and location of turbines is not yet known. It is likely that the whole area will not be subject to development following detailed design and project refinement. Furthermore, a reduction in area may drive the need for larger turbines to meet the generation capacity and may have a knock on effect to SPA features, particularly kittiwake at Flamborough and Filey Coast for which impacts would also need to be mitigated for. There is also potential that larger turbines would require larger foundation pieces, including those The Crown Estate have identified to be restricted within Dogger Bank SAC due to technical feasibility, increasing the amount of habitat loss. Detailed project design is not known at the plan-level stage and would only be available once site specific survey work and detailed engineering and design work has been completed. Through the AA stage The Crown Estate has considered introducing feasible design restrictions that can reduce the impact on Dogger Bank SAC and Flamborough and Filey Coast SPA. Even with the inclusion of such restrictions and other forms of mitigation, The Crown Estate has concluded that in each case, an

	adverse effect on site integrity cannot be excluded. The Crown Estate has not been able to identify any other alternative project design restrictions that would result in no AEOSI.
Offshore Wind Farms not in UK EEZ	Offshore wind farm projects that are located outside UK territorial waters are not an alternative to the Round 4 Plan as this would not meet the objective to support the decarbonisation of the UK electricity supply and UK commitments on offshore wind generation. Although the UK is party to international treaties and conventions in relation to climate change and renewable energy, according to the principle of subsidiarity and its legally binding commitments under those treaties and conventions, the UK has its own specific legal obligations and targets in relation to carbon emission reductions and renewable energy generation. Other international and EU countries similarly have their own (different) binding targets. Sites outside the UK are required for other countries to achieve their own respective targets in respect of climate change and renewable energy.

Conclusion on Alternatives

8.1.8. The Crown Estate has considered a range of alternative solutions and has concluded that there are no feasible alternative solutions to the Round 4 Plan which meet the plan's objectives and which would lead to less harm to the affected European Sites.

8.1.9. Having identified the objectives of the Round 4 Plan and considered all alternative means of fulfilling these objectives, The Crown Estate is satisfied that no feasible alternative solutions with lesser effects are available.

8.2. Imperative Reasons of Overriding Public Interest (IROPI)

8.2.1. Having demonstrated the absence of alternative solutions, the HRA process provides that a plan (or project) having an adverse effect on the integrity of a European Site may (subject to there being no feasible alternative solutions and provision of necessary compensation) proceed if there are IROPI why the plan (or project) must, nevertheless, go ahead.

8.2.2. A number of in-principle grounds for IROPI are established through the derogation provisions and set out in guidance provided by Defra (Defra, 2021) and the European Commission (European Commission, 2019). It should be noted that where the site concerned hosts a priority natural habitat or a priority species, and those features are at risk of adverse effects, the grounds for IROPI should normally include human health, public safety or beneficial consequences of primary importance to the environment but may also be of a social or economic nature (subject to the opinion of the relevant national government in England or Wales). Neither feature (kittiwake at Flamborough and Filey Coast SPA or sandbanks at Dogger Bank SAC) are classed as priority habitats or species.

8.2.3. The guidance identifies the following principles for considerations of IROPI:

- Imperative: There would usually be urgency to the objective(s) and it must be considered "indispensable" or "essential" (i.e. imperative). In practical terms, this can be evidenced where the objectives of the plan (or project) falls within a framework for one or more of the following:
  (i) actions or policies aiming to protect fundamental values for citizens' life (health, safety, environment);
  (ii) fundamental policies for the State and the Society; or
  (iii) activities of an economic or social nature, fulfilling specific obligations of public service.

- Public interest: The interest must be a public rather than a solely private interest (although a private interest can coincide with delivery of a public objective).
- Long-term: The interest would generally be long-term; short-term interests are unlikely to be regarded as overriding because the conservation objectives of European Sites are long term interests.
- Overriding: The public interest (which can be national, regional or local) of proceeding with the plan (or project) must be greater than the interest of conservation interest potentially put at risk should the plan or project go ahead.

Reasons of Public Interest

8.2.4. The Round 4 Plan will provide a significant contribution to limiting the extent of climate change in accordance with the objectives of the Paris Agreement and is essential for meeting the UK's NDC for the period 1 January 2021 - 31 December 2030. Renewables such as offshore wind will play a critical role in the transition away from fossil fuels, as outlined by the British Energy Security Strategy released in April 2022. Beyond the 2030 time horizon, the Government's Sixth Carbon Budget sets a target to reduce greenhouse gas emissions by 78% from 1990 to 2035 (including international aviation and shipping emissions)[9]; as part of this target, the Government's Net Zero Strategy commits to the decarbonisation of power generation by 2035[10] and identifies Round 4 as a high level essential activity (Fig.16). In addition, in its proposed Sixth Carbon Budget, the Committee on Climate Change concluded that offshore wind is expected to become the "backbone" of the whole UK energy system, providing 65-70% of total generation by 2050; generating capacity for offshore wind is expected to be 100GW or more by 2050, with the CCC's five different scenarios ranging from 65GW to 140GW.

8.2.5. The consequences of not achieving the objectives of the Paris Agreement would be severely detrimental to societies across the globe and to human health, to social and economic interests and to the environment. Namely the increases in mean temperature in most land and ocean regions, hot extremes in most inhabited regions, heavy precipitation in several regions and the probability of drought and precipitation deficits in some regions. Sea level rise will continue and marine ice sheet instability in Antarctica or irreversible loss of the Greenland ice sheet could result in multi-metre rise in sea levels leading to extreme flooding (IPCC, 2018). Increasing the risks associated with sea level rise to small islands, low-lying coastal areas and deltas for many human and ecological systems (IPCC, 2018). Climate-related risks to health, livelihoods, food security, water supply, human security, and economic growth are projected to increase with global warming of 1.5°C and increase further with 2°C (IPCC, 2018).The impacts of climate change are global in scope and unprecedented in human existence; the science linking the concentration of greenhouse gas emissions to average global temperature on Earth is without question.

8.2.6. The need to address climate change is established through the Climate Change Act 2008, the UK has a legal commitment to decarbonise with legally binding targets in place to cut emissions (versus 1990 baselines) by 34% by 2020 and 100% by 2050 (Net Zero). This commitment is further enshrined in the UK's NDC (reducing greenhouse gas emissions by at least 68% from 1990 levels by 2030) and through the UK Low Carbon Transition Plan and the UK Clean Growth Energy Strategy. In April 2022 the UK Government further reinforced its commitment to addressing climate change through the British Energy Security Strategy.

[9] https://www.gov.uk/government/news/uk-enshrines-new-target-in-law-to-slash-emissions-by-78-by-2035

[10] https://www.gov.uk/government/publications/net-zero-strategy

The Government's most recent Sixth Carbon Budget sets a target to reduce greenhouse gas emissions by 78% from 1990 to 2035 (including international aviation and shipping emissions). Round 4 will aid the government in the delivery of its strategy for decarbonisation and to achieve the legally binding commitments set out in the Climate Change Act 2008.

8.2.7. In March 2019, the UK government announced its ambition to deliver at least 30 GW of offshore wind by 2030, as part of the Offshore Wind Sector Deal. The Sector Deal reinforces the aims of the UK's Industrial Strategy and Clean Growth Strategy, which seeks to maximise the advantages for UK industry from the global shift to clean growth, and in particular: 'The deal will drive the transformation of offshore wind generation, making it an integral part of a low-cost, low-carbon, flexible grid system.' Within supplementary documents to the Queens Speech, December 2019, the UK government committed to increase their ambition on offshore wind to 40 GW by 2030. In April 2022, the British Energy Security Statement was released and the UK Government further committed offshore wind to 50 GW by 2030. As noted in the Alternatives table above there is a need to have a plentiful pipeline due to the potential attrition of projects. The inclusion of a project on a 'future project pipeline' does not indicate that the project will go ahead, or if it does, at a particular generation capacity; attrition occurs for reasons various reasons, including the time taken in the consenting process, financial reasons (too costly), construction reasons (too challenging) or supply chain issues. It is therefore not the case that the ambitions of the Sector Deal, nor the newly adopted government policy and British Energy Security Strategy, will certainly be met by those projects currently under consideration by developers. Within this context, the importance of all offshore wind projects currently under development, to the achievement of Government policy and pledges, is clear. Without the Round 4 Plan, it is very possible that delivery of the Sector Deal and the UK government's 2030 ambition will fall short.

8.2.8. In October 2021, the UK government published The Net Zero Strategy: Build back Greener which sets out the measures the UK government plans to take to keep the UK on a path to net zero. The UK recently concluded that to reach these targets it could require having to build out all currently known low carbon technologies in the power sector at or close to their maximum technical limits by 2035. The Net Zero Strategy identifies Round 4 as a high level essential activity in the period to 2035 (Fig.16). Furthermore, in its proposed Sixth Carbon Budget, the Committee on Climate Change concluded that offshore wind is expected to become the "backbone" of the whole UK energy system, providing 65-70% of total generation by 2050; generating capacity for offshore wind is expected to be 100GW or more by 2050, with the CCC's five different scenarios ranging from 65GW to 140GW.

8.2.9. Key objectives (Objective 2 and Objective 6) of the Round 4 Plan is the security of UK electricity supply. The UK has committed to decarbonise the electricity system by 2035, subject to security of supply, focusing on 'home-grown technologies'. The energy minister Greg Hands noted, in November 2021, that a diverse source of renewable technologies will be key to ensuring the security of energy supply during the UK's transition to net zero. As the UK continues to move forward in renewable energy developments, to which the Round 4 Plan supports, there will be greater security of supply and reduced dependence on fossil fuels.

8.2.10. In April 2022, the UK Government published the British Energy Security Strategy which outlines the UK's long-term plans for greater energy security. The strategy includes various targets and ambitions, including raising the previous 40 GW by 2030 target to 50 GW by 2030, and the ambition that offshore wind will provide over half of the UK's renewable generation capacity by 2030. It is the UK Government's expectation, as outlined within the strategy, that the offshore wind sector will grow to support around 90,000 jobs by 2030, help to reduce cost of energy to individual households and help to reduce reliance on Russian energy through an increase domestic energy generation and clean jobs. The Round 4 Plan supports this strategy.

8.2.11. There is a clear public interest in the Round 4 Plan proceeding. The Round 4 Plan will provide a substantial contribution in the late 2020s towards achieving UK government policies, in particular achieving 50 GW by 2030 and as part of this target, the Government's Net Zero Strategy commitment to the decarbonisation of power generation by 2035. The Round 4 Plan implements national policy and will provide an essential public benefit.

Conservation Interest potentially at risk

Dogger Bank SAC

8.2.12. The Secondary Assessment calculated for habitat loss the impact from the Round 4 Plan alone is 2.035km^2, which equates to 0.016% of this features distribution within this the Dogger Bank SAC European Site. JNCC (undated) report that there are 20 sites in the UK where sandbanks which are slightly covered by sea water all the time (sandbanks) are a primary reason for site selection and a further 16 sites where this Annex I habitat is a qualifying feature, but not a primary reason for site selection - totalling 36 sites across the UK National Site Network.

8.2.13. Dogger Bank is understood to comprise more than 70% of the UK Annex I sandbank resource (Barnfield et al, 2021). Based on the figure for the total estimated area of Annex I sandbank in the UK of 17,090 km^2 (JNCC, 2013), Dogger Bank (area of 12,331 km^2 indicated in R4 HRA) is calculated to represent 72.2% of all UK Annex I sandbank resource. On this basis, loss of an estimated worst case 2.035 km^2 of sandbank habitat from Dogger Bank would represent 0.012% of total UK Annex I sandbank. This estimate may need to be considered in the context of the particular importance of Dogger Bank to the MPA network arising from the fact that Dogger Bank was formed by geological, glacial processes prior to being submerged through sea level rise and is therefore a different sub-type of Annex I sandbank feature compared to other sites (Barnfield et al, 2021).

8.2.14. All offshore sandbanks are within five SACs that all have restore conservation objectives for the Annex I feature and condition assessments (low confidence) undertaken suggest that sandbanks are highly disturbed due to widespread fishing (JNCC, 2019). Feature condition of Annex I sandbank habitats across the National Site Network is noted as under half of the coverage is in good condition (8260 km^2) and over half is in not-good condition (8865km^2) the remaining coverage condition was not known (15km^2). JNCC (2019) noted that the short term trend of habitat area in good condition is decreasing and this based on mainly expert opinion with very limited data.

Flamborough and Filey Coast SPA

8.2.15. The worst case collision mortalities reported in the RIAA (not including mitigation) have been used (94.3-108) to establish percentage loss of kittiwake at the SPA. Using the population listed on the SPA citation results in 0.11-0.12% (94.3-108/89,040*100 = 0.11 - 0.12%); using the latest count data from Aitken et al (2017) results in 0.09 – 0.1% (94.3-108/103,070*100= 0.09 – 0.1%). There are a total of 33 sites (as of 2016) across the UK National Site Network where kittiwake are a feature within an SPA.

8.2.16. Based on the figures above the total estimated impact from collision risk on kittiwake population, within the National Site Network, in the UK is 0.02%. This calculation is based on the UK SPA population as reported in Stroud et al. (2016). Stroud et al. (2016) noted that the long term (1985-1988 to 1998-2002) UK

trend for kittiwake demonstrates a 24.8% decline in population and in the short term (1999 to 2011) there was a 46.6% decline in UK populations.

Does the public interest 'override'?

8.2.17. The impacts outlined above for the sandbank feature at Dogger Bank SAC and kittiwake feature at Flamborough and Filey Coast SPA represent adverse effect to site integrity but considering the conservation interests across the UK National Site Network demonstrates that the percentage loss of these features is not significant across the UK. Annex I sandbanks slightly covered by seawater at all times are a relatively widespread habitat across the UK, however Dogger Bank SAC is a sub-type of Annex I sandbank (see 8.2.13) and is considered a one-of-a-kind habitat within the UK National Site Network, as such this carries a greater conservation interest than the main feature. Kittiwake have a widespread range across the UK but have experienced decline in abundance, with regional variations, since 1986. Abundance for the UK declined rapidly from 1995, reaching the lowest values in 2013. Since then abundances have increased overall but are still 50% below the 1986 baseline (JNCC, 2021). Due to the decline of kittiwake populations this increases the conservation interest of the feature.

8.2.18. However, the strategy to significantly increase offshore wind generating capacity is part of a fundamental national policy with long term public benefit which protects the environment and public health from the consequences of climate change and ensures public safety. In addition, the Round 4 Plan will:

- Provide a significant contribution to limiting the extent of climate change in accordance with the objectives of the Paris Agreement;
- Be essential for meeting the UK's NDC for the period 1 January 2021 - 31 December 2030;
- Help to achieve the UK government's ambitions in the British Energy Security Strategy (2022);
- Help to ensure the Government's Sixth Carbon Budget target is met to reduce greenhouse gas emissions by 78% from 1990 to 2035 (including international aviation and shipping emissions); and
- Help to enable the Government's Net Zero Strategy of decarbonisation of power generation by 2035.

8.2.19. The Crown Estate has considered if there are IROPI for the Round 4 Plan to proceed and is satisfied that there are IROPI for the Round 4 Plan to proceed. In arriving at this decision The Crown Estate has considered that the Round 4 Plan provides a public benefit which is essential and urgent despite the harm to the integrity of the kittiwake feature of the Flamborough and Filey Coast SPA and the sandbank feature at the Dogger Bank SAC.

8.2.20. Consequently, based on the reasons noted above The Crown Estate is satisfied that the Round 4 Plan is supported by IROPI related to human health, public safety or beneficial consequences of primary importance to the environment.

8.3. Compensatory Measures

8.3.1. The Crown Estate asked its technical advisors NIRAS to assess potential compensatory measures and provided a technical note (authored by NIRAS) on potential compensatory measures to the EWG for consultation in October 2021. This work identified a range of potential measures to compensate for the impact identified in the RIAA, without prejudice to outcome of The Crown Estate's plan-level HRA. The Crown Estate has now concluded that it cannot rule out an adverse effect on site integrity in relation to the kittiwake feature of the Flamborough and Filey Coast SPA and the sandbank feature of the Dogger Bank SAC.

8.3.2. Given the strategic nature of plan-level HRA, there are inherent uncertainties within the AA conclusions; in particular, projects will undergo significant further refinement as part of the consenting process, following detailed site specific environmental and technical survey works and detailed engineering and design. It is therefore not possible to specify the precise nature (for both European Sites) and location (for kittiwake alone) of compensatory measures that might be required but the nature of the adverse effects, and the conservation objectives which might be undermined, can reasonably be anticipated at this time and the associated risks to the coherence of the network can be meaningfully be explored. To give confidence that compensatory measures will fully compensate for the negative effects of the Round 4 Plan on the affected European Sites, The Crown Estate considers that the Plan must provide a robust framework that sets out the broad parameters and mechanisms for the delivery of compensatory measures, on the assumption that they will be required following the more detailed project level assessments noted above.

Dogger Bank SAC

8.3.3. The predicted effect of the Round 4 Plan on the Dogger Bank SAC is a both loss and habitat damage of sandbank habitat, undermining the Conservation Objectives of the site due to a reduction in extent of the designated feature. As the spatial extent of the habitat within the network is reduced the objective of compensatory measures identified is to ensure the ability of the National Site Network to restore sandbank to a favourable conservation status is not compromised.

8.3.4. The Crown Estate are aware of a wide variety of compensatory measures as set out in relevant guidance (European Commission 2019). The review undertaken by NIRAS identified a range of potential compensatory measures. The Crown Estate agrees with the conclusion of NIRAS that compensatory measures are available to compensate for the adverse effect identified on the sandbank feature of Dogger Bank SAC, but also considers that it may be possible to extend the existing site. The following measures are considered to be potentially available to appropriately compensate for the identified impact, whilst it is acknowledged that measures considered in relevant guidance (European Commission 2019) may be evidenced to be suitable when project specific information is available:

- Removal of Structures
- Removal of Debris
- Enhancement of existing habitat
- Reduction of other pressures from other activities (e.g. reserve creation and associated restrictions)
- New site designation (including extension of the existing site)

Review of potential compensation measures

8.3.5. Consideration of the measures, based on the review undertaken by NIRAS, is provided below. Some measures could be delivered independently by the project proposer whilst other measures would require a coordinated approach with Government and the exercise of statutory powers.

8.3.6. In addition, any relevant new or novel compensatory measures that may come to light will also be considered.

<u>Removal of structures</u>

8.3.7. The Crown Estate has considered the potential for removal of disused structures within the Dogger Bank SAC. Removal of disused structures directly addresses an issue, the presence of structures such as mattressing and pipelines from oil and gas industries, which JNCC (2018) note as adversely affecting feature condition. The measure could be delivered within the same location as the Preferred Projects in the Dogger Bank SAC;

it could potentially also be delivered on sandbank habitats at another UK European Site. In the context of DEFRA (2021) guidance this measure is therefore ranked '1' (address same impact at same location).

8.3.8. There is sufficient evidence of structures and their potential for removal within Dogger Bank SAC. NIRAS estimated:

- 0.77km^2 of the seabed could be impacted by the physical presence of existing disused pipelines,
- 30.2km of rock placed along the existing pipelines within the SAC,
- 0.3km^2 of seabed could be impacted by existing rock along pipelines within the SAC, and
- removal of disused telecommunication cables would represent an area of 0.018km^2.

8.3.9. NIRAS noted however that the area of habitat damage, associated with the Round 4 plan, could not be offset in a like-for-like manner, and this may require a wider approach seeking to secure benefits both within and outside the European Site. Removal at another SAC will help to ensure the overall coherence of the National Site Network in the context of Annex 1 habitats. Time required for implementation was estimated by NIRAS to be a period of 1-3 years. As noted by NIRAS however recovery of habitats would take place quickly in areas of active sediment movement but the timescale for full recovery is uncertain and could take many years; NIRAS outline that a pragmatic view may be required to accept that recovery is ongoing but contributing to the network and that 3- 6 years may be required before the commencement of any Projects within the Dogger Bank SAC. The Crown Estate consider there is adequate time before the likely commencement of projects for this measure to be implemented and for recovery to occur.

8.3.10. Consultation was undertaken with the EWG on the technical compensation note drafted by NIRAS. The Wildlife Trusts raised concerns that following the polluter pays principle and due to licence conditions, infrastructure decommissioning should be undertaken by the oil and gas industry. Natural England highlighted that there was thoughtful analysis around this measure but, as a result, highlighted significant issues with the achievement of compensatory measures of a like scale. Additionally, that removal of structures on other Annex I sandbanks is a potential option but further discussion is required to ensure that this is a viable option for maintaining the coherence of the MPA network. The Crown Estate has considered these comments and agrees within the Dogger Bank SAC the scale of compensation required would not be met by removal of structures alone, consideration may need to be given to other Annex I sandbanks within the MPA network. As such this measure will be taken forward as part of a suite of other measures that could potentially be used in combination to achieve the desired scale of compensation at Dogger Bank SAC before considering whether additional compensation is required at other sites.

8.3.11. JNCC highlighted that rock placement (associated with oil and gas installations) is considered to be a permanent impact and that rock armour removal has never been achieved even though it is considered within decommissioning programmes. JNCC raised concerns that permanent environmental damage could be caused by the removal of rock placement. The Crown Estate has considered these comments and notes further discussion is required with SNCBs on implications of removal of rock protection. Additionally it is worth noting removal of structures is not limited to one sector or one type of removal – NIRAS outline disused pipelines and cables which may be targeted in addition to rock protection. As such this measure will be taken forward as part of a suite of other measures that could potentially be used to achieve the desired scale of compensation for Dogger Bank SAC.

8.3.12. This compensation measure could be undertaken by a project proposer provided all necessary consents are in place.

Removal of debris

8.3.13. The Crown Estate has considered the potential for removal of debris within the Dogger Bank SAC. The measure is similar to the removal of structures in that it directly addresses an issue which has potential to adversely affect the condition of the European Site. The measure could be delivered within the same location as the Preferred Projects in the Dogger Bank SAC; it could potentially also be delivered on sandbank habitats at another UK European Site. In the context of DEFRA (2021) guidance there is preference for this measure to be implemented within the European Site and is therefore ranked '1', however it could also be implemented on the same feature outside of the European Site (ranked '2').

8.3.14. NIRAS noted a key uncertainty in the amount of material present for removal and the appropriate level of compensation for physical habitat damage, complicated further by the expected recovery, over time, of areas of damage which also affects consideration of gain quantification for both habitat loss and damage (the timescale for full recovery is uncertain and this is important when determining the point at which the gain can be measured). Removal at another SAC will help to ensure the overall coherence of the National Site Network in the context of Annex 1 habitats. Time required for implementation was estimated by NIRAS to be a period of 3-4 years before commencement of construction of any Preferred Project in the SAC under the Round 4 Plan.

8.3.15. Consultation was undertaken with the EWG on the technical compensation note drafted by NIRAS. Defra raised the suitability of the measure and where SNCBs identify this as a known pressure on features and in line with Defra's policy on marine litter removal. The Wildlife Trusts outlined no endorsement for this measure and a complete lack of support for this measure across numerous stakeholders adding that further site decline would be expected if these measures were implemented - which would mean the coherence of the UK Sites Network would not be met. JNCC outlined debris removal would not deliver at one-to-one ratio in relation to habitat loss it is not considered critical in determining the achievement of the conservation objectives for the site. Natural England added that whether there would be sufficient material across multiple MPAs and consider that litter/debris is likely to be very sparse. Natural England also noted that the presence of marine debris has never been raised as hindering the conservation objectives for the site, noting that if debris removal is intended as a one-off removal it is extremely unlikely to compensate for lasting impacts over the lifetime of the projects.

8.3.16. The Crown Estate has considered these comments and reviewed the Advice on Operations for Dogger Bank SAC, within the supporting information litter is identified as a potential pressure from a number of offshore activities, however it is acknowledged that there is a lack of certainty over the amount of debris present on the site. The Crown Estate considered it would be premature to remove this as a potential compensation option at this time without further consideration and investigation, but acknowledges the challenges identified by Natural England, JNCC and The Wildlife Trusts. Additionally The Crown Estate agrees that within the Dogger Bank SAC the scale of compensation required would likely not be met by removal of debris alone. It is also noted that at this time this measure has been adopted at a project level but there are concerns that the measure may not be viable by the time the Preferred Projects of Round 4 come to implement compensation. As such, this measure will remain part of a suite of other measures that could potentially be used alongside other compensatory measures to achieve the desired scale of compensation for Dogger Bank SAC.

8.3.17. This compensation measure could be undertaken by a project proposer provided all necessary consents are in place.

Enhancement of existing habitat

8.3.18. The Crown Estate has considered the potential for the enhancement of existing habitats within the Dogger Bank SAC or at other sites within the network designated for the same feature. The measure could be delivered within the same location as the Preferred Projects in the Dogger Bank SAC; it could potentially also be delivered on sandbank habitats at another UK European Site. In the context of DEFRA (2021) guidance this measure is therefore ranked '1' (address same impact at same location), however it could also be implemented on the same feature outside of the European Site ranked (ranked '2').

8.3.19. With regards to sandbank restoration at the Dogger Bank SAC or restoring another (degraded) sandbank, given the unique nature of the site (shallow sandy mound feature, produced by glacial processes) any new sandbank feature would have to be recognised as not equivalent in terms of its provenance, but that it could potentially deliver benefits to the National Site Network as the Annex 1 feature 'sandbanks slightly covered by seawater all the time'. There are substantial uncertainties regarding the ability to create a sustainable sandbank feature at another location and as such is excluded as a possible compensation option. However, restoration of one or more other degraded sandbanks may be a more successful option. Whilst noting that substantial work would be required to evidence likely deliverability from a practical perspective it is considered premature to exclude sandbank restoration at the Dogger Bank SAC or elsewhere in the network.

8.3.20. NIRAS noted that there is evidence that a true (pre-industrial fishing) baseline would be more structurally diverse with ubiquitous 'encrusting' invertebrates (Plumeridge & Roberts, 2017), and has identified reef enhancement measures including biodiversity enhancement through introduction of stony reef or seeding of biogenic reef as potential compensation. Additionally, RWE (2021) identified that historically a large area of native oyster (*Ostrea edulis*) was present to the immediate south of Dogger Bank and therefore could provide a natural biogenic feature, and suitable habitat for planting may exist to the south of the Dogger Bank SAC. This measure would not address current conservation objectives, but it is noted here as potentially relevant if a case for restoration towards a more natural baseline were to be made by SNCBs. Whilst noting that substantial engagement and technical work would be required to understand the practicalities of this option, due to its deliverability and the timescales associated with the Round 4 plan allowing for further exploration of this option it is considered premature to exclude sandbank restoration at the Dogger Bank SAC or elsewhere in the network.

8.3.21. Consultation was undertaken with the EWG on the technical compensation note drafted by NIRAS. Natural England outlined agreement with NIRAS' conclusions but outlined that further consideration of this measure may be worthwhile and the opportunity to collate the evidence for seabed recovery to better understand the likely scale and speed. NIRAS noted that these measures would potentially result in wider biodiversity gains and if measured against a pre-industrial baseline as opposed to the conditions resulting from historic fishing and other industrial pressures, or where the recovery of other habitats in the UK are supported.

8.3.22. This compensation measure could be undertaken by a project proposer provided all necessary consents are in place.

Reduction of other pressures

8.3.23. The Crown Estate has considered the potential for reduction of pressures from other activities within the Dogger Bank SAC or at other sites within the network designated for same feature. Reduction of pressure from fishing activity would represent a direct benefit for sandbank habitat by reducing/removing a pressure

currently acting on the designated feature at the European Site. Other than reduction or removal of pressure from demersal fishing it is concluded that there is currently no realistic opportunity of working with other marine industries, or regulators, to change the scale of an existing impact at the Dogger Bank SAC. In the context of DEFRA (2021) guidance there is preference for this measure to be implemented within the European Site and is therefore ranked '1', however it could also be implemented on the same feature outside of the European Site ranked (ranked '2').

8.3.24. NIRAS noted that the Marine Management Organisation ("MMO") have made a byelaw which comes into force in June 2022, prohibiting all bottom towed fishing throughout the SAC (MMO, 2021). There is, however, the potential to add to the spatial extent, longevity or effectiveness of the fishing prohibition which represents additional benefit. Time required for implementation was estimated by NIRAS to be a period of 2-3 years before commencement of construction of any Preferred Project in the SAC under the Round 4 Plan.

8.3.25. Consultation was undertaken with the EWG on the technical compensation note drafted by NIRAS. MMO raised that reducing demersal fishing in the Dogger Bank SAC had already been proposed and as such would mean that reducing pressure from demersal fishing would not be considered additional to normal practice. JNCC outlined that given the current MMO consultation on the byelaw for bottom towed fishing within Dogger Bank SAC that removing fisheries pressure within the site or any other MPA would not be considered compensation. Natural England outlined support in principle for this measure and outlined that the reduction of fishing pressure is a compensatory measure with significant potential, noting additional work which The Crown Estate could commission to review the range and scale of fishing activity to understand the potential contribution additional management measures might make. The Wildlife Trusts also highlighted this measure as one of the most powerful compensation measures adding that The Wildlife Trusts are open to discuss how The Crown Estate could provide additionality in this management measure.

8.3.26. The Crown Estate has considered these comments and note that the measure is included as a method to assist in the successful implementation longevity, extent and/or effectiveness of any fishing prohibition, with the potential to demonstrate additional benefit over the current prohibition. It would be premature to remove this as a potential compensation option at this time especially given that additional benefit, through longevity and effectiveness, from the implementation of the byelaw is unknown. As such this measure will be taken forward as part of a suite of other measures that could potentially be used alongside other compensatory measures to achieve the desired scale of compensation for the Dogger Bank SAC.

8.3.27. This compensation measure could not be delivered by a project proposer but would require the exercise of statutory powers by Government or the marine regulator.

Uncertainty

8.3.28. A remaining uncertainty at the Dogger Bank SAC is also the potential impact/benefit of the proposed restriction of bottom towed fishing by byelaw, which was consulted upon by the MMO in February 2021, and the reduction of pressure and potential recovery of the Annex I sandbank habitat and the implications for a change in conservation status of the European Site.

New site designation (including extension of the existing site)

8.3.29. The Crown Estate has considered the potential for new site designation and extension of the existing site. New compensatory areas would likely be current-tidal sandbanks which would meet the same criteria in terms of Annex I habitat definition in relation to structure and function but would not be ecologically identical to the habitat lost. In the context of DEFRA (2021) guidance there is preference for this measure to

be implemented within the European Site (extension of existing site) and is therefore ranked '1', however it could also be implemented on the same feature outside of the European Site (new site designation) and ranked '2'. NIRAS concluded that the timing for implementation is uncertain but it would need to be accomplished within 5-8 years to contribute to the network before the start of construction of projects within the Dogger Bank SAC.

8.3.30. Preferred Bidder 1 and 2 supplied a report on potential compensation options: extension of existing site and habitat creation (RWE, 2021). This report will be made publicly available upon completion of the HRA process.

8.3.31. The document considered further the potential for an extension of the Dogger Bank SAC, outlining the decision-making process around the current SAC boundary, first recommended to Defra as a draft SAC in 2005, which was delineated in 2010 by examining aspects of the geology, biology and topography of the sandbank and "closely follows the extent of the Annex I sandbank habitat" (JNCC, 2011a). The report noted that Annex I sandbank habitat generally occurs in shallow waters (less than 20m water depth) the habitat extent is not defined by water depth (European Commission 2007, RWE 2021). As part of the decision-making process, the 2010 SAC boundary was delineated following peer-reviewed re-analysis of available data on benthos and epibenthos to identify the characteristic biological communities of the shallower parts of the bank (those in less than 20m water depth) and their extent into deeper waters (RWE, 2021). However, the report noted that the biological communities characteristic of the shallower parts of the bank extended out to approximately 35-40m water depth.

8.3.32. As highlighted above, JNCC had first recommended the Dogger Bank to Defra as a draft SAC in 2005, but in 2008, JNCC conducted informal dialogue meetings with UK Government departments and stakeholder groups and received informal feedback on the 2008 draft SAC proposal (the site boundary (Figure 4 and Figure 5) which included sandy sediments down to 50m water depth) (JNCC 2011b, RWE 2021). The report indicates that in response to concerns raised, JNCC conducted the above mentioned independent peer review and re-examined scientific justification for the draft SAC. Ultimately this resulted in a site recommendation to Government (with a reduced site boundary) which did not change the features for which the site was identified but resulted in the smaller 2010 site boundary as shown in Figure 3 (JNCC 2011a) nor have either subsequently changed (RWE, 2021).

8.3.33. Consultation was undertaken with the EWG on the technical compensation note drafted by NIRAS. The Wildlife Trusts and JNCC outlined their lack of support for designation of a new site as compensation primarily noting that Dogger Bank SAC is a unique glacial sandbank system and there are no other glacial sandbank which can be designated to account for the impact on this site. Whilst The Crown Estate consider the uniqueness of the glacial sandbank as notable, it should be noted that the glacial sandbanks are not Annex 1 qualifying habitats. The Wildlife Trusts added a lack of support for the extension of the European Site due to the potential for chipping away and deterioration of existing sites as well as creating further problems in the future for offshore wind farm development, complicating the consenting process and further risking the ecological integrity of the UK MPA network. The Crown Estate has considered these comments and notes the lack of support for a new designation that is not ecologically identical but meets the same Annex 1 qualifying criteria, given the uniqueness of the Dogger Bank SAC. However further extension of Dogger Bank SAC would improve the coherence of the site as areas to the north of the current boundary are structurally and functionally similar to adjacent communities.

8.3.34. The MMO noted that new site designation or extension of existing sites are not promoted by Defra but noted that the sites are intended to form part of the national network and therefore must be protected to the same standard as a candidate, proposed and designated European Site. Natural England outlined that site extension would be a less time consuming than identifying a new site and the benefits of existing site management measures that could be extended quickly following designation. The Crown Estate has considered these comments and agrees The Dogger Bank SAC has clear areas of potential for extension where the Annex 1 Sandbank extends beyond the existing site boundary. As identified by Natural England an advantage of this and promoting an extension to the Dogger Bank SAC over identifying a new site for designation elsewhere, is that this would occur well within the timeframe that would be required for site selection of a new SAC. As such this measure will be taken forward as part of a suite of other measures that could potentially be potentially be used alongside other compensatory measures to achieve the desired scale of compensation at Dogger Bank SAC.

8.3.35. This compensation measure could not be delivered by a project proposer but would require the exercise of statutory powers by Government.

Summary

8.3.36. The Crown Estate has considered the measures available at the Dogger Bank SAC and is content that there is enough information available at this stage to demonstrate that the above options have the potential to meet the key criteria outlined in DEFRA guidance (2021), either on their own or used as part of a wider suite of measures.

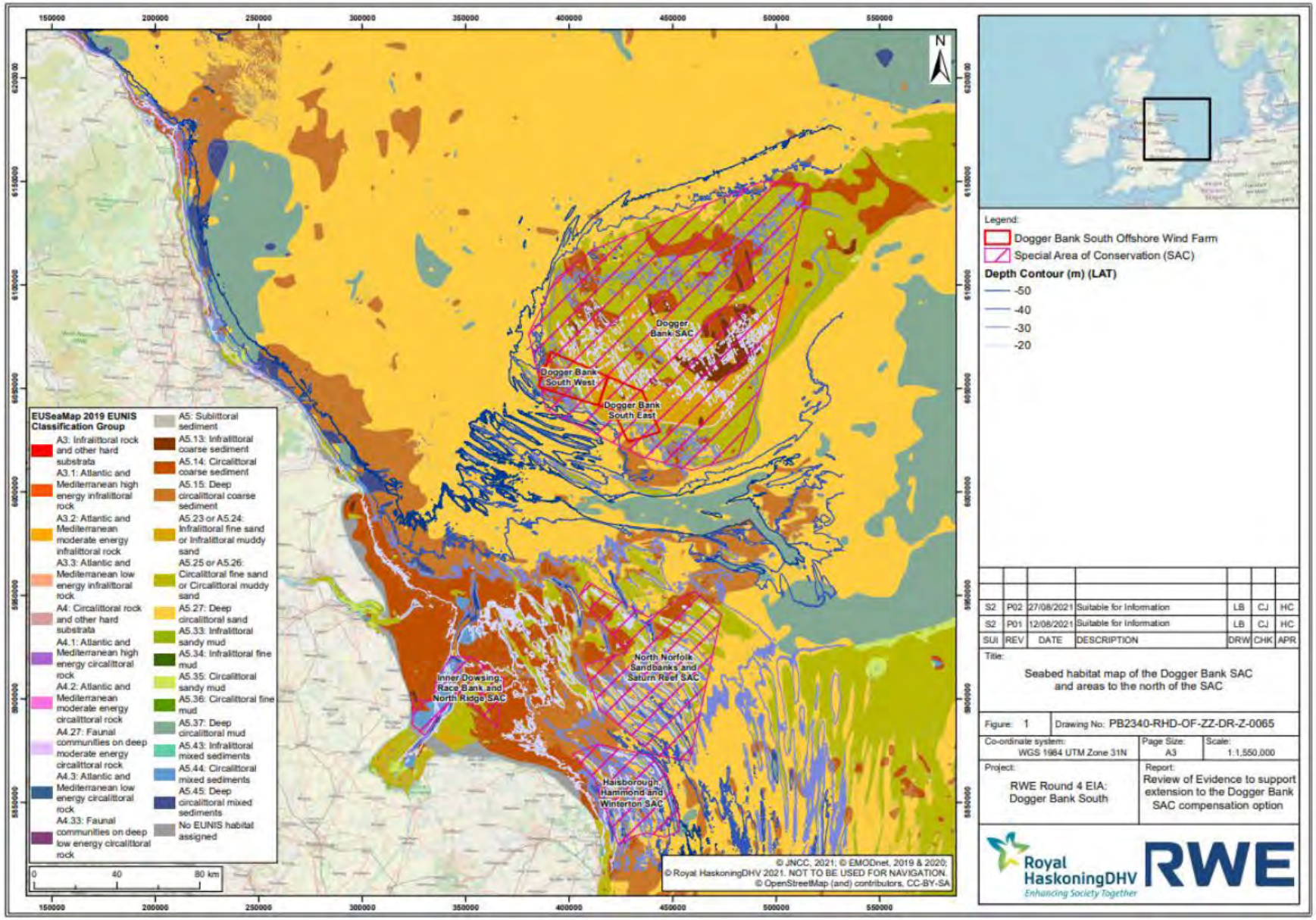


Figure 3. Seabed habitat map of the Dogger Bank SAC and areas to the north of the SAC (RWE, 2021)

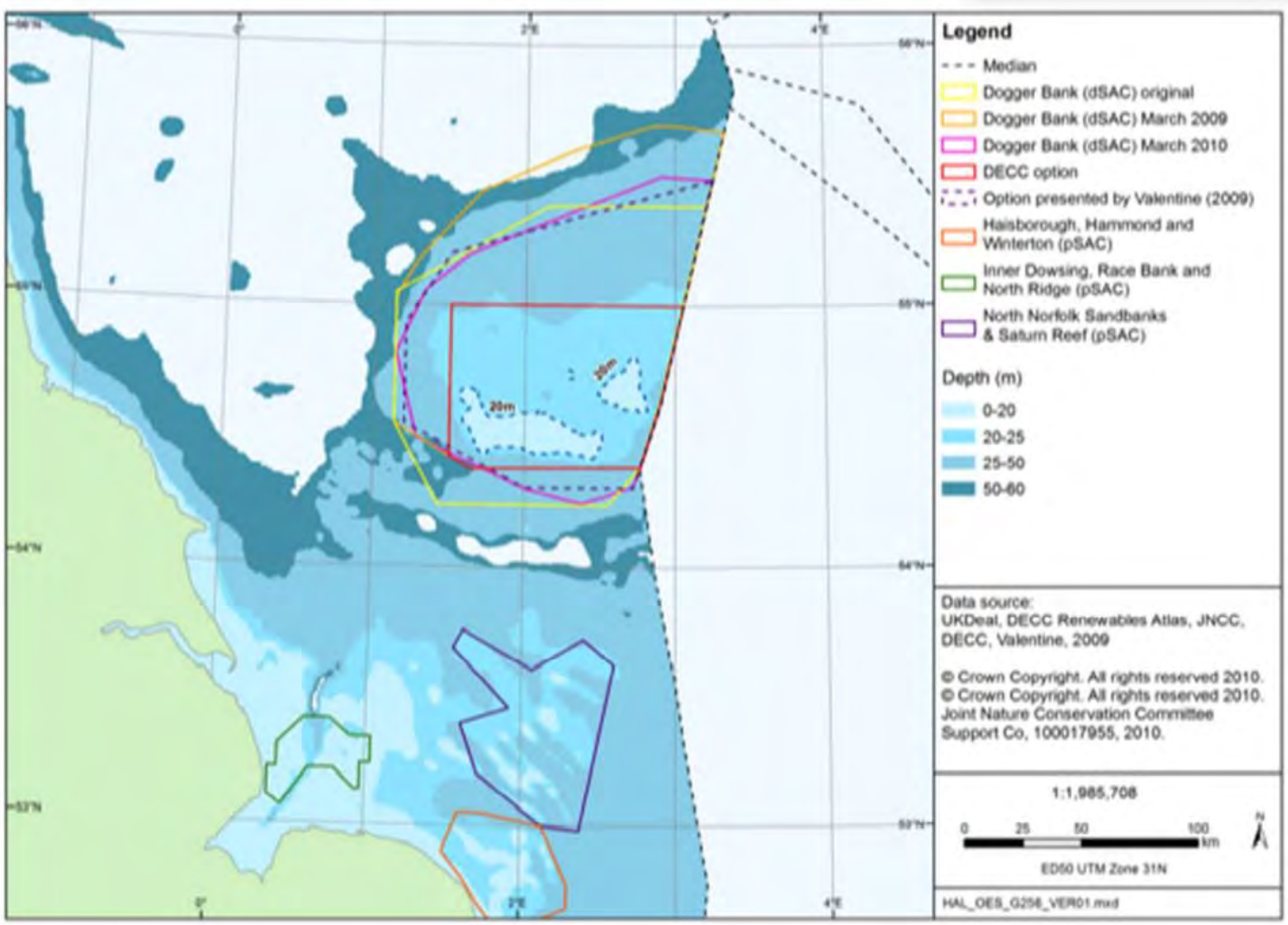


Figure 4 Proposed boundaries for Dogger Bank draft SAC (RWE, 2021)

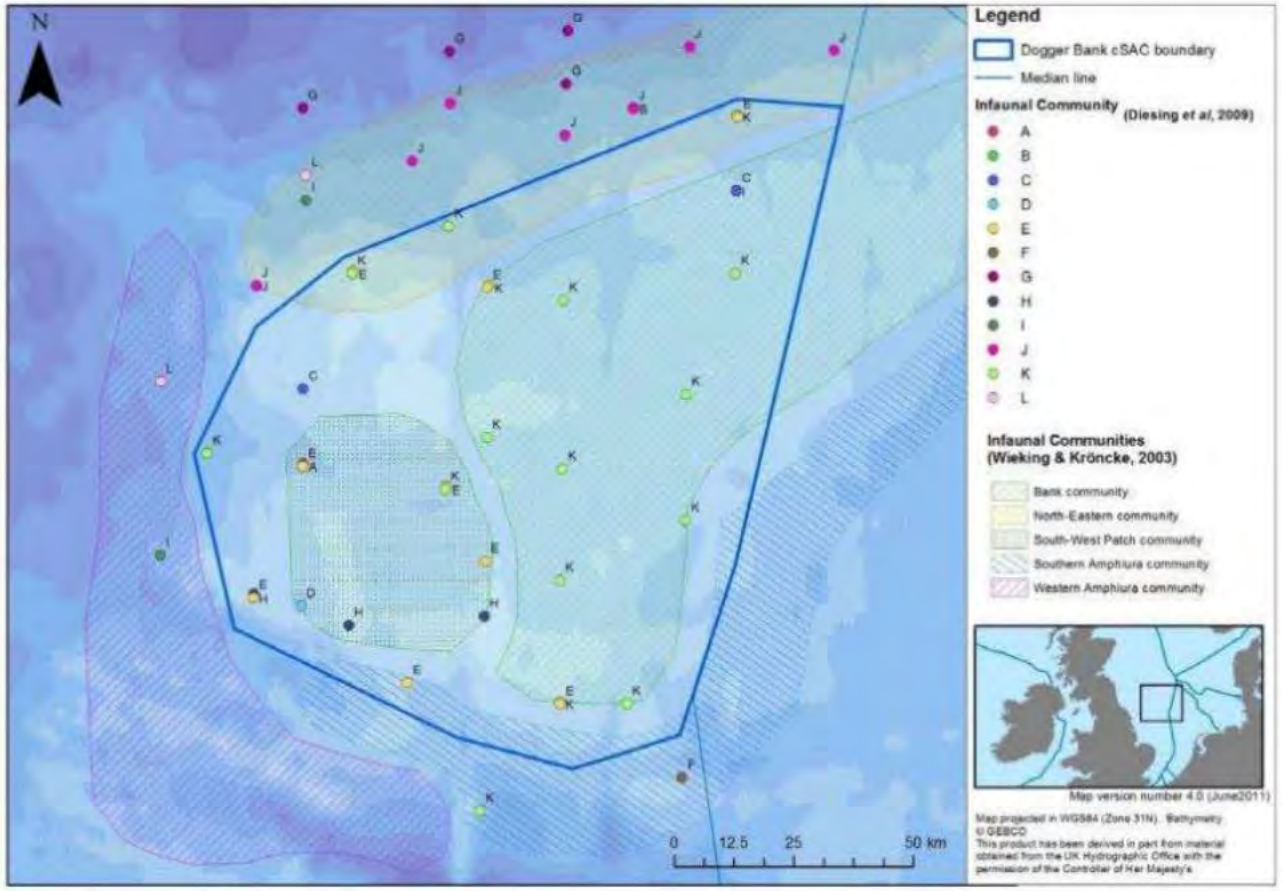


Figure 5. Infaunal communities of the Dogger Bank SAC (source: Figure 4a of JNCC 2011b, RWE 2021)

Flamborough and Filey Coast SPA

8.3.37. The predicted effect of the Round 4 Plan on the kittiwake feature of the Flamborough and Filey Coast SPA is associated with collision mortality in combination with other plans and projects, undermining the conservation objective to restore or maintain the kittiwake population as a qualifying feature of the site. As loss of kittiwake is contrary to the conservation objective of the site the objective of compensatory measures is to ensure that the ability of the National Site Network to maintain or restore the population of kittiwake is not compromised.

8.3.38. The Crown Estate are aware of a wide variety of compensatory measures as set out in relevant guidance (European Commission 2019). The review undertaken by NIRAS identified a range of potential compensatory measures, The Crown Estate agrees with the conclusion of NIRAS that potential compensatory measures are available to compensate for the adverse effect identified on the kittiwake feature of Flamborough and Filey Coast SPA. The following measures are considered to be potentially available to appropriately compensate for the identified impact, whilst it is acknowledged that measures considered in relevant guidance (European Commission 2019) may be evidenced to be suitable when project specific information is available:

- Onshore artificial nesting structures
- Offshore artificial nesting structures
- Limitations and/or restrictions to southern North Sea sand eel fishery
- Other enhancement measures to increase prey availability

Review of potential compensation measures

8.3.39. Consideration of the measures, based on the review undertaken by NIRAS, is provided below.

8.3.40. In addition, any relevant new or novel compensatory measures that may come to light will also be considered.

<u>Onshore artificial nesting structures</u>

8.3.41. The Crown Estate has considered the potential for onshore artificial nesting structure for kittiwake from the Flamborough and Filey Coast SPA. Successful breeding at artificial nesting structures can contribute kittiwake to the Flamborough and Filey Coast SPA population to offset collision mortalities and has the potential to be considered a like for like compensation. The measure would be located outside of the European Site due to competition for food with the resident kittiwake population reducing the likelihood of breeding success (Vattenfall, 2021).

8.3.42. Breeding success of kittiwakes on artificial structures can be just as high as at more natural sites in the UK, and NIRAS noted the location of artificial nesting structures is key in determining successful colonisation and breeding; they also noted that there is uncertainty around the extent of kittiwake nesting on existing offshore platforms and the design features that promote or deter their colonisation - such considerations could constrain the number of suitable locations, especially with increasing build out of wind farms further offshore. Examples of successful kittiwake colonies on artificial coastal structures include: Sizewell nuclear power station (outfall structures), Tyneside and Gateshead (buildings and bridges) as well as bespoke kittiwake towers, Lowestoft harbour wall structure and town centre buildings, and finally Dunbar Castle and harbour walls. However mortality was noted for breeding kittiwake along the breeding wall at Lowestoft (Furness et al., 2013) when a fox accessed the breeding ledge. In regards to recruitment, Vatenfall (2020)

noted that a small area of wall, measuring 30m by 8m could accommodate 200 pairs. A colony of this size could produce around 5 times as many adult recruits as the mortalities to be lost.

8.3.43. Time required for implementation of this measure was estimated by NIRAS to be a period of 5-8 years.

8.3.44. Consultation was undertaken with the EWG on the technical compensation note drafted by NIRAS. RSPB raised that artificial nesting structures are not a 'proven' solution as a compensatory measure, outlining the remaining uncertainty of efficacy and oversupply of structures (due to Round 3). RSPB added that meta-population analysis should be carried out by The Crown Estate to understand the feasibility of the establishment of colonies. The Wildlife Trusts outlined that it does not support this measure as a compensation measure as it is not a long-term sustainable option with little evidence to support the effectiveness of the structures. Natural England highlighted that the measure has support in the short term but may not be ecologically meaningful in the medium to long term. The Crown Estate consider that it would be inappropriate to remove this as a possible compensatory measure at this time but should remain in consideration as part of a possible suite of measures. As part of The Crown Estates proposed 'managed implementation' approach to mitigation and compensation the appropriateness of this measure will be explored further should projects enter into an agreement for lease.

8.3.45. The Crown Estate has considered these comments and note that there is a lack of certainty over the efficacy of these structures and the potential for suitable sites to be 'used up' as well as the suggestion of meta-population analysis and how this could be useful in a strategic approach. This will be taken forward and considered during The Crown Estate's managed implementation approach to compensation. The Crown Estate notes that there are short term benefits to the introduction of these platforms which means it is premature to remove this as a potential compensation option at this time. As such this measure will be taken forward as part of a suite of other measures that could potentially be used alone or in combination to achieve the desired scale of compensation at Flamborough and Filey Coast SPA.

8.3.46. This compensation measure could be undertaken by a project proposer provided all necessary consents are in place.

Offshore artificial nesting structures

8.3.47. The Crown Estate has considered the potential for offshore artificial nesting structure for kittiwake from the Flamborough and Filey Coast SPA. As with onshore artificial nesting structures, successful breeding can contribute kittiwake to the Flamborough and Filey Coast SPA population to offset collision mortalities and has the potential to be considered a like for like compensation. Additionally, kittiwake are known to breed on offshore structures such as oil and gas platforms (Vattenfall 2021), and those colonised in the southern North Sea form part of the southern North Sea metapopulation.

8.3.48. Breeding success of kittiwakes on artificial structures can be just as high as at more natural sites in the UK, and NIRAS noted the location of artificial nesting structures is key in determining successful colonisation and breeding and that there is uncertainty around the extent of kittiwake nesting on existing offshore platforms and the design features that promote or deter their colonisation - such considerations could constrain the number of suitable locations, especially with increasing build out of wind farms further offshore. Time required for implementation was estimated by NIRAS to be a period of 5-8 years.

8.3.49. Consultation was undertaken with the EWG on the technical compensation note drafted by NIRAS. The Wildlife Trusts outlined that seabirds can be found nesting on existing infrastructure, but there are a number

of concerns regarding the use of existing and new infrastructure especially if within an MPA. The Wildlife Trusts added that there has been a lack of consideration of this measure in relation to other ambitions for UK seas (e.g. location of existing and future activities alongside a recovered marine environment) and the lack of sustainability for sea space and kittiwake populations. The Wildlife Trusts concluded that is not supportive of offshore nesting platforms as a principle across all offshore wind farm developments. RSPB raised that artificial nesting structures are not a 'proven' solution as a compensatory measure, outlining the remaining uncertainty of efficacy and oversupply of structures (due to Round 3). RSPB added that meta-population analysis should be carried out by The Crown Estate to understand the feasibility of the establishment of colonies. Natural England highlighted that a key area of uncertainty is the difficulty in proving additionality in relation to artificial structures. JNCC outlined the remaining uncertainty on the optimum design of offshore structures and their rate of success (whether new or modification of existing platforms).

8.3.50. The Crown Estate has considered these comments and note that there is a lack of certainty over the efficacy of these structures, siting of the structures and proving additionality as well as the suggestion of meta-population analysis and how this could be useful in a strategic approach. This will be taken forward and considered during The Crown Estate's managed implementation approach to compensation. The Crown Estate notes that there are short term benefits to the introduction of these platforms which means it is premature to remove this as a potential compensation option at this time. As such this measure will be taken forward as part of a suite of other measures that could potentially be used alone or in combination to achieve the desired scale of compensation at Flamborough and Filey Coast SPA.

8.3.51. This compensation measure could be undertaken by a project proposer provided all necessary consents are in place.

Reduced southern North Sea sand eel fishery

8.3.52. The Crown Estate has considered the potential for a reduction in southern North Sea sand eel fishery for kittiwake from the Flamborough and Filey Coast SPA. Reducing the sand eel fishery pressure in waters where kittiwake forage would allow sand eel stocks to recover, increasing prey availability for kittiwake which could improve regional colony productivity. Reducing sand eel fishery pressure therefore offers a strategic opportunity to compensate for the cumulative/in-combination impact of offshore wind farms on the southern North Sea kittiwake population.

8.3.53. NIRAS noted that the effectiveness of local sand eel fishery closure for kittiwake has been demonstrated off the east coast of Scotland and resulted in higher sand eel stock biomass (Greenstreet et al., 2006) and an increase in kittiwake breeding success at colonies within the closed area compared to those outside (Daunt et al., 2008, Frederiksen et al. 2008). Carroll et al. (2017) suggested that a 50% reduction in fishing mortality on the southern North Sea sand eel stock would increase local kittiwake productivity by an average of 0.2 chicks per nest. Vatenfall (2020) noted that restrictions on sandeel fishing in the North Sea would result in nearly 10,000 adults per year surviving to recruit into colonies at 4 years of age. Time required for implementation was estimated by NIRAS to be a period of 5 years.

8.3.54. Consultation was undertaken with the EWG on the technical compensation note drafted by NIRAS. The Wildlife Trusts and Natural England outlined support the delivery of a reduced sand eel fishery as a compensation measure. Natural England added that the measure offers a strategic opportunity to compensate for the cumulative/in-combination impact and advised that consideration would be needed of reducing the overall take of sandeels, not just spatial management measures. RSPB outlined the first requirement to reduce

the sandeel fishery to benefit the European Site would be as an SPA site management measure. RSPB added that it would be necessary to demonstrate additionality over and above the ability to restore the population to above 83,700 pairs (the designation level). JNCC noted uncertainty in the feasibility of reducing fishing pressure in the locations required as this would be out of the hands of any project developer(s).

8.3.55. The Crown Estate has considered these comments and note the support for this measure and the remaining uncertainty around additionality and delivery of the measure by developers. The Crown Estate notes that NIRAS recommended - to increase confidence in the delivery of compensatory measures - a managed implementation approach to compensation. As such this measure will be taken forward as part of a suite of other measures that could potentially be used alongside other compensatory measures to achieve the desired scale of compensation at Flamborough and Filey Coast SPA.

8.3.56. This compensation measure could not be delivered by a project proposer but would require the exercise of statutory powers by Government or the marine regulator, and engagement with the regulator will be required to determine whether this measure can be taken forward in practice, but it is not considered that it should be ruled out as a potential measure at this time.

Other enhancement measures to increase prey availability

8.3.57. The Crown Estate has considered the potential to identify measures that would increase prey availability for kittiwake from the Flamborough and Filey Coast SPA. These measures would be in addition to the reduction of the North Sea sand eel fishery as described in paragraphs 8.3.44 to 8.3.48. Examples of these measures may include creation of habitat with ecosystem services (such as sea grass restoration to increase small forage fish), or new site designation to allow increased management of fisheries for prey species.

8.3.58. NIRAS noted that there is a lack of real word examples to evidence the effectiveness of a measure and there would be significant difficulties demonstrating the effectiveness of these measures.

8.3.59. Consultation was undertaken with the EWG on the technical compensation note drafted by NIRAS. The Wildlife Trusts indicated that they consider reef creation or enhancement not to be a viable option. Natural England recommended that further consideration of this option may be worthwhile, in particular there could be work undertaken to collate the evidence for seabed recovery to better understand the likely scale and speed of habitat creation or enhancement, but agreed with the conclusion in principle that it is unlikely to be a realistic compensatory option. The JNCC acknowledged that various habitats have been present in the North Sea throughout its history, but identified difficulties in understanding what habitats may be appropriate to create or enhance. The MMO agreed that nature based solutions such as reef or seagrass creation or restoration could be used as part of a suite of compensatory measures.

8.3.60. The Crown Estate are aware of a range of compensatory measures which could enhance prey availability, however, The Crown Estate acknowledge the significant uncertainty around this option at the present time and further work would be required prior to determining the appropriateness of any measure that may be considered to deliver this compensation. Given the potential range of potential measures and timescales associated with delivery of compensation measures The Crown Estate consider that it would be premature to remove this as a potential compensation option at this time.

8.3.61. Some of the measures could be delivered by a project proposer, whilst some measures could not be delivered by a project proposer but would require the exercise of statutory powers by Government or the marine regulator.

Summary

8.3.62. The Crown Estate has considered the measures available for the Flamborough and Filey Coast SPA and is content that there is enough information available at this stage to demonstrate that the above options have the potential to meet the key criteria outlined in DEFRA guidance (2021), either on their own or used in combination with other measures.

Proposed approach to delivery of compensation

8.3.63. As highlighted in the previous sections, The Crown Estate is content that there are multiple measures available which are appropriate to deliver compensation for adverse effects on both Annex 1 sandbank at Dogger Bank SAC and kittiwake at the Flamborough and Filey Coast SPA prior to the construction of Round 4 Preferred Projects.

8.3.64. The review undertaken by NIRAS indicated that at the plan-level stage it is not possible to rule out the possibility that further evidence and information may come to light prior to construction which would render the compensatory measures identified in this HRA inappropriate or conversely require compensatory measures to be increased. NIRAS noted projects could be amended or abandoned and that adequate time will need to be allocated to consult appropriately with relevant stakeholder organisations. The evolution of projects and the availability of project detail for appropriate consultation with stakeholders will occur over a timescale that extends beyond the plan level HRA process for the Round 4 Plan. NIRAS also concluded that the ability for The Crown Estate to make a definitive decision on compensation at the plan level is highly constrained.

8.3.65. NIRAS recommended that The Crown Estate defers definition and delivery of compensation to the project level allowing for flexibility to be retained; however, NIRAS also recommended that The Crown Estate seek to provide assurance for the delivery of any necessary compensatory measures using a managed implementation approach. The delivery of measures which secure the optimum ecological outcomes (and which best protect network coherence) is likely to require a strategic co-ordinated approach between project proposers and Government and the exercise of statutory powers. This approach will secure mechanisms that steer the direction of compensation as a requirement of the plan (see paragraph 8.3.66).

8.3.66. The Crown Estate agrees with NIRAS in relation to the difficulty in agreeing delivery of compensation at the plan level without the complete, precise and definitive findings that are typically associated with project level HRAs. However, it is clear that strategic solutions are now required to allow the delivery of appropriate compensatory measures.

8.3.67. The identification and delivery of compensatory measures at a strategic level has wide support amongst SNCBs and environmental NGOs, and has been advocated to be the most appropriate approach to derogations to address the in-combination effects of multiple windfarms (Machin, 2020).

8.3.68. The Crown Estate will therefore establish a process for the delivery of compensatory measures on a strategic basis as a result of the Round 4 plan-level HRA.

8.3.69. The Crown Estate will develop a Dogger Bank Strategic Compensation Plan ("DBSCP") which must be adhered to by Preferred Projects 1 and 2 and to which The Crown Estate will also commit. The development of the DBSCP will be overseen by a steering group established and chaired by The Crown Estate. Membership will include the Department for Business Energy & Industrial Strategy ("BEIS"), Department for Environment, Food & Rural Affairs ("Defra"), Natural England, the Joint Nature Conservation Committee ("JNCC"), Preferred Project 1 and Preferred Project 2. A terms of reference will be agreed with Steering Group members before it commences operation. The Steering Group will engage on the development of the DBSCP with The Crown Estate's HRA Expert Working Group.

8.3.70. The overall objective of the Compensation Plan will be the development and delivery of strategic compensation to ensure the coherence of the UK Sites Network; the Plan and Steering Group will be in place as soon as practicable following the entering of projects into Agreement for Lease and no later than the end of 2022. The Compensation Plan will be required to include details of:

- Roles and responsibilities of involved parties
- Scale and location of proposed strategic compensation
- Consultation and engagement with stakeholders and relevant scientific experts
- Delivery mechanism and funding agreements
- Commercial agreements (if required)
- Monitoring and adaptive management
- Programme for proposed implementation and delivery

8.3.71. As identified above a key component of the DBSCP will be the monitoring and adaptive management measures. Adaptive management is an iterative process which will occur after preferred projects have entered into an Agreement for Lease and will combine management measures and monitoring with the aim of improving effectiveness of compensation measures whilst also providing up to date knowledge and improvements to decision making over time. The adaptive management of the DBSCP will be an important component of the compensation measure and will be used as a method to address unforeseen issues with compensation measures, deviations from expected time scales (i.e. recovery period of habitat following removal of structures).

8.3.72. The Crown Estate will develop a Kittiwake Strategic Compensation Plan ("KSCP") which must be adhered to by Preferred Projects 1, 2 and 3 and to which The Crown Estate will also commit. The development of the KSCP will be overseen by a Steering Group established and chaired by The Crown Estate. Membership will include the Department for Business Energy & Industrial Strategy ("BEIS"), Department for Environment, Food & Rural Affairs ("Defra"), Natural England, the Joint Nature Conservation Committee ("JNCC"), Preferred Project 1, Preferred Project 2 and Preferred Project 3. A terms of reference will be agreed with Steering Group members before it commences operation. The Steering Group will engage on the development of the KSCP with The Crown Estate's HRA Expert Working Group.

8.3.73. The overall objective of the Compensation Plan will be the development and delivery of strategic compensation to ensure the overall coherence of the UK Sites Network; the KSCP and Steering Group will be in place as soon as practicable following the entering of projects into Agreement for Lease and no later than the end of 2022. The Compensation Plan will require:

- Roles and responsibilities of involved parties
- Scale and location of proposed strategic compensation
- Consultation and engagement with stakeholders and relevant scientific experts

- Delivery mechanism and funding agreements
- Commercial agreements (if required)
- Monitoring and adaptive management
- Programme for proposed implementation and delivery

8.3.74. As identified above a key component of the KSCP will be the monitoring and adaptive management measures. Adaptive management is an iterative process which will occur after preferred projects have entered into an Agreement for Lease and will combine management measures and monitoring with the aim of improving effectiveness of compensation measures whilst also providing up to date knowledge and improvements to decision making over time. The adaptive management of the KSCP will be an important component of the compensation measure and will be used as a method to address unforeseen issues with compensation measures, deviations from expected time scales (i.e. colonisation rate of structure).

8.3.75. These requirements will be secured through Agreements for Lease.

8.4. Conclusion

8.4.1. Consideration has been provided above on the further tests set out in the Habitat Regulations for the demonstration of the absence of alternative solutions and IROPI as well as the identification of a range of possible measures which could compensate for adverse impacts as a result of the Round 4 Plan. The Crown Estate has demonstrated there are no alternative solutions that would be less damaging or avoid damage to the European Site and meet the objectives of Round 4, that there are IROPI to proceed and that the Round 4 plan provides a robust framework for the delivery of compensatory measures.

8.4.2. The Crown Estate also notes that during the consenting process as a matter of law each project will be required to undertake an impact assessment, including project level HRA, where a LSE on a European site cannot be excluded beyond reasonable scientific doubt. This assessment will take account of the detailed project design, informed by site-specific information, the distribution of the habitat features and their sensitivity to the proposed development. If necessary, project level assessment may also involve detailed site surveys and modelling work. This assessment will be used by the consenting body, as the competent authority, to undertake a statutory HRA, the outcome of which will ensure that the integrity of the European site(s) will be safeguarded because no project will be awarded consent where it is considered that it will lead to an AEOSI in respect of a European site save in the case of a derogation under Habitats Regulations.

8.4.3. The Crown Estate therefore considers the three tests have been met and as such the Round 4 plan can proceed to the next stage – notification of derogation to the Secretary of State and Welsh Ministers.

8.4.4. The Crown Estate will complete the 'Notice of a proposed habitats regulations assessment (HRA) derogation in England and Wales' to notify the relevant government department (Department for Business, Energy and Industrial Strategy), Welsh Government and the Department for Environment, Food and Rural Affairs, that the HRA for the Round 4 plan has been completed and intend to allow the plan with adverse effects on two European sites to go ahead under an HRA derogation. Following submission The Crown Estate will wait 21 days (unless advised otherwise) before adopting the plan.

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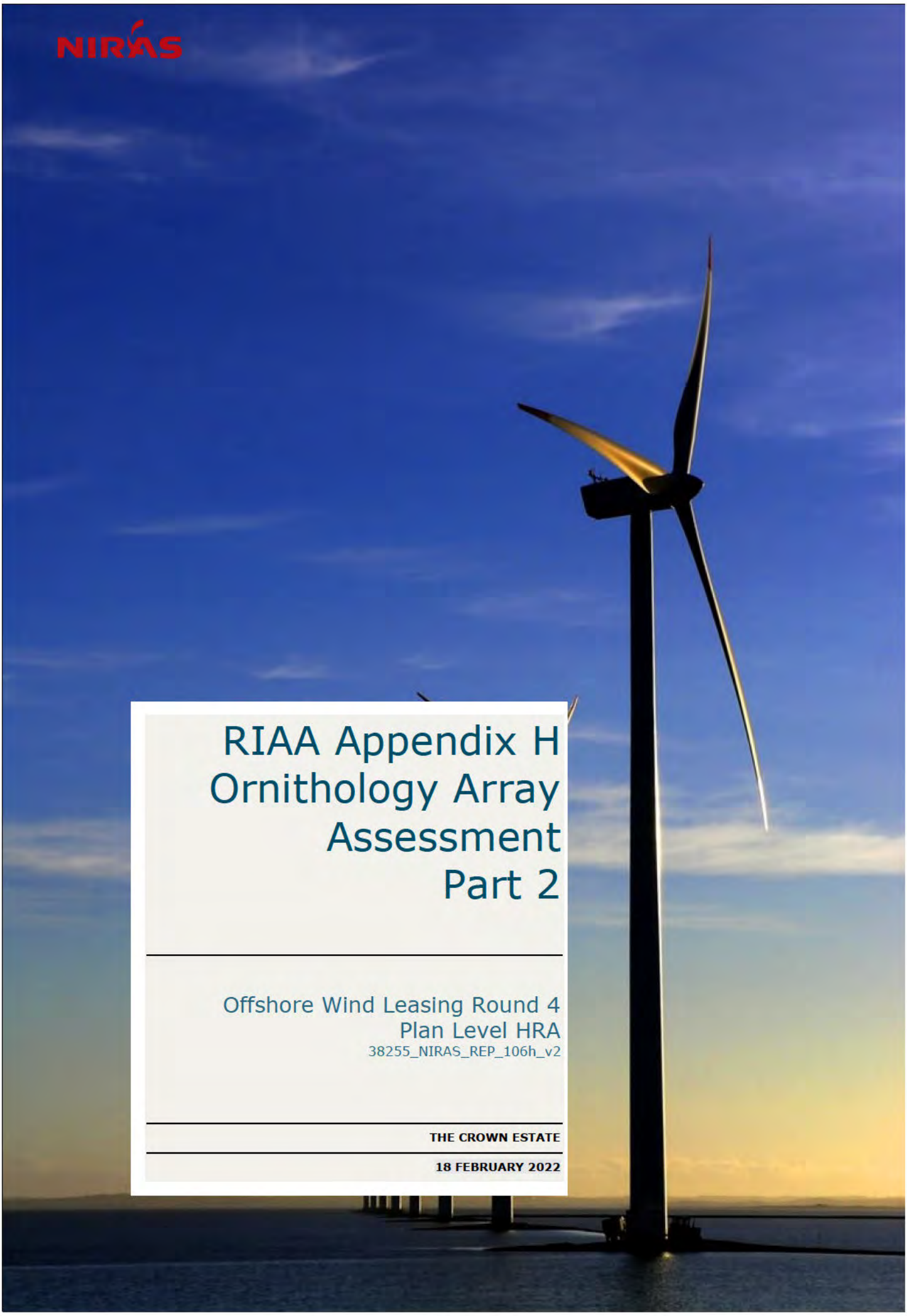
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1. Introduction

1.1.1 This Appendix presents the ornithology methodology and results used to inform the Array Assessment (Part 2) in the RIAA.

2. Background

2.1.1 Following the screening process (NIRAS, 2021), a number of ornithological feature/pressure combinations remain to be assessed within the Array Assessment (Part 2). These feature/pressure combinations have been assessed in two steps:

2.1.2 Step 1: The 'Primary Assessment' uses available evidence to establish which feature/pressure combinations can be assessed using a reasoned evaluation, and to identify those that require further consideration, including quantitative assessment where this is feasible.

2.1.3 Step 2: The 'Secondary Assessment' provides further evidence (qualitative and quantitative) required for the assessment of those feature/pressure combinations for which the Primary Assessment identified as requiring further consideration.

3. Primary Assessment Methods

3.1.1 A qualitative assessment has been undertaken for each feature/pressure combination screened in to the RIAA. This has used appropriate evidence, including published research, statutory guidance and grey literature sources. The impact associated with each pressure has been determined qualitatively in order to establish which feature/pressure combinations would result in a negligible impact at any meaningful population scale. Those feature/pressure combinations for which this could not be demonstrated were carried forward to a Secondary Assessment (Section 6).

4. Primary Assessment Results

P1. Habitat loss/gain

4.1.1 Potential habitat loss associated with the construction of turbines and inter-array cables is predicted to comprise no more than 0.14-0.21% of the proposed array area in each of the Preferred Projects.

4.1.2 The effect of this habitat loss is to reduce the area available for foraging and also the extent of habitat for species which form prey.

4.1.3 All seabird species screened in forage widely within the marine environment and the predicted loss of habitat represents a very small proportion of the foraging habitat available.

4.1.4 Any impact is, therefore, considered to be negligible and would not make an appreciable difference to any in-combination impact.

P2. Direct physical damage

4.1.5 Potential habitat directly damaged due to the construction of turbines and inter-array cables is predicted to comprise no more than 0.14-0.21% of the proposed array area in each of the Preferred Projects.

4.1.6 The effect of this direct habitat damage is to potentially reduce the area available for foraging and also the extent of habitat for species which form prey.

4.1.7 All seabird species screened in forage widely within the marine environment and the predicted area of habitat damaged represents a very small proportion of the foraging habitat available.

4.1.8 Any impact is, therefore, considered to be negligible and would not make an appreciable difference to any in-combination impact.

P3. Indirect physical damage

4.1.9 Potential habitat indirectly damaged due to the construction of turbines and inter-array cables is predicted to comprise no more than 0.14-0.21% of the proposed array area in each of the Preferred Projects.

4.1.10 The effect of this indirect habitat damage is to potentially reduce the area available for foraging and also the extent of habitat for species which form prey. Whilst indirect effects have been screened using a 15 km buffer, marked change to seabed habitats from scour or suspended sediment deposition are expected to occur over a much smaller area. For example, post-construction monitoring was undertaken at Scroby Sands offshore wind farm and Cefas (2006) commented that the likely significant effects on sediment transport were probably limited to the order of 100m around each monopile (i.e. well within the buffer zone) and unlikely to combine cumulatively between monopiles.

4.1.11 All seabird species screened in forage widely within the marine environment and the predicted area of habitat damaged represents a very small proportion of the foraging habitat available.

4.1.12 Any impact is, therefore, considered to be negligible and would not make an appreciable difference to any in-combination impact.

P5. Collision

4.1.13 Some species are susceptible to collision with turbines and this is assumed to lead to an excess mortality within the affected populations. The level of impact varies from species to species and also in relation to the location, scale and design of offshore wind farms. Established methods exist to quantify the level of impact through collision risk modelling.

4.1.14 In the secondary assessment, therefore, collision risk modelling has been undertaken for those species considered to be susceptible to collision with turbines and for which a pathway for an impact has been identified. This includes:

- Gannet;
- Kittiwake;
- Lesser black-backed gull; and
- Herring gull.

P7. Physical presence

4.1.15 Some species are disturbed by the physical presence of turbine structures (and associated vessel traffic) resulting in the displacement of birds from the array and a surrounding area. It is assumed that this displacement (from areas that would otherwise form part of the foraging habitat for those species) may lead to an excess mortality within the affected populations. The level of this potential impact varies from species to species and also in relation to the location and scale of offshore wind farms. Established methods exist to quantify the level of this potential impact through displacement analysis.

4.1.16 At this stage it is not possible to undertake a reasonable and meaningful assessment of individual vessel movements during construction and operation phases. However, vessel impacts in general will be minimised due to a requirement for Preferred Projects to produce a Vessel Traffic Management Plan. On this basis, the magnitude of vessel traffic impacts that may arise is not considered likely to extend or exacerbate the predicted impact for displacement from the array area.

4.1.17 The methodology for the displacement assessment of this impact assumes a general dispersal of sensitive birds from an area surrounding the proposed array area. In the secondary assessment, displacement analysis (quantitative or qualitative) has been undertaken for those species considered to be susceptible to displacement and for which a pathway for an impact has been identified. This includes:

- Gannet;
- Guillemot;
- Razorbill;
- Puffin;
- Red-throated diver;
- Common scoter; and
- Red-breasted merganser

4.1.18 In addition, cormorant, little gull and storm petrel were also screened in to the assessment in relation to P7. However, displacement analysis has not been conducted for these species as these were screened in due to the physical presence of vessels operating in the Preferred Project areas rather than due to displacement associated with offshore wind farm arrays (for which these species exhibit no vulnerability (Wade *et al*., 2016; Bradbury *et al*., 2014)).

P8. Underwater noise

4.1.19 Underwater noise may be generated by activities associated with offshore windfarm development, including, for example, turbine foundation installation and cable laying. There is limited evidence about the extent to which seabirds would be disturbed by underwater noise, but it is expected that it could affect those species that dive for prey. Noise could in turn disturb and displace those prey species on which diving birds forage. However, noise impacts on seabird prey fish are expected to be temporary (e.g. piling during construction) and minor. The primary seabird prey in the North Sea, sand eel, have no swim bladder and are classed in the least sensitive category in guidelines by Popper et al. (2014) on the sensitivity of fish to underwater noise. Seabird prey fish species sensitive to underwater noise, such as herring, are expected to temporarily escape the

construction area. Considering the large spatial scales that seabirds forage over, any escape movement of prey fish is unlikely to reduce prey availability.

4.1.20 The magnitude of underwater noise impacts that may arise is not considered likely to extend or exacerbate the predicted impact for displacement (P7 Physical presence) and the methodology for the assessment of this impact assumes a general dispersal of sensitive birds from an area surrounding the proposed array area.

4.1.21 No additional impact is, therefore, predicted beyond that assessed for displacement above.

P9. Above water noise

4.1.22 Above water noise may be generated by activities associated with offshore windfarm development including, for example, turbine foundation installation and the erection of wind turbine structures. There is limited evidence about the extent to which seabirds would be disturbed by above water noise, but it is expected that it could affect those species that forage in the vicinity of the array.

4.1.23 The magnitude of above water noise impacts that may arise is not considered likely to extend or exacerbate the predicted impact for displacement (P7 Physical presence) and the methodology for the assessment of this impact assumes a general dispersal of sensitive birds from an area surrounding the proposed array area.

4.1.24 No additional impact is, therefore, predicted beyond that assessed for displacement above.

P10. Toxic contamination

4.1.25 There is theoretical potential for contamination to occur during activities associated with offshore wind farm (e.g. mobilisation of historical contamination by inter-array cable installation or seabed preparation, and/or accidental release of pollutants such as hydrocarbons by vessel traffic during all phases of construction and operation).

4.1.26 The levels of seabed contamination for offshore sites is considered to be very low and there is no indication that any of the Preferred Projects are located in areas of known, historical contamination. In any event, is expected that construction projects will avoid, as a matter of course, the disturbance of areas of known contamination. Furthermore, irrespective of the conclusions of this assessment, marine vessels are required to implement protocols to reduce the risk of accidental spillages.

4.1.27 Nevertheless, the potential for accidental pollution events cannot be discounted, but the risk is considered to be low. Any impact is, therefore, considered to be negligible and would not make an appreciable difference to any in-combination impact.

P12. Attraction to lit structures

4.1.28 It is a requirement for navigational and aviation safety that offshore wind farms include safety lighting. There is potential for seabirds to be attracted to lit offshore structures during the hours of darkness.

4.1.29 The presence of lighting could lead to the changes in orientation, disorientation and attraction or repulsion from lights that could lead to collisions with structures or exhaustion (Longcore and Rich, 2004). Conversely it is also possible that unlit turbines may pose a greater risk for collision (at night or during foggy conditions) because they are less detectable to seabirds (Trapp, 1998).

4.1.30 The evidence for any impact is, however, mixed. ICES (2011) state that birds are somewhat less inclined to avoid turbines at night, but infra-red monitoring at night using a Thermal Animal Detection System (TADS) at Nysted provided did not indicate any increased risk during hours of darkness, even during periods of heavy seabird migration (Desholm, 2005). Welcker *et al.* (2017) found nocturnal migrants do not have a higher risk of collision with wind energy facilities than do diurnally active species, but rather appear to circumvent collision more effectively.

4.1.31 Some species, including kittiwake, gannet and auk species are not expected to be very active at night in the offshore locations of the Preferred Projects (Kotzerka *et al.*, 2010, Wade *et al.*, 2016).

4.1.32 Fulmar and large gull species may be more active offshore at night in these locations (Garthe and Hüppop, 2004, King *et al.*, 2009), but, are not expected in very high densities and, in the case of fulmar, not susceptible to collision.

4.1.33 To the extent that lighting of offshore turbines could lead to greater attraction of birds, there is no consistent evidence that this translates into higher rates of collision, disorientation, exhaustion etc. Any impact is, therefore, considered to be negligible and would not make an appreciable difference to any in-combination impact.

P14. Suspended sediments

4.1.34 Construction and decommissioning activities, including the installation of foundations and inter-array cables has the potential to release and disperse sediments into the water column. These sediments may disperse over a wider area as a result of currents and tidal excursions (up to 15 km). Suspended sediments will increase the opacity of water and potentially reduce the availability and visibility of prey to foraging seabirds.

4.1.35 The impact is expected to be localised and temporary. Furthermore, any area affected represents a very small proportion of the foraging habitat available to seabird species. Any impact is, therefore, considered to be negligible and would not make an appreciable difference to any in-combination impact.

4.2 Summary

4.2.1 In view of the above, this Primary assessment concludes that for the following pressures it is reasonable to expect that impacts from the Round 4 Plan will be negligible at any meaningful population scale:

- P1 Habitat Loss Gain
- P2 Direct Physical Damage
- P3 Indirect Physical Damage
- P7 Physical Presence (other than displacement from the array)
- P8 Underwater Noise
- P9 Above Water Noise
- P10 Toxic Contaminants

- P12 Light
- P14 Suspended Sediments

5. Secondary Assessment Methods

5.1.1 In view of the results from the Primary Assessment, a Secondary Assessment has been provided for P5 Collision and P7 Physical Presence (specifically to assess the impacts of displacement from wind turbines and disturbance from vessels). The Secondary Assessment has used a combination of qualitative information and quantitative analysis in the form of displacement methods (Annex H.1), collision risk modelling (Annex H.2), apportioning (Annex H.3), in-combination quantification (Annex H.4) and population viability analysis (Annex H.5) to present the impact from the Round 4 Plan at each Protected Site.

5.1.2 Within the Secondary Assessment there are various sources of variability in the prediction of potential impacts and this leads to uncertainty. The sources of uncertainty are discussed in the relevant Annexes (H.1, H.2, H.3) and summarised and elaborated on in Section 5.2 below. A range of potential impacts are provided in the assessment based on the range of variability within source data, assumptions made and advice received. The approach in this assessment is precautionary, but not overly so, hence the most likely impact (and realistic worst case) within the range calculated is indicated and relied upon in most cases; not just the largest impact which may be predicted if all the most precautionary assumptions are made and compounded. However, in taking a highly conservative approach, the largest impacts calculated from the Preferred Projects alone have been used as an indicator for the necessity of a quantified in-combination assessment, and subsequent population modelling (see section 5.3).

5.2 Uncertainty

Density data

5.2.1 To allow for quantification of both collision risk and displacement, in the absence of site-specific baseline survey data, density data from several data sources, including the MERP dataset has been sourced, following the guidance in Johnston *et al.* (2020). In order to determine if the data from the MERP database provide an accurate representation of the likely abundance of birds at each of the Preferred Projects, where possible, a comparison between MERP data and available site-specific baseline survey data from Round 3 offshore wind farms has been made.

5.2.2 Of the six Preferred Projects, Preferred Projects 1 and 2 are located within close proximity to a Round 3 project (Dogger Bank Creyke Beck A). The density data extracted for Preferred Projects 1 and 2 has therefore been compared to density data from Dogger Bank Creyke Beck A in Annex H.1 and Annex H.2. In reviewing this analysis the following conclusions were identified:

- For gannet, the densities from the two datasets are comparable in most months. Differences do however occur in migratory months and suggest that any effect estimates calculated using MERP data may represent an underestimate of potential impacts.
- The abundance of kittiwake extracted from the MERP dataset was lower than the average abundance of kittiwake at Dogger Bank Creyke Beck A

in all months suggesting that the use of the MERP dataset may underestimate impacts.

- For lesser black-backed gull, the abundance of birds in the MERP dataset was higher than corresponding values at Dogger Bank Creyke Beck A in the majority of months. The MERP dataset may therefore overestimate the abundance of lesser black-backed gull, especially in the non-breeding season and this may lead to inflated impacts.
- The abundance of herring gull in the MERP dataset was higher than the corresponding values at Dogger Bank Creyke Beck A in all months suggesting that the use of the MERP dataset may over-estimate impacts for the species.
- The abundance of guillemot in the MERP dataset was lower than the corresponding values at Dogger Bank Creyke Beck A in the majority of months, although there was overlap between May and July, suggesting that the use of the MERP dataset may underestimate impacts for the species.
- The abundance of razorbill in the MERP dataset was lower than the corresponding values at Dogger Bank Creyke Beck A in the majority of months, although there was overlap between May and July, suggesting that the use of the MERP dataset may underestimate impacts for the species.
- The abundance of puffin in the MERP dataset was generally higher than or similar to the abundance of the species recorded at Dogger Bank Creyke Beck A. This suggests that the use of the MERP dataset may over-estimate impacts for the species.

5.2.3 In addition, utilisation data of three species from Flamborough and Filey Coast SPA, as presented in Cleasby *et al.* (2018), has been consulted as part of the consideration of the representativeness of the MERP density data. Of relevance is the utilisation of kittiwake at Preferred Projects 1, 2 and 3. Utilisation at Preferred Projects 1 and 2 is lower than recorded at Preferred Project 3 suggesting densities of kittiwake should be higher at Preferred Project 3 when compared to Preferred Projects 1 and 2. The data presented in Cleasby *et al.* (2018) is relevant to breeding adults from the colony and therefore does not account for immature and non-breeding birds, which could occur in higher densities and could result in increased densities at Preferred Projects 1 and 2. The implications of the utilisation information presented in Cleasby *et al.* (2018) on the impact predicted will be considered in applicable sections below.

Collision risk modelling

5.2.4 The results have been presented using a range of collision risk estimates calculated using different sets of parameters incorporating uncertainty associated with Band (2012) model Option, nocturnal activity factor, flight speed and avoidance rates. The use of different parameters represents consideration of the position of Natural England (and, in some cases, other UK SNCBs) and that presented by Applicants as part of the applications for development consent for recent offshore wind farms. As part of these applications there have been debates around which of the parameter values provide the most realistic appraisal of collision risk. The main points of discussion for each of the parameter and model Options are discussed in the following paragraphs.

5.2.5 The first model parameter discussed is the model Option that is selected in the collision risk model. For the Round 4 HRA, this is restricted to the use of Option 2

(Basic model) or Option 3 (Extended model) due to the lack of site-specific baseline survey data. This is associated with the availability of an appropriate avoidance rate that takes into account the mechanics of the two models within the Band (2012) CRM, the Basic and Extended models. The Basic model assumes that there is an equal distribution of birds across a rotor swept area and that there is an equal risk of collision within that area. The Extended model is able to take into account more detailed consideration of the distribution of birds across the rotor swept area and takes into account the differing risk of collision across that area. As a result the Extended model, if applied when using appropriate values for other parameters will provide a more accurate representation of collision risk. Of the required parameter values, the one that, until recently has been applied using a generic value for the Extended model, is avoidance rate. However, the recent publication of Bowgen and Cook (2018), which provides an avoidance rate for use with the Extended model based on empirical data from an operational offshore wind farm, allows for the Extended model to be applied for a number of species.

5.2.6 Collision risk modelling for all species has applied two nocturnal activity rates (gannet = 1 and 2, kittiwake and large gull species = 2 and 3 in the Band (2012) CRM) representing 0% (1) 25% (2) and 50% (3) nocturnal activity. There exists information that suggests the nocturnal activity of gannet and kittiwake is lower than the rate that has previously been applied in collision risk modelling (50%). Historically, the subjective nocturnal activity scores for birds presented in Garthe and Hüppop (2004) were translated to percentage rates for use in the Band (2012) CRM. For recent offshore wind farm projects in the Hornsea Zone and East Anglia Zone, available evidence on the nocturnal activity of kittiwake has been reviewed and it has been concluded that the translation of rates from Garthe and Hüppop (2004) likely over-estimates collision risk (MacArthur Green 2015a). The use of a range of nocturnal activity rates for all species attempts to account for over-estimation and based on previous reviews for gannet and kittiwake is considered to provide a more realistic representation of the collision risk for these species at the Preferred Projects.

5.2.7 Collision risk modelling for all species has applied two values for flight speed. The first of these is derived from either Alerstam *et al.* (2007) (kittiwake and large gull species) or Pennycuick (1987) (gannet). The values from Alerstam *et al.* (2007) and Pennycuick (1987) all have low associated sample sizes and are not representative of the flight speeds of birds across an annual cycle or at an offshore wind farm. For example, the value for kittiwake presented in Alerstam *et al.* (2007) represents the flight speeds of two birds observed in either southern Sweden or the Arctic Circle, with no differentiation between migratory or foraging behaviour. For gannet, the value presented in Pennycuick (1987) represents birds flying at a breeding colony. The second values for each species are sourced from Skov *et al.* (2018) and represent the behaviour of birds at an operational wind farm throughout the year and therefore these values have associated large sample sizes. It is therefore considered that the latter of these values represents the best available evidence and provides a more accurate representation of collision risk for all species at the Preferred Projects.

5.2.8 In summary it is therefore considered that the best available evidence for relevant species is that presented in Bowgen and Cook (2018) (avoidance rates); Skov *et al*. (2018) (flight speeds) and a range of nocturnal activity factors in line with Natural England guidance (Natural England, 2018). The collision risk estimates associated with these parameters are therefore considered to represent 'most

likely' impact (and most realistic worst case scenario) however, the species-specific sections below do also present collision risk estimates calculated using a range of parameters as outlined in Annex H.2.

Apportioning

5.2.9 The results are presented using a range of apportioning values when considering the breeding adult component of the population present at any Preferred Project. In order to identify an appropriate value to consider in the assessment, the apportioning approach outlined in Annex H.3 has been applied. This approach which is based on that advised by SNH, considers the distance between a colony and the size of each population and assumes an equal distribution of birds across the available foraging area to derive an apportioning value. In reality birds are not equally distributed across an available foraging area and therefore the apportioning values derived for each of the Preferred Projects represents either an over-estimate or under-estimate of the likely proportion of breeding adult birds present. Where possible, consideration has been given to other data sources to determine if the value derived from the approach outlined in Annex H.3 is representative of the likely usage of birds from the relevant designated site.

5.2.10 In addition to breeding adult birds, a population of birds in a given sea area is likely to contain immature birds. Determining the proportion of immature birds at a wind farm is often informed by site-specific baseline survey data accompanied by consideration of the proportion of different age classes within the wider population of a species (e.g. see Ørsted, 2018a). As site-specific data are not available for the Preferred Projects, a different approach has been defined which calculates the proportion of different age classes within the wider population of a species. This approach however does not give consideration to the distribution of immature birds and therefore will likely represent an over-estimate as birds often show an increased association with natal waters as they reach breeding age.

Seasonal definitions

5.2.11 The collision risk estimates and displacement mortality values presented in the following sections have been calculated based on site-specific seasonal definitions provided on Natural England's designated sites online portal or those for the full UK breeding season presented in Furness (2015). It is important to understand that these seasonal definitions represent the occurrence of breeding birds at a colony and although it is important that impacts are apportioned to a breeding colony in all months when birds are present an apportioning approach based on these seasons will over-estimate the likely impact. This is because collision and displacement events do not occur at the colony but, in many cases, many kilometres offshore where the composition of any population is different to that at a breeding colony. In a given sea area located 100 km offshore of any breeding colony the composition of the population of a species present will at different times of year consist different proportions of breeding adult birds from the colony of interest, immature birds, non-breeding birds and breeding adult birds from other colonies. This is illustrated in Figure 5.1 which shows, simplistically, how the abundance of each of these population components is likely to change throughout the breeding season. In March and October, when migration of birds is occurring, a proportion of breeding birds at the colony of interest will be present in the relevant sea area, however so too will be birds migrating to other breeding colonies and therefore any apportioning approach should account for these birds by applying a lower apportioning value in migratory months.

5.2.12 The approach presented in the following assessment sections is to apply the same apportioning value throughout the wider breeding season thus incorporating migratory periods and representing an over-estimate of the associated impact. Furness (2015) provides seasonal definitions which exclude migratory periods and these have been considered within the conclusions presented for each species to determine the implications of using the wider breeding season on the conclusions reached.

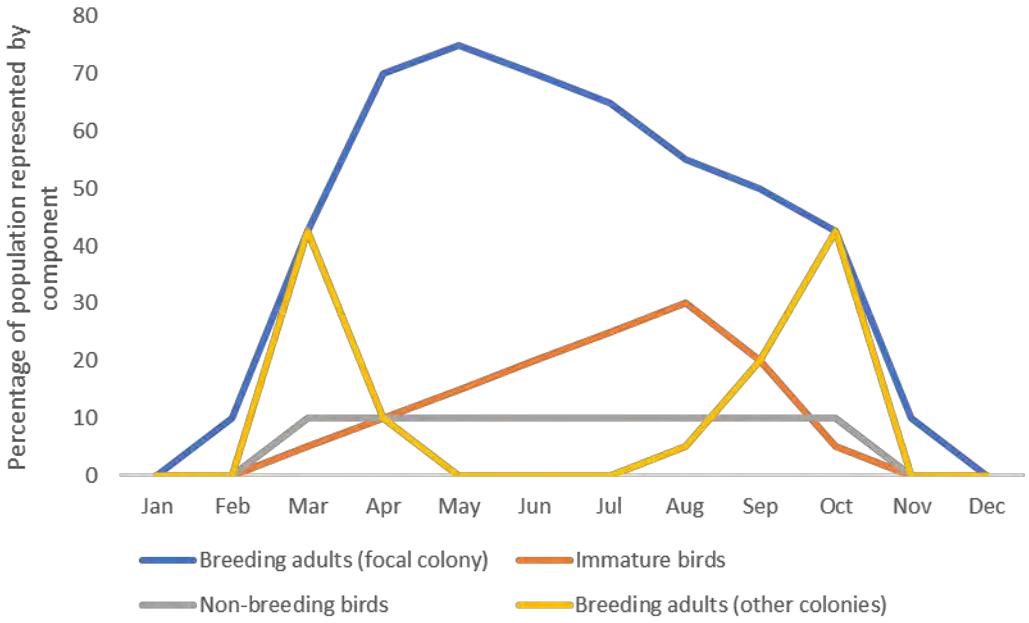


Figure 5.1: A generic representation of the proportion of different population components for a generic seabird in a sea area across an annual cycle

5.3 Protected Site Assessment

5.3.1 The assessment of the specific feature/pressure combinations identified in the Screening Report (NIRAS, 2021) is provided in the Secondary Assessment Results, below. Quantitative collision risk and/or displacement analysis has been undertaken for the majority of feature/pressure combinations. However, for a small number of feature/pressure combinations, where quantitative information was unavailable, a qualitative assessment has been undertaken instead.

5.3.2 The proceeding sections consider the impact of the Round 4 Plan alone and the Plan in-combination with other plans and projects. In-combination assessments are either provided qualitatively or quantitatively. Quantitative in-combination assessments are undertaken in cases where any predicted impact (including the highest impact predicted) from the Round 4 Plan alone exceeds 0.5% of the baseline mortality of the relevant Protected Site population. Exceptions are applied to small populations where the estimated number of mortalities associated with collision or displacement are very low (e.g. below five birds). For small populations, even minor impact mortality causes an unproportionally large increase to baseline mortality, which in reality is likely to be indiscernible given the uncertainty described above. A qualitative in-combination assessment is provided in all other cases.

5.3.3 In line with the methods established in Appendix A and Annex H.4, each quantitative in-combination assessment relies on the SNCB Tiering System[1], specifically the impact estimates found for plans and projects in Tiers 1-4. It is recognised that other estimates are available for some plans and projects classed within Tiers 5-6, however, even where these are available there is considerable uncertainty about them. For example, the 2017 Extensions Plan included 8 projects, of which 2 are not proceeding. The six remaining projects are classified as Tiers 5 and 6 and where there is information about the predicted effects of those projects, from early stage development application material, for example, this has been used to identify effect estimates within Annex H.4. Where that information is not available the predicted effects from the 2017 Extensions Plan HRA (2019) have been incorporated into Annex H.4 (where these were calculated). In line with the methods outlined in Appendix A, these effect estimates have been considered qualitatively where appropriate. Other plans, for which there are no quantified effects, such as the Scottish Sectoral Marine Plan for offshore wind, will be considered qualitatively where appropriate. It is acknowledged that these projects, if they were to be granted development consent and ultimately constructed, would contribute to an in-combination impact that would include the Round 4 Plan however, at this stage the uncertainty associated with these projects means they have not been considered quantitatively in the following assessment sections.

5.3.4 Population Viability Analysis (PVA) is undertaken in cases where any predicted impact (including the highest impact predicted) from the Round 4 Plan alone exceeds 0.5% of the baseline mortality of the relevant Protected Site population. Exceptions are made when the estimated number of mortalities associated with collision or displacement are very low (e.g. below five birds). 0.5% of baseline mortality represents proportion of a population that it is so small that it is considered to be practically unmeasurable with any accuracy (in light of the uncertainty and noise associated with seabird population fluctuations and the precision of impact prediction methods). It is, therefore, judged that an impact of this magnitude is negligible by definition and can be discounted without the need for further population modelling (PVA). Even if it were to be modelled, the results would be subject to the same levels of uncertainty and would not provide any additional reliable information on the likely effects of such an impact.

6. Secondary Assessment Results

6.1 Protected sites

Ailsa Craig SPA

Gannet

Alone

[1] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010056/EN010056-001638-EA3%20-%20JNCC%20and%20NE%20suggested%20tiers%20for%20CIA.pdf

Collision risk

6.1.1 Collision risk modelling has been undertaken for gannet using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.1. In the breeding season, there is only connectivity between the Ailsa Craig SPA and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.1: Collision risk estimates for gannet (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																
				Breeding season				Post-breeding							Pre-breeding						
				PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	1	14.9	98.9	5	3	6	14	1	1	0	0	0	0	2	2	1	0	0	0	0	4
			99.5	2	1	3	7	0	0	0	0	0	0	1	1	1	0	0	0	0	2
		13.33	98.9	5	3	5	13	1	0	0	0	0	0	2	2	1	0	0	0	0	4
			99.5	2	1	2	6	0	0	0	0	0	0	1	1	1	0	0	0	0	2
	2	14.9	98.9	6	4	7	17	1	1	0	0	0	0	2	3	2	0	0	0	0	6
			99.5	3	2	3	8	1	0	0	0	0	0	1	1	1	0	0	0	0	3
		13.33	98.9	6	4	6	16	1	1	0	0	0	0	2	3	2	0	0	0	0	5
			99.5	3	2	3	7	1	0	0	0	0	0	1	1	1	0	0	0	0	2

6.1.2 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.2, Table 6.3 and Table 6.4.

Table 6.2 Breeding season apportioning for gannet at Ailsa Craig SPA for the impact from Preferred Project 4

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	1	14.9	98.9	0.5	1.1	1.6	2.2	2.7	3.3	3.8	4.4	4.9	5.5
			99.5	0.2	0.5	0.7	1.0	1.2	1.5	1.7	2.0	2.2	2.5
		13.33	98.9	0.5	1.0	1.5	2.0	2.6	3.1	3.6	4.1	4.6	5.1
			99.5	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.3
	2	14.9	98.9	0.6	1.3	1.9	2.5	3.2	3.8	4.4	5.1	5.7	6.3
			99.5	0.3	0.6	0.9	1.2	1.4	1.7	2.0	2.3	2.6	2.9
		13.33	98.9	0.6	1.2	1.8	2.4	3.0	3.6	4.1	4.7	5.3	5.9
			99.5	0.3	0.5	0.8	1.1	1.3	1.6	1.9	2.2	2.4	2.7

Table 6.3 Breeding season apportioning for gannet at Ailsa Craig SPA for the impact from Preferred Project 5

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	1	14.9	98.9	0.3	0.7	1.0	1.3	1.6	2.0	2.3	2.6	2.9	3.3
			99.5	0.1	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.3	1.5
		13.33	98.9	0.3	0.6	0.9	1.2	1.5	1.9	2.2	2.5	2.8	3.1
			99.5	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4
	2	14.9	98.9	0.4	0.8	1.1	1.5	1.9	2.3	2.6	3.0	3.4	3.8
			99.5	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.5	1.7
		13.33	98.9	0.4	0.7	1.1	1.4	1.8	2.1	2.5	2.9	3.2	3.6
			99.5	0.2	0.3	0.5	0.7	0.8	1.0	1.1	1.3	1.5	1.6

Table 6.4 Breeding season apportioning for gannet at Ailsa Craig SPA for the impact from Preferred Project 6

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	1	14.9	98.9	0.6	1.1	1.7	2.3	2.8	3.4	3.9	4.5	5.1	5.6
			99.5	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.0	2.3	2.6
		13.33	98.9	0.5	1.1	1.6	2.1	2.6	3.2	3.7	4.2	4.7	5.3
			99.5	0.2	0.5	0.7	1.0	1.2	1.4	1.7	1.9	2.2	2.4
	2	14.9	98.9	0.7	1.3	2.0	2.6	3.3	3.9	4.6	5.2	5.9	6.5
			99.5	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0
		13.33	98.9	0.6	1.2	1.8	2.4	3.0	3.7	4.3	4.9	5.5	6.1
			99.5	0.3	0.6	0.8	1.1	1.4	1.7	1.9	2.2	2.5	2.8

6.1.3 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.2, Table 6.3 and Table 6.4. The three components of the population present at each of the Preferred Projects in the breeding season have been considered (see Annex H.3). The values associated with each of these population components is presented in Table 6.5 and multiplied together to provide an apportioning value for each of the Preferred Projects.

Table 6.5: Breeding season apportioning values for gannet at Ailsa Craig SPA based on the approach applied in Annex H.3

Preferred Project	Proportion of breeding adult birds from SPA	Proportion of immature birds	Proportion of non-breeding birds	Overall breeding season apportioning value
4	0.54	0.426	0.1	0.28
5	0.57	0.426	0.1	0.29
6	0.61	0.426	0.1	0.32

6.1.4 The results of the apportioning approach in Annex H.3 suggest that between 28-32% of the predicted impact at each of the Preferred Projects is attributable to Ailsa Craig SPA. As mentioned in Section 5.2, the estimated proportion of immature birds in Table 6.5 does not take account of the distribution of immature birds and may therefore over-estimate this component of the population present at each of the Preferred Projects.

6.1.5 The apportioning results in Annex H.3 have been reviewed against relevant site specific data. There is strong evidence showing space partitioning between gannet breeding colonies. The results shown in Wakefield *et al.* (2013) suggest that the areas in which the Preferred Projects are located overlap with foraging areas of birds from Ailsa Craig SPA. It is therefore proposed that the most appropriate apportioning values for the proportion of breeding adult birds at each of the Preferred Projects (column 2 of Table 6.5) is 100%.

6.1.6 Breeding adult birds represent only one component of the population present at any of the Preferred Projects in the breeding season. In order to determine an appropriate apportioning value to apply at each of the Preferred Projects, the proportions of immature and non-breeding birds must also be taken into account. A 10% sabbatical rate has been assumed based on guidance from Scottish Ministers to previous offshore wind farm projects (Marine Scotland, 2017). The estimated proportion of immature birds in Table 6.5 does not take account of the distribution of immature birds and may therefore over-estimate this component of the population present at each of the Preferred Projects. However, immature birds will be present throughout the Irish Sea in the breeding season as these birds return to natal waters to prospect for future nesting areas and therefore they should be accounted for in the apportioning process. There is however no specific information relating to the proportion of immature birds found in specific sea areas of the Irish Sea.

6.1.7 Information collected elsewhere in UK waters has found that the proportion of immature gannet increases as distance from breeding colonies increases (Ørsted, 2018a). The Preferred Projects in the Irish Sea are located approximately 150 km

from Ailsa Craig SPA (assuming a straight line of flight which would take birds over land). This is a distance similar to that between areas of the Hornsea Zone and the Flamborough and Filey Coast SPA. At a distance of 150 km the proportion of immature gannets present was 59.6%. The lowest proportion of immature gannet recorded was approximately 100 km from the breeding colony at the Flamborough and Filey Coast SPA and was 16.3%. The geography of the Irish Sea is very different to that of the North Sea and although immature gannets will be present it is not known how they may be distributed in the Irish Sea, due to its more complex geography.

6.1.8 If it were assumed that no immatures were present in the Irish Sea during the breeding season, an ecologically invalid assumption but one which is necessary due to a lack of information on the proportions of immatures likely to be present, then the apportioning values at each of the Preferred Projects would be 90% (Table 6.6). In order to not under-estimate the potential impact on the Ailsa Craig SPA however, it is proposed that an apportioning value of 90% is applied in the breeding season noting that this will lead to an over-estimate of the impact on Ailsa Craig SPA from the Round 4 Plan.

Table 6.6: Breeding season apportioning values for gannet at Ailsa Craig SPA based on information in Wakefield *et al.* (2013) and immature proportions recorded in baseline survey data from the Hornsea Zone

Preferred Project	Proportion of breeding adult birds from SPA	Proportion of immature birds	Proportion of non-breeding birds	Overall breeding season apportioning value
4	1	0	0.1	0.9
5	1	0	0.1	0.9
6	1	0	0.1	0.9

6.1.9 In the post-breeding and pre-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post- and pre-breeding seasons for the Preferred Projects in the Irish Sea are 9.9% and 8.2% and for the Preferred Projects in the North Sea are 0% in both seasons. The apportioned values from each of the Preferred Projects combined to the Ailsa Craig SPA are presented in Table 6.7.

Table 6.7: Apportioning for gannet at Ailsa Craig SPA in the post- and pre-breeding season for the impact from all Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
Option 2	1	14.9	98.9	0.0	0.0
			99.5	0.0	0.0
		13.33	98.9	0.0	0.0

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
			99.5	0.0	0.0
	2	14.9	98.9	0.0	0.0
			99.5	0.0	0.0
		13.33	98.9	0.0	0.0
			99.5	0.0	0.0

6.1.10 The annual apportioned impact for gannet at the Ailsa Craig SPA is provided in Table 6.8.

Table 6.8: Calculation of the annual impact attributable to gannet at the Ailsa Craig SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding			Post-breeding	Pre-breeding	Total	Increase in baseline mortality (%)
				PP4	PP5	PP6	All projects	All projects		
Option 2	1	14.9	98.9	4.9	2.9	5.1	0.0	0.0	13.0	0.35
			99.5	2.2	1.3	2.3	0.0	0.0	5.9	0.16
		13.33	98.9	4.6	2.8	4.7	0.0	0.0	12.2	0.33
			99.5	2.1	1.3	2.2	0.0	0.0	5.5	0.15
	2	14.9	98.9	5.7	3.4	5.9	0.0	0.0	15.0	0.40
			99.5	2.6	1.5	2.7	0.0	0.0	6.8	0.18
		13.33	98.9	5.3	3.2	5.5	0.0	0.0	14.1	0.38
			99.5	2.4	1.5	2.5	0.0	0.0	6.4	0.17

6.1.11 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.8 is considered to be 5.5-6.4 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the gannet densities extracted from the MERP dataset are comparable with the exception of migratory periods where the use of the MERP dataset may underestimate gannet abundance.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.
- The proportion of immatures present at each of the Preferred Projects.

6.1.12 An impact of 5.5-6.4 collisions/annum represents 0.15-0.17% of the baseline mortality of the Ailsa Craig SPA gannet population (46,000 breeding adults). When considering the highest impact estimated in Table 6.8, which is considered to be unrealistic due to an over-application of precaution, an annual collision risk estimate of 13.0-15.0 collisions/annum represents an increase in baseline mortality of 0.35-0.40%.

Displacement

6.1.13 Consideration of displacement impacts on gannet has not previously been recommended by Marine Scotland Science, Scottish Natural Heritage (now Nature Scot) and the RSPB (Marine Scotland Science, 2017). This advice has been based on the findings of Searle *et al.* (2014). Searle *et al.* (2014) estimated that the in-combination impact predicted on the Forth Islands SPA gannet population did not exceed 0.5% of the baseline mortality and although the proportion of birds interacting with wind farms was comparatively high, when compared to other species, the associated costs of doing so were small relative to the overall cost of foraging trips. This resulted in overall effects that were negligible. This conclusion is also considered applicable to the Ailsa Craig SPA gannet population. The potential impact from the Plan alone has however, been estimated in the following section.

6.1.14 Displacement analysis has been undertaken for gannet using the approach advised in JNCC *et al*. (2017) (Annex H.1). To account for uncertainty in the analysis approach a range of displacement and mortality rates have been applied following the recommended approach to defining these in JNCC *et al*. (2017). Table 6.9 presents the unapportioned seasonal displacement mortality for gannet at each of the Preferred Projects using the appropriate range of displacement and mortality rates. The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.9: Displacement mortality for gannet at each of the Preferred Projects (unapportioned values) (no. of birds)

Preferred Project	Displacement rate (%)	Mortality rate (%)											
		Breeding				Post-breeding				Pre-breeding			
		1	2	5	10	1	2	5	10	1	2	5	10
1	60	N/A				1	2	4	9	1	1	4	7
	80	N/A				1	2	6	12	1	2	5	10
2	60	N/A				1	1	3	6	1	1	3	5
	80	N/A				1	2	4	8	1	1	3	7
3	60	N/A				1	2	4	8	1	1	4	7
	80	N/A				1	2	6	11	1	2	5	9
4	60	1	3	7	14	0	0	0	1	0	0	0	1
	80	2	4	9	18	0	0	1	1	0	0	0	1
5	60	0	1	2	4	0	0	0	0	0	0	0	0
	80	1	1	3	6	0	0	0	0	0	0	0	0
6	60	1	2	5	9	0	0	0	1	0	0	0	0
	80	1	2	6	12	0	0	0	1	0	0	0	1

6.1.15 In the breeding season, the population of birds present in an area of sea can be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.10.

Table 6.10: Breeding season apportioning for gannet at Ailsa Craig SPA for the impact from all Preferred Projects with connectivity in the breeding season

Preferred Project	Displacement / mortality rate (%)	Apportioning value (%)									
		10	20	30	40	50	60	70	80	90	100
4	60 / 1	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.2	1.4
	80 / 10	1.8	3.7	5.5	7.4	9.2	11.1	12.9	14.7	16.6	18.4
5	60 / 1	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.4	0.4
	80 / 10	0.6	1.1	1.7	2.3	2.9	3.4	4.0	4.6	5.2	5.7
6	60 / 1	0.1	0.2	0.3	0.4	0.5	0.6	0.6	0.7	0.8	0.9
	80 / 10	1.2	2.5	3.7	4.9	6.2	7.4	8.6	9.8	11.1	12.3

6.1.16 Discussion on the appropriate apportioning values to apply for gannet is provided in paragraphs 6.1.3 to 6.1.8.

6.1.17 In the post-breeding and pre-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post- and pre-breeding seasons for the Preferred Projects in the Irish Sea are 9.9% and 8.2% and for the Preferred Projects in the North Sea are 0% and 0%. The apportioned values from each of the Preferred Projects combined to the Ailsa Craig SPA are presented in Table 6.11.

Table 6.11: Apportioning for gannet at Ailsa Craig SPA in the post- and pre-breeding season for the impact from all Preferred Projects

Preferred Project	Displacement rate (%)	Mortality rate (%)	Apportioned values	
			Post-breeding	Non-breeding
1	60	1	0.0	0.0
	80	10	0.0	0.0
2	60	1	0.0	0.0
	80	10	0.0	0.0
3	60	1	0.0	0.0
	80	10	0.0	0.0
4	60	1	0.0	0.0
	80	10	0.1	0.1
5	60	1	0.0	0.0
	80	10	0.0	0.0
6	60	1	0.0	0.0
	80	10	0.1	0.0
Total	60	1	0.0	0.0
	80	10	0.2	0.1

6.1.18 The annual apportioned impact for gannet at the Ailsa Craig SPA is provided in Table 6.12.

Table 6.12: Calculation of the annual impact attributable to gannet at the Ailsa Craig SPA from the Round 4 Plan alone

Displacement / mortality assumptions	Breeding season			Post-breeding season						Pre-breeding season						Total	Increase in baseline mortality (%)
	PP4	PP5	PP6	PP1	PP2	PP3	PP4	PP5	PP6	PP1	PP2	PP3	PP4	PP5	PP6		
60 / 1	1.2	0.4	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.07
80 / 10	16.6	5.2	11.1	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	33.2	0.89

6.1.19 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.12 is considered to be 2.5-33.2 birds. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the gannet densities extracted from the MERP dataset are comparable with the exception of migratory periods where the use of the MERP dataset may underestimate gannet abundance.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.
- The proportion of immatures present at each of the Preferred Projects.

6.1.20 An impact of 2.5-33.2 birds represents 0.07-0.89% of the baseline mortality of the Ailsa Craig SPA gannet population (46,000 breeding adults).

Collision and displacement

6.1.21 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.8 in relation to collision risk is considered to be 5.5-6.4 collisions/annum. The most likely impact from the Round 4 Plan alone from Table 6.12 in relation to displacement is considered to be 2.5-33.2 birds. This provides a combined value of 8.0-39.6 birds/annum. This represents 0.21-1.06% of the baseline mortality of the gannet population at Ailsa Craig SPA.

6.1.22 However, Marine Scotland Science and NatureScot have previously advised that, consideration of displacement impacts for gannet is not required as such impacts are not considered likely to result in an adverse effect on the site integrity of an SPA based on the findings of Searle *et al* (2014).

In-combination

Collision

6.1.23 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Ailsa Craig SPA.

Displacement

6.1.24 Consideration of displacement impacts on gannet has not previously been recommended by Marine Scotland Science, Scottish Natural Heritage (now Nature Scot) and the RSPB (Marine Scotland Science, 2017) based on the findings of Searle *et al.* (2014). Searle *et al.* (2014) estimated that the in-combination impact predicted did not exceed 0.5% of the baseline mortality for gannets at the Forth Islands SPA and although the proportion of birds interacting with wind farms was comparatively high, when compared to other species, the associated costs of doing so were small relative to the overall cost of foraging trips. This resulted in overall effects that were negligible. This advice is therefore considered applicable to the gannet population at Ailsa Craig SPA.

6.1.25 In any case, due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Ailsa Craig SPA.

Collision and displacement

6.1.26 The number of bird collisions apportioned to the Ailsa Craig SPA from the Round 4 Plan is estimated to be 5.5-6.4 birds/annum. This represents between 0.15-0.17% of the baseline mortality at the Ailsa Craig SPA. The predicted displacement mortality apportioned to the Ailsa Craig SPA from the Round 4 Plan is estimated to be 2-33 birds/annum. This represents 0.07-0.89% of the baseline mortality at the Ailsa Craig SPA. However, Marine Scotland Science and NatureScot have previously advised that in reality, displacement impacts for gannet would be unlikely to represent an increase in baseline mortality above 0.5% based on the findings of Searle *et al* (2014).

Lesser black-backed gull

Alone

6.1.27 Collision risk modelling for the Round 4 Plan has been undertaken for lesser black-backed gull using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated a range of values for a number of input parameters. The results of collision risk modelling for each Preferred Project are presented on an unapportioned seasonal basis in Table 6.13. In the breeding season, there is only connectivity between the designated site and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.13: Collision risk estimates for lesser black-backed gull (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																								
				Breeding season				Post-breeding							Non-breeding							Pre-breeding						
				PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	99.5	4	5	4	13	1	1	0	1	1	0	5	2	2	1	1	1	1	7	1	1	0	0	0	0	3
		9.8	99.5	3	5	3	11	1	1	0	0	1	0	4	1	2	0	1	1	0	6	1	1	0	0	0	0	3
	3	13.1	99.5	5	6	4	15	1	2	0	1	1	1	6	2	3	1	1	1	1	9	1	1	0	0	1	0	4
		9.8	99.5	4	5	3	12	1	1	0	1	1	0	5	2	3	1	1	1	1	7	1	1	0	0	0	0	3
Option 3	2	13.1	98.9	3	4	2	9	1	1	0	0	0	0	4	1	2	0	0	1	0	5	1	1	0	0	0	0	3
			99.3	2	2	2	6	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
		9.8	98.9	2	4	2	8	1	1	0	0	0	0	3	1	2	0	0	1	0	5	1	1	0	0	0	0	2
			99.3	1	2	1	5	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
	3	13.1	98.9	3	4	3	10	1	1	0	0	1	0	4	2	3	0	1	1	0	7	1	1	0	0	0	0	3
			99.3	2	3	2	6	1	1	0	0	0	0	3	1	2	0	0	0	0	4	1	1	0	0	0	0	2
		9.8	98.9	3	4	2	9	1	1	0	0	1	0	4	2	2	0	0	1	0	6	1	1	0	0	0	0	3
			99.3	2	3	2	6	1	1	0	0	0	0	2	1	2	0	0	0	0	4	1	1	0	0	0	0	2

6.1.28 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.14, Table 6.15 and Table 6.16.

Table 6.14: Breeding season apportioning for lesser black-backed gull at the Ailsa Craig SPA for the impact from Preferred Project 4

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.4	0.8	1.2	1.6	2.0	2.4	2.9	3.3	3.7	4.1
		9.8	99.5	0.3	0.7	1.0	1.3	1.7	2.0	2.4	2.7	3.0	3.4
	3	13.1	99.5	0.5	0.9	1.4	1.8	2.3	2.7	3.2	3.6	4.1	4.5
		9.8	99.5	0.4	0.8	1.1	1.5	1.9	2.3	2.6	3.0	3.4	3.8
Option 3	2	13.1	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
			99.3	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.6
		9.8	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.4
			99.3	0.1	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.3	1.5
	3	13.1	98.9	0.3	0.6	0.9	1.2	1.4	1.7	2.0	2.3	2.6	2.9
			99.3	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.8
		9.8	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.4	2.6
			99.3	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.7

Table 6.15: Breeding season apportioning for lesser black-backed gull at the Ailsa Craig SPA for the impact from Preferred Project 5

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.5	1.1	1.6	2.1	2.6	3.2	3.7	4.2	4.8	5.3
		9.8	99.5	0.5	0.9	1.4	1.9	2.3	2.8	3.3	3.7	4.2	4.7
	3	13.1	99.5	0.6	1.2	1.8	2.4	2.9	3.5	4.1	4.7	5.3	5.9
		9.8	99.5	0.5	1.0	1.6	2.1	2.6	3.1	3.6	4.2	4.7	5.2
Option 3	2	13.1	98.9	0.4	0.7	1.1	1.5	1.8	2.2	2.6	2.9	3.3	3.7
			99.3	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.3
		9.8	98.9	0.4	0.7	1.1	1.4	1.8	2.2	2.5	2.9	3.3	3.6
			99.3	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.8	2.1	2.3
	3	13.1	98.9	0.4	0.8	1.2	1.6	2.0	2.4	2.9	3.3	3.7	4.1
			99.3	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
		9.8	98.9	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0
			99.3	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.1	2.3	2.6

Table 6.16: Breeding season apportioning for lesser black-backed gull at the Ailsa Craig SPA for the impact from Preferred Project 6

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.4	0.8	1.1	1.5	1.9	2.3	2.7	3.0	3.4	3.8
		9.8	99.5	0.3	0.6	0.9	1.3	1.6	1.9	2.2	2.5	2.8	3.1
	3	13.1	99.5	0.4	0.8	1.3	1.7	2.1	2.5	3.0	3.4	3.8	4.2
		9.8	99.5	0.3	0.7	1.0	1.4	1.7	2.1	2.4	2.8	3.1	3.5
Option 3	2	13.1	98.9	0.2	0.5	0.7	1.0	1.2	1.4	1.7	1.9	2.2	2.4
			99.3	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5
		9.8	98.9	0.2	0.4	0.7	0.9	1.1	1.3	1.5	1.7	2.0	2.2
			99.3	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4
	3	13.1	98.9	0.3	0.5	0.8	1.1	1.3	1.6	1.9	2.1	2.4	2.7
			99.3	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.5	1.7
		9.8	98.9	0.2	0.5	0.7	1.0	1.2	1.5	1.7	1.9	2.2	2.4
			99.3	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5

6.1.29 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.14, Table 6.15 and Table 6.16. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All of the Preferred Projects are beyond the mean-maximum foraging range of lesser black-backed gull from the Ailsa Craig SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. All three projects are however, within the foraging range of lesser black-backed gull when using the mean-maximum foraging range plus one standard deviation for lesser black-backed gull (236 km) presented in Woodward *et al.* (2019). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al.* (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual lesser black-backed gulls from Ailsa Craig SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.30 There is no site-specific foraging range data available for lesser black-backed gull from the Ailsa Craig SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Ailsa Craig SPA then this should only be a limited amount (e.g. 10%).

6.1.31 In the post-, non- and pre-breeding seasons, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, non- and pre-breeding seasons for the Preferred Projects in the Irish Sea are 0.1%, 0.2% and 0.1%, respectively. For the Preferred Projects in the North Sea, 0.1% has been applied in all seasons. The apportioned values from each of the Preferred Projects combined to the Ailsa Craig SPA are presented in Table 6.17. In all cases the impact is less than 0.1 collisions.

Table 6.17: Apportioned collision risk estimates for lesser black-backed gull at the Ailsa Craig SPA in non-breeding seasons

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values		
				Post-breeding	Non-breeding	Pre-breeding
Option 2	2	13.1	99.5	0.0	0.0	0.0
		9.8	99.5	0.0	0.0	0.0

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values		
				Post-breeding	Non-breeding	Pre-breeding
	3	13.1	99.5	0.0	0.0	0.0
		9.8	99.5	0.0	0.0	0.0
Option 3	2	13.1	98.9	0.0	0.0	0.0
			99.3	0.0	0.0	0.0
		9.8	98.9	0.0	0.0	0.0
			99.3	0.0	0.0	0.0
	3	13.1	98.9	0.0	0.0	0.0
			99.3	0.0	0.0	0.0
		9.8	98.9	0.0	0.0	0.0
			99.3	0.0	0.0	0.0

6.1.32 The annual apportioned impact for lesser black-backed gull at the Ailsa Craig SPA is provided in Table 6.18.

Table 6.18: Calculation of the annual impact attributable to lesser black-backed gull at the Ailsa Craig SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding			Post-breeding	Non-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP4	PP5	PP6	All projects	All projects	All projects		
Option 2	2	13.1	99.5	0.4	0.5	0.4	0.0	0.0	0.0	1.3	0.32
		9.8	99.5	0.3	0.5	0.3	0.0	0.0	0.0	1.1	0.27
	3	13.1	99.5	0.5	0.6	0.4	0.0	0.0	0.0	1.5	0.36
		9.8	99.5	0.4	0.5	0.3	0.0	0.0	0.0	1.3	0.31
Option 3	2	13.1	98.9	0.3	0.4	0.2	0.0	0.0	0.0	0.9	0.21
			99.3	0.2	0.2	0.2	0.0	0.0	0.0	0.6	0.13
		9.8	98.9	0.2	0.4	0.2	0.0	0.0	0.0	0.8	0.20
			99.3	0.1	0.2	0.1	0.0	0.0	0.0	0.5	0.13
	3	13.1	98.9	0.3	0.4	0.3	0.0	0.0	0.0	1.0	0.24
			99.3	0.2	0.3	0.2	0.0	0.0	0.0	0.6	0.15
		9.8	98.9	0.3	0.4	0.2	0.0	0.0	0.0	0.9	0.22
			99.3	0.2	0.3	0.2	0.0	0.0	0.0	0.6	0.14

6.1.33 The most likely impact (and most realistic worst case) for the Round 4 Plan alone from Table 6.18 is considered to be 0.5-0.6 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the densities for lesser black-backed gull from the MERP dataset potentially overestimate lesser black-backed gull abundance.
- The appropriate apportioning value to apply. It is considered highly unlikely that a significant proportion of lesser black-backed gulls from Ailsa Craig SPA will forage in the sea areas in which the Preferred Projects will be located. A value of 10% has been applied however, this is considered to be highly precautionary with large gulls unlikely to be found foraging at distances offshore commensurate with the distance between Ailsa Craig SPA and the Preferred Projects.

6.1.34 An impact of less than one collisions/annum represents 0.13-0.14% of the baseline mortality of the Ailsa Craig SPA lesser black-backed gull population (3,600 breeding adults). When considering the highest impact estimated in Table 6.18, which is considered to be unrealistic, an annual collision risk estimate of 1.3-1.5 collisions/annum represents an increase in baseline mortality of 0.32-0.36%. Under any of the scenarios presented, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.35 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Ailsa Craig SPA.

Kittiwake

Alone

6.1.36 Collision risk modelling has been undertaken for kittiwake using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.19. In the breeding season, there is only connectivity between the Ailsa Craig SPA and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.19: Collision risk estimates for kittiwake (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																
				Breeding season				Post-breeding							Pre-breeding					
				PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	98.9	3	2	3	8	29	21	5	2	1	2	59	21	15	3	1	0	1	41
			99.0	3	2	3	7	26	19	4	2	1	2	54	19	14	3	1	0	0	37
		8.71	98.9	2	2	2	6	22	16	3	1	1	1	45	16	12	2	0	0	0	31
			99.0	2	1	2	5	20	14	3	1	1	1	41	15	11	2	0	0	0	29
	3	13.1	98.9	4	2	3	9	37	26	6	2	1	2	75	28	20	4	1	0	1	53
			99.0	3	2	3	8	34	24	5	2	1	2	68	25	18	4	1	0	1	49
		8.71	98.9	3	2	2	7	28	20	4	2	1	2	58	21	15	3	1	0	1	41
			99.0	2	2	2	6	26	18	4	2	1	1	52	19	14	3	1	0	0	37
Option 3	2	13.1	98	1	1	1	3	14	10	1	1	0	1	27	10	7	1	0	0	0	19
		8.71	98	1	1	1	2	12	9	1	1	0	0	23	9	6	1	0	0	0	16
	3	13.1	98	1	1	1	3	18	13	2	1	1	1	34	13	9	1	0	0	0	24
		8.71	98	1	1	1	3	15	11	2	1	1	1	30	12	8	1	0	0	0	21

6.1.37 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.20, Table 6.21 and Table 6.22.

Table 6.20: Breeding season apportioning for kittiwake at Ailsa Craig SPA for the impact from Preferred Project 4

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.3	0.6	0.9	1.2	1.6	1.9	2.2	2.5	2.8	3.1
			99.0	0.3	0.6	0.8	1.1	1.4	1.7	2.0	2.3	2.5	2.8
		8.71	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.3
			99.0	0.2	0.4	0.6	0.8	1.1	1.3	1.5	1.7	1.9	2.1
	3	13.1	98.9	0.4	0.7	1.1	1.4	1.8	2.1	2.5	2.8	3.2	3.5
			99.0	0.3	0.6	1.0	1.3	1.6	1.9	2.2	2.6	2.9	3.2
		8.71	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
			99.0	0.2	0.5	0.7	0.9	1.2	1.4	1.7	1.9	2.1	2.4
Option 3	2	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		8.71	98	0.1	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.8	0.9
	3	13.1	98	0.1	0.2	0.3	0.5	0.6	0.7	0.8	0.9	1.0	1.2
		8.71	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

Table 6.21: Breeding season apportioning for kittiwake at Ailsa Craig SPA for the impact from Preferred Project 5

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.9
			99.0	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.4	1.5	1.7
		8.71	98.9	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.6
			99.0	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4
	3	13.1	98.9	0.2	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.9	2.1
			99.0	0.2	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9
		8.71	98.9	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.6	1.7
			99.0	0.2	0.3	0.5	0.6	0.8	1.0	1.1	1.3	1.4	1.6
Option 3	2	13.1	98	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
		8.71	98	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
	3	13.1	98	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8
		8.71	98	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8

Table 6.22: Breeding season apportioning for kittiwake at Ailsa Craig SPA for the impact from Preferred Project 6

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.3	0.6	0.8	1.1	1.4	1.7	2.0	2.2	2.5	2.8
			99.0	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.0	2.3	2.6
		8.71	98.9	0.2	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.9	2.1
			99.0	0.2	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9
	3	13.1	98.9	0.3	0.6	0.9	1.3	1.6	1.9	2.2	2.5	2.8	3.2
			99.0	0.3	0.6	0.9	1.2	1.4	1.7	2.0	2.3	2.6	2.9
		8.71	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.4
			99.0	0.2	0.4	0.6	0.9	1.1	1.3	1.5	1.7	1.9	2.1
Option 3	2	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.8	0.9
		8.71	98	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.6	0.7	0.8
	3	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		8.71	98	0.1	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8	0.9

6.1.38 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.20, Table 6.21 and Table 6.22. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). Preferred Projects 4 and 5 are beyond the mean-maximum foraging range of kittiwake from Ailsa Craig SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%.

6.1.39 Both projects are within the foraging range of kittiwake when using the mean-maximum foraging range plus one standard deviation (300.5 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual kittiwakes from Ailsa Craig SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.40 Preferred Project 6 is on the edge of the mean-maximum foraging range (when a straight flight line, which passes over land, is used which is not considered representative of the behaviour of a seabird such as kittiwake) with the centre of the wind farm, used in the apportioning approach in Annex H.3 lying outside of the mean-maximum foraging range. As a result the apportioning value calculated for Preferred Project 2 is also 0%.

6.1.41 There is no site-specific foraging range data available for kittiwake from the Ailsa Craig SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Ailsa Craig SPA then this should only be a limited amount (e.g. 10%).

6.1.42 In the post-breeding and pre-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, and pre-breeding seasons for the Preferred Projects in the Irish Sea are 0.06% and 0.11% and for the Preferred Projects in the North Sea are less than 0.01% in both seasons. The apportioned values from each of the Preferred Projects combined to the Ailsa Craig SPA are presented in Table 6.23. In all cases the apportioning impact is less than 0.1 collisions.

Table 6.23: Apportioning for kittiwake at Ailsa Craig SPA in the post- and pre-breeding season for the impact from all Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
Option 2	2	13.1	98.9	0.0	0.0
			99.0	0.0	0.0
		8.71	98.9	0.0	0.0
			99.0	0.0	0.0
	3	13.1	98.9	0.0	0.0
			99.0	0.0	0.0
		8.71	98.9	0.0	0.0
			99.0	0.0	0.0
Option 3	2	13.1	98	0.0	0.0
		8.71	98	0.0	0.0
	3	13.1	98	0.0	0.0
		8.71	98	0.0	0.0

6.1.43 The annual apportioned impact for kittiwake at Ailsa Craig SPA is provided in Table 6.24.

Table 6.24: Calculation of total impact attributable to kittiwake at Ailsa Craig SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding			Post-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP4	PP5	PP5	All projects	All projects		
Option 2	2	13.1	98.9	0.3	0.2	0.3	0.0	0.0	0.8	0.09
			99.0	0.3	0.2	0.3	0.0	0.0	0.7	0.08
		8.71	98.9	0.2	0.2	0.2	0.0	0.0	0.6	0.07
			99.0	0.2	0.1	0.2	0.0	0.0	0.5	0.06
	3	13.1	98.9	0.4	0.2	0.3	0.0	0.0	0.9	0.10
			99.0	0.3	0.2	0.3	0.0	0.0	0.8	0.09
		8.71	98.9	0.3	0.2	0.2	0.0	0.0	0.7	0.07
			99.0	0.2	0.2	0.2	0.0	0.0	0.6	0.07
Option 3	2	13.1	98	0.1	0.1	0.1	0.0	0.0	0.3	0.03
		8.71	98	0.1	0.1	0.1	0.0	0.0	0.2	0.03
	3	13.1	98	0.1	0.1	0.1	0.0	0.0	0.3	0.03
		8.71	98	0.1	0.1	0.1	0.0	0.0	0.3	0.03

6.1.44 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.24 is considered to be 0.2-0.3 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that kittiwake densities from the MERP dataset potentially underestimate kittiwake abundance.
- The appropriate apportioning value to apply. It is considered highly unlikely that a significant proportion of kittiwake from Ailsa Craig SPA will forage in the sea areas in which the Preferred Projects will be located. A value of 10% has been applied however, this is considered to be highly precautionary with kittiwake unlikely to be found foraging at distances offshore commensurate with the distance between Ailsa Craig SPA and the Preferred Projects.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.

6.1.45 An impact of 0.2-0.3 collisions/annum represents 0.03% of the baseline mortality of the Ailsa Craig SPA kittiwake population (6,200 breeding adults). When considering the highest impact estimated in Table 6.24, which is considered to be unrealistic due to an over-application of precaution, an annual collision risk estimate of 0.8-0.9 collisions/annum represents an increase in baseline mortality of 0.09-0.1%. Under any of the scenarios presented, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.46 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Ailsa Craig SPA.

Alde-Ore Estuary SPA and Ramsar

Lesser black-backed gull

Alone

6.1.47 Collision risk modelling for the Round 4 Plan has been undertaken for lesser black-backed gull using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated a range of values for a number of input parameters. The results of collision risk modelling for each Preferred Project are presented on an unapportioned seasonal basis in Table 6.25. In the breeding season, there is only connectivity between the designated site and Preferred Project 3 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.25: Collision risk estimates for lesser black-backed gull (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																				
				Breeding season	Post-breeding							Non-breeding							Pre-breeding						
				PP3	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	99.5	3	1	1	0	1	1	0	5	2	2	1	1	1	1	7	1	1	0	0	0	0	3
		9.8	99.5	2	1	1	0	0	1	0	4	1	2	0	1	1	0	6	1	1	0	0	0	0	3
	3	13.1	99.5	3	1	2	0	1	1	1	6	2	3	1	1	1	1	9	1	1	0	0	1	0	4
		9.8	99.5	2	1	1	0	1	1	0	5	2	3	1	1	1	1	7	1	1	0	0	0	0	3
Option 3	2	13.1	98.9	2	1	1	0	0	0	0	4	1	2	0	0	1	0	5	1	1	0	0	0	0	3
			99.3	1	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
		9.8	98.9	1	1	1	0	0	0	0	3	1	2	0	0	1	0	5	1	1	0	0	0	0	2
			99.3	1	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
	3	13.1	98.9	2	1	1	0	0	1	0	4	2	3	0	1	1	0	7	1	1	0	0	0	0	3
			99.3	1	1	1	0	0	0	0	3	1	2	0	0	0	0	4	1	1	0	0	0	0	2
		9.8	98.9	2	1	1	0	0	1	0	4	2	2	0	0	1	0	6	1	1	0	0	0	0	3
			99.3	1	1	1	0	0	0	0	2	1	2	0	0	0	0	4	1	1	0	0	0	0	2

6.1.48 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA, each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for Preferred Project 3 has been apportioned using a range of apportioning values in Table 6.26.

Table 6.26: Breeding season apportioning for lesser black-backed gull at the Alde-Ore Estuary SPA for the impact from Preferred Project 3

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.3	0.5	0.8	1.1	1.3	1.6	1.9	2.1	2.4	2.7
		9.8	99.5	0.2	0.4	0.7	0.9	1.1	1.3	1.5	1.8	2.0	2.2
	3	13.1	99.5	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0
		9.8	99.5	0.2	0.5	0.7	1.0	1.2	1.5	1.7	2.0	2.2	2.5
Option 3	2	13.1	98.9	0.2	0.3	0.5	0.7	0.8	1.0	1.1	1.3	1.5	1.6
			99.3	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		9.8	98.9	0.1	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.3	1.5
			99.3	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.8	0.9
	3	13.1	98.9	0.2	0.4	0.5	0.7	0.9	1.1	1.3	1.5	1.6	1.8
			99.3	0.1	0.2	0.3	0.5	0.6	0.7	0.8	0.9	1.0	1.2
		9.8	98.9	0.2	0.3	0.5	0.7	0.8	1.0	1.1	1.3	1.5	1.6
			99.3	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

6.1.49 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.26. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). Preferred Project 3 is beyond the mean-maximum foraging range of lesser black-backed gull from the Alde-Ore Estuary SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%.

6.1.50 The apportioning results in Annex H.3 have been reviewed against relevant site specific data. These data indicate that lesser black-backed gulls from the Alde-Ore-Estuary SPA do not interact with the sea area in which Preferred Project 3 is located, foraging instead off the eastern coast of East Anglia or inland (Thaxter *et al.,* 2015). As a result no impact has been apportioned to the Alde-Ore Estuary SPA from Preferred Project 3 (or any other Preferred Project) in the breeding season.

6.1.51 In the post-, non- and pre-breeding seasons, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, non- and pre-breeding seasons for the Preferred Projects in the North Sea are 0.6%, 0.6% and 1.6%, respectively. For the Preferred Projects in the Irish Sea, 0% has been applied in all seasons. The apportioned values from each of the Preferred Projects combined to the Alde-Ore Estuary SPA are presented in Table 6.27. In all cases the impact is less than 0.1 collisions.

Table 6.27: Apportioned collision risk estimates for lesser black-backed gull at the Alde-Ore Estuary SPA in non-breeding seasons

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values		
				Post-breeding	Non-breeding	Pre-breeding
Option 2	2	13.1	99.5	0.0	0.0	0.0
		9.8	99.5	0.0	0.0	0.0
	3	13.1	99.5	0.0	0.0	0.0
		9.8	99.5	0.0	0.0	0.0
Option 3	2	13.1	98.9	0.0	0.0	0.0
			99.3	0.0	0.0	0.0
		9.8	98.9	0.0	0.0	0.0
			99.3	0.0	0.0	0.0
	3	13.1	98.9	0.0	0.0	0.0
			99.3	0.0	0.0	0.0
		9.8	98.9	0.0	0.0	0.0

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values		
				Post-breeding	Non-breeding	Pre-breeding
			99.3	0.0	0.0	0.0

6.1.52 The annual apportioned impact for lesser black-backed gull at the Alde-Ore Estuary SPA is provided in Table 6.28.

Table 6.28: Calculation of the annual impact attributable to lesser black-backed gull at the Alde-Ore Estuary SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Post-breeding	Non-breeding	Pre-breeding	Total	Baseline mortality (%)	
				All projects	All projects	All projects		Citation	Natural England designated sites viewer
Option 2	2	13.1	99.5	0.0	0.0	0.0	0.1	0.0	0.0
		9.8	99.5	0.0	0.0	0.0	0.1	0.0	0.0
	3	13.1	99.5	0.0	0.0	0.0	0.1	0.0	0.0
		9.8	99.5	0.0	0.0	0.0	0.1	0.0	0.0
Option 3	2	13.1	98.9	0.0	0.0	0.0	0.1	0.0	0.0
			99.3	0.0	0.0	0.0	0.0	0.0	0.0
		9.8	98.9	0.0	0.0	0.0	0.1	0.0	0.0
			99.3	0.0	0.0	0.0	0.0	0.0	0.0
	3	13.1	98.9	0.0	0.0	0.0	0.1	0.0	0.0
			99.3	0.0	0.0	0.0	0.0	0.0	0.0
		9.8	98.9	0.0	0.0	0.0	0.1	0.0	0.0
			99.3	0.0	0.0	0.0	0.0	0.0	0.0

6.1.53 The most likely impact (and most realistic worst case) for the Round 4 Plan alone from Table 6.28 is considered to be less than 0.1 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. It should also be noted that, when compared to baseline surveys undertaken for Round 3 projects, that the densities in the MERP dataset for lesser black-backed gull appear relatively high and hence the risk may be over-estimated.

6.1.54 The lesser black-backed gull population at the Alde-Ore Estuary SPA has undergone significant declines since designation and therefore both the designated population and the lower population count documented on the Natural England designated sites viewer (1,940 pairs) have been considered in relation to changes in baseline mortality in Table 6.28. An impact of less than 0.1 collisions/annum represents less than 0.01% of the baseline mortality of the Alde-Ore Estuary SPA lesser black-backed gull population on both the citation (14,070 pairs) and the lower population count documented on the Natural England designated sites viewer (1,940 pairs).

6.1.55 Even if the highest value in the calculated range is assumed (which is considered to be unrealistic due to an over-application of precaution) the resulting impact would still be considered negligible, representing less than 0.01% of the baseline mortality of the lesser black-backed gull population at the SPA.

In-combination

6.1.56 It is acknowledged that Natural England have previously advised that the current level of in-combination mortality estimated for lesser black-backed gull at the Alde-Ore Estuary SPA represents an adverse effect on the integrity (e.g. Natural England, 2020). However, the very small impact predicted for the Round 4 Plan would not be expected to make an appreciable difference to any in-combination impact.

Anglesey Terns/ Morwenoliaid Ynys Môn SPA

Arctic tern

Plan alone

6.1.57 The Anglesey Terns / Morwenoliaid Ynys Môn SPA is designated to protect breeding species of terns and their associated marine foraging area. The SPA was a re-classification and extension of the original Ynys Feurig, Cemlyn Bay and The Skerries SPA which was designated to protect only the breeding colonies of a number of tern species.

6.1.58 The generic mean-maximum foraging range of Arctic tern is 25.7 ± 14.8 km Woodward *et al.* (2019), with the SPA boundary located approximately 21.5 km from the nearest Preferred Project. However, the SPA boundary includes a proportion of the generic foraging range and therefore the actual distance an Arctic tern would have to travel from a breeding colony to reach the nearest Preferred Project is approximately 39 km. This distance is on the limit of the foraging range of Arctic tern when including one standard deviation. The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this

reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual Arctic terns from the Anglesey terns / Morwenoliaid Ynys Môn SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.59 Wilson *et al.* (2014) presents tracking data for Arctic tern from Cemlyn Bay, one of the constituent breeding colonies of the SPA. The data collected show a limited foraging range with Woodward *et al.* (2019) stating that the maximum foraging range from Cemlyn Bay was 2.6 km and from the Skerries was 29 km (Perrow *et al.* 2011), both far short of the Preferred Projects. However, data were only collected from a limited number of birds suggesting the foraging behaviour exhibited may not be representative of the colony as a whole. Woodward *et al.* (2019).

6.1.60 As part of the departmental brief that supported the proposals to extend the existing SPA, survey data were used to determine the distribution of Arctic terns around the Anglesey coast during the breeding season. These data showed highest abundances within approximately 5 km of the coast with very few birds observed beyond this.

6.1.61 The boundary of the SPA was defined using a 'Maximum curvature' approach to identify a threshold representing the optimum trade-off between the number of birds included and the area included as part of the SPA boundary. This analysis approach utilised information on habitat conditions alongside the tern distribution data described above. Natural Resources Wales (2016) shows the results of this process with the foraging areas of Arctic tern responsible for the marine limit of the SPA on the eastern and north-eastern sides of the SPA and Sandwich tern on the western side. This boundary is, at its nearest point over 20 km from the nearest Preferred Project and it is therefore considered that very few birds (if any) would utilise the Preferred Project areas.

6.1.62 It is therefore considered highly unlikely that the abundance of Arctic terns at Preferred Project 6 would be sufficient to result in an impact of a magnitude high enough to result in an adverse effect.

In-combination

6.1.63 Due to the limited impact expected from the Round 4 Plan it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Anglesey Terns/ Morwenoliaid Ynys Môn SPA.

Sandwich tern

Plan alone

6.1.64 The Anglesey Terns / Morwenoliaid Ynys Môn SPA is designated to protect breeding species of terns and their associated marine foraging area. The SPA was a re-classification and extension of the original Ynys Feurig, Cemlyn Bay and The

Skerries SPA which was designated to protect only the breeding colonies of a number of tern species.

6.1.65 The generic mean-maximum foraging range of Sandwich tern is 34.3 ± 23.2 km Woodward *et al.* (2019), with the SPA boundary located approximately 21.5 km from the nearest Preferred Project. However, the SPA boundary includes a proportion of the generic foraging range and therefore the actual distance an Arctic tern would have to travel from a breeding colony to reach the nearest Preferred Project is approximately 39 km. This distance falls within the foraging range of Sandwich tern when including one standard deviation. The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual Sandwich terns from the Anglesey terns / Morwenoliaid Ynys Môn SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.66 Wilson *et al.* (2014) presents tracking data for Sandwich tern from Cemlyn Bay, one of the constituent breeding colonies of the SPA. The data collected suggest a maximum foraging range of 34.75 km although this distance was associated with birds flying east from the colony around the Anglesey coast to Red Wharf Bay. None of the birds tracked interacted with the sea areas in which the Preferred Projects are located.

6.1.67 As part of the departmental brief that supported the proposals to extend the existing SPA, survey data were used to determine the distribution of Sandwich terns around the Anglesey coast during the breeding season. These data showed highest abundances within approximately 5 km of the coast with very few birds observed beyond this.

6.1.68 The boundary of the SPA was defined using a 'Maximum curvature' approach to identify a threshold representing the optimum trade-off between the number of birds included and the area included as part of the SPA boundary. This analysis approach utilised information on habitat conditions alongside the tern distribution data described above. Natural Resources Wales (2016) shows the results of this process with the foraging areas of Arctic tern responsible for the marine limit of the SPA on the eastern and north-eastern sides of the SPA and Sandwich tern on the western side. This boundary is, at its nearest point over 20 km from the nearest Preferred Project and it is therefore considered that very few birds (if any) would utilise the Preferred Project areas.

6.1.69 It is therefore considered highly unlikely that the abundance of Sandwich terns at Preferred Project 6 would be sufficient to result in an impact of a magnitude high enough to result in an adverse effect.

In-combination

6.1.70 Due to the limited impact expected from the Round 4 Plan it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Anglesey Terns/ Morwenoliaid Ynys Môn SPA.

Bowland Fells SPA

Lesser black-backed gull

Alone

6.1.71 Collision risk modelling for the Round 4 Plan has been undertaken for lesser black-backed gull using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated a range of values for a number of input parameters. The results of collision risk modelling for each Preferred Project are presented on an unapportioned seasonal basis in Table 6.29. In the breeding season, there is only connectivity between the designated site and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.29: Collision risk estimates for lesser black-backed gull (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																							
				Breeding season				Post-breeding							Non-breeding							Pre-breeding						
				PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	99.5	4	5	4	13	1	1	0	1	1	0	5	2	2	1	1	1	1	7	1	1	0	0	0	0	3
		9.8	99.5	3	5	3	11	1	1	0	0	1	0	4	1	2	0	1	1	0	6	1	1	0	0	0	0	3
	3	13.1	99.5	5	6	4	15	1	2	0	1	1	1	6	2	3	1	1	1	1	9	1	1	0	0	1	0	4
		9.8	99.5	4	5	3	12	1	1	0	1	1	0	5	2	3	1	1	1	1	7	1	1	0	0	0	0	3
Option 3	2	13.1	98.9	3	4	2	9	1	1	0	0	0	0	4	1	2	0	0	1	0	5	1	1	0	0	0	0	3
			99.3	2	2	2	6	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
		9.8	98.9	2	4	2	8	1	1	0	0	0	0	3	1	2	0	0	1	0	5	1	1	0	0	0	0	2
			99.3	1	2	1	4	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
	3	13.1	98.9	3	4	3	10	1	1	0	0	1	0	4	2	3	0	1	1	0	7	1	1	0	0	0	0	3
			99.3	2	3	2	7	1	1	0	0	0	0	3	1	2	0	0	0	0	4	1	1	0	0	0	0	2
		9.8	98.9	3	4	2	9	1	1	0	0	1	0	4	2	2	0	0	1	0	6	1	1	0	0	0	0	3
			99.3	2	3	2	7	1	1	0	0	0	0	2	1	2	0	0	0	0	4	1	1	0	0	0	0	2

6.1.72 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.30, Table 6.31 and Table 6.32.

Table 6.30: Breeding season apportioning for lesser black-backed gull at the Bowland Fells SPA for the impact from Preferred Project 4

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.4	0.8	1.2	1.6	2.0	2.4	2.9	3.3	3.7	4.1
		9.8	99.5	0.3	0.7	1.0	1.3	1.7	2.0	2.4	2.7	3.0	3.4
	3	13.1	99.5	0.5	0.9	1.4	1.8	2.3	2.7	3.2	3.6	4.1	4.5
		9.8	99.5	0.4	0.8	1.1	1.5	1.9	2.3	2.6	3.0	3.4	3.8
Option 3	2	13.1	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
			99.3	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.6
		9.8	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.4
			99.3	0.1	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.3	1.5
	3	13.1	98.9	0.3	0.6	0.9	1.2	1.4	1.7	2.0	2.3	2.6	2.9
			99.3	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.8
		9.8	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.4	2.6
			99.3	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.7

Table 6.31: Breeding season apportioning for lesser black-backed gull at the Bowland Fells SPA for the impact from Preferred Project 5

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.5	1.1	1.6	2.1	2.6	3.2	3.7	4.2	4.8	5.3
		9.8	99.5	0.5	0.9	1.4	1.9	2.3	2.8	3.3	3.7	4.2	4.7
	3	13.1	99.5	0.6	1.2	1.8	2.4	2.9	3.5	4.1	4.7	5.3	5.9
		9.8	99.5	0.5	1.0	1.6	2.1	2.6	3.1	3.6	4.2	4.7	5.2
Option 3	2	13.1	98.9	0.4	0.7	1.1	1.5	1.8	2.2	2.6	2.9	3.3	3.7
			99.3	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.3
		9.8	98.9	0.4	0.7	1.1	1.4	1.8	2.2	2.5	2.9	3.3	3.6
			99.3	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.8	2.1	2.3
	3	13.1	98.9	0.4	0.8	1.2	1.6	2.0	2.4	2.9	3.3	3.7	4.1
			99.3	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
		9.8	98.9	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0
			99.3	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.1	2.3	2.6

Table 6.32: Breeding season apportioning for lesser black-backed gull at the Bowland Fells SPA for the impact from Preferred Project 6

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.4	0.8	1.1	1.5	1.9	2.3	2.7	3.0	3.4	3.8
		9.8	99.5	0.3	0.6	0.9	1.3	1.6	1.9	2.2	2.5	2.8	3.1
	3	13.1	99.5	0.4	0.8	1.3	1.7	2.1	2.5	3.0	3.4	3.8	4.2
		9.8	99.5	0.3	0.7	1.0	1.4	1.7	2.1	2.4	2.8	3.1	3.5
Option 3	2	13.1	98.9	0.2	0.5	0.7	1.0	1.2	1.4	1.7	1.9	2.2	2.4
			99.3	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5
		9.8	98.9	0.2	0.4	0.7	0.9	1.1	1.3	1.5	1.7	2.0	2.2
			99.3	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4
	3	13.1	98.9	0.3	0.5	0.8	1.1	1.3	1.6	1.9	2.1	2.4	2.7
			99.3	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.5	1.7
		9.8	98.9	0.2	0.5	0.7	1.0	1.2	1.5	1.7	1.9	2.2	2.4
			99.3	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5

6.1.73 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.30, Table 6.31 and Table 6.32. The three components of the population present at each of the Preferred Projects in the breeding season have been considered (see Annex H.3). The values associated with each of these population components is presented in Table 6.33 and multiplied together to provide an apportioning value for each of the Preferred Projects.

Table 6.33: Breeding season apportioning values for lesser black-backed gull at Bowland Fells SPA based on the approach applied in Annex H.3

Preferred Project	Proportion of breeding adult birds from SPA	Proportion of immature birds	Proportion of non-breeding birds	Overall breeding season apportioning value
4	0.46	0.38	0.34	0.19
5	0.43	0.38	0.34	0.17
6	0.48	0.38	0.34	0.20

6.1.74 The results of the apportioning approach in Annex H.3 suggest that 17-20% of the predicted impact at the Preferred Projects is attributable to Bowland Fells SPA. As mentioned in Section 5.2, the estimated proportion of immature birds in Table 6.33 does not take account of the distribution of immature birds and may therefore over-estimate this component of the population present at each of the Preferred Projects.

6.1.75 Tracking data for lesser black-backed gulls from the Bowland Fells SPA indicates limited usage of the offshore environment with birds making extensive use of landfill and urban areas to the south of the SPA or areas to the north and east of the SPA (Clewley *et al.,* 2017). This suggests that the apportioning values presented in Table 6.33 significantly over-estimate the apportioning value applicable to the Bowland Fells SPA despite the assumptions associated with immature birds. Notwithstanding this, and on a precautionary basis the apportioning values in Table 6.33 will be used in the breeding season.

6.1.76 In the post-, non- and pre-breeding seasons, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, non- and pre-breeding seasons for the Preferred Projects in the Irish Sea are 2.8%, 4.5% and 2.8%, respectively. For the Preferred Projects in the North Sea, 2.2%, 2.3% and 2.3% has been applied, respectively. The apportioned values from each of the Preferred Projects combined to the Bowland Fells SPA are presented in Table 6.34.

Table 6.34: Apportioned collision risk estimates for lesser black-backed gull at the Bowland Fells SPA in non-breeding seasons

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values		
				Post-breeding	Non-breeding	Pre-breeding
Option 2	2	13.1	99.5	0.1	0.2	0.1
		9.8	99.5	0.1	0.2	0.1
	3	13.1	99.5	0.1	0.3	0.1
		9.8	99.5	0.1	0.2	0.1
Option 3	2	13.1	98.9	0.1	0.1	0.1
			99.3	0.1	0.1	0.0
		9.8	98.9	0.1	0.1	0.1
			99.3	0.0	0.1	0.0
	3	13.1	98.9	0.1	0.2	0.1
			99.3	0.1	0.1	0.0
		9.8	98.9	0.1	0.2	0.1
			99.3	0.1	0.1	0.0

6.1.77 The annual apportioned impact for lesser black-backed gull at the Bowland Fells SPA is provided in Table 6.35.

Table 6.35: Calculation of the annual impact attributable to lesser black-backed gull at the Bowland Fells SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding season			Post-breeding	Non-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP4	PP5	PP6	All projects	All projects	All projects		
Option 2	2	13.1	99.5	0.8	0.9	0.7	0.1	0.2	0.1	2.8	0.11
		9.8	99.5	0.6	0.8	0.6	0.1	0.2	0.1	2.4	0.09
	3	13.1	99.5	0.8	1.0	0.8	0.1	0.3	0.1	3.2	0.12
		9.8	99.5	0.7	0.9	0.6	0.1	0.2	0.1	2.7	0.10
Option 3	2	13.1	98.9	0.5	0.6	0.4	0.1	0.1	0.1	1.9	0.07
			99.3	0.3	0.4	0.3	0.1	0.1	0.0	1.2	0.05
		9.8	98.9	0.4	0.6	0.4	0.1	0.1	0.1	1.8	0.07
			99.3	0.3	0.4	0.3	0.0	0.1	0.0	1.1	0.04
	3	13.1	98.9	0.5	0.7	0.5	0.1	0.2	0.1	2.1	0.08
			99.3	0.3	0.5	0.3	0.1	0.1	0.0	1.4	0.05
		9.8	98.9	0.5	0.7	0.5	0.1	0.2	0.1	2.0	0.08
			99.3	0.3	0.4	0.3	0.1	0.1	0.0	1.3	0.05

6.1.78 The most likely impact (and most realistic worst case) for the Round 4 Plan alone from Table 6.35 is considered to be 1.1-1.3 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the densities for lesser black-backed gull from the MERP dataset potentially overestimate lesser black-backed gull abundance.

6.1.79 An impact of 1.1-1.3 collisions/annum represents 0.04-0.05% of the baseline mortality of the Bowland Fells SPA lesser black-backed gull population (22,940 breeding adults). When considering the highest impact estimated in Table 6.35, which is considered unrealistic due to an over-application of precaution an annual collision risk estimate of 2.8-3.2 collisions/annum represents an increase in baseline mortality of 0.11-0.12%. Under any of the scenarios presented, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.80 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Bowland Fells SPA.

Bray Head SAC

Kittiwake

Alone

6.1.81 Collision risk modelling has been undertaken for kittiwake using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.36. In the breeding season, there is only connectivity between the Bray Head SAC and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.36: Collision risk estimates for kittiwake (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																
				Breeding season				Post-breeding							Pre-breeding						
				PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	98.9	3	2	3	8	29	21	5	2	1	2	59	21	15	3	1	0	1	41
			99.0	3	2	3	7	26	19	4	2	1	2	54	19	14	3	1	0	0	37
		8.71	98.9	2	2	2	6	22	16	3	1	1	1	45	16	12	2	0	0	0	31
			99.0	2	1	2	5	20	14	3	1	1	1	41	15	11	2	0	0	0	29
	3	13.1	98.9	4	2	3	9	37	26	6	2	1	2	75	28	20	4	1	0	1	53
			99.0	3	2	3	8	34	24	5	2	1	2	68	25	18	4	1	0	1	49
		8.71	98.9	3	2	2	7	28	20	4	2	1	2	58	21	15	3	1	0	1	41
			99.0	2	2	2	6	26	18	4	2	1	1	52	19	14	3	1	0	0	37
Option 3	2	13.1	98	1	1	1	3	14	10	1	1	0	1	27	10	7	1	0	0	0	19
		8.71	98	1	1	1	2	12	9	1	1	0	0	23	9	6	1	0	0	0	16
	3	13.1	98	1	1	1	3	18	13	2	1	1	1	34	13	9	1	0	0	0	24
		8.71	98	1	1	1	3	15	11	2	1	1	1	30	12	8	1	0	0	0	21

6.1.82 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.37, Table 6.38 and Table 6.39.

Table 6.37: Breeding season apportioning for kittiwake at Bray Head SAC for the impact from Preferred Project 4

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.3	0.6	0.9	1.2	1.6	1.9	2.2	2.5	2.8	3.1
			99.0	0.3	0.6	0.8	1.1	1.4	1.7	2.0	2.3	2.5	2.8
		8.71	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.3
			99.0	0.2	0.4	0.6	0.8	1.1	1.3	1.5	1.7	1.9	2.1
	3	13.1	98.9	0.4	0.7	1.1	1.4	1.8	2.1	2.5	2.8	3.2	3.5
			99.0	0.3	0.6	1.0	1.3	1.6	1.9	2.2	2.6	2.9	3.2
		8.71	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
			99.0	0.2	0.5	0.7	0.9	1.2	1.4	1.7	1.9	2.1	2.4
Option 3	2	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		8.71	98	0.1	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.8	0.9
	3	13.1	98	0.1	0.2	0.3	0.5	0.6	0.7	0.8	0.9	1.0	1.2
		8.71	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

Table 6.38: Breeding season apportioning for kittiwake at Bray Head SAC for the impact from Preferred Project 5

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.9
			99.0	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.4	1.5	1.7
		8.71	98.9	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.6
			99.0	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4
	3	13.1	98.9	0.2	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.9	2.1
			99.0	0.2	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9
		8.71	98.9	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.6	1.7
			99.0	0.2	0.3	0.5	0.6	0.8	1.0	1.1	1.3	1.4	1.6
Option 3	2	13.1	98	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
		8.71	98	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
	3	13.1	98	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8
		8.71	98	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8

Table 6.39: Breeding season apportioning for kittiwake at Bray Head SAC for the impact from Preferred Project 6

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.3	0.6	0.8	1.1	1.4	1.7	2.0	2.2	2.5	2.8
			99.0	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.0	2.3	2.6
		8.71	98.9	0.2	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.9	2.1
			99.0	0.2	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9
	3	13.1	98.9	0.3	0.6	0.9	1.3	1.6	1.9	2.2	2.5	2.8	3.2
			99.0	0.3	0.6	0.9	1.2	1.4	1.7	2.0	2.3	2.6	2.9
		8.71	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.4
			99.0	0.2	0.4	0.6	0.9	1.1	1.3	1.5	1.7	1.9	2.1
Option 3	2	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.8	0.9
		8.71	98	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.6	0.7	0.8
	3	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		8.71	98	0.1	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8	0.9

6.1.83 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.37, Table 6.38 and Table 6.39. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). Preferred Project 5 is beyond the mean-maximum foraging range of kittiwake from Bray Head SAC and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%.

6.1.84 Preferred Project 5 is however, within the foraging range of kittiwake when using the mean-maximum foraging range plus one standard deviation (300.5 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual kittiwakes from Bray Head SAC could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.85 Preferred Project 6 is on the edge of the mean-maximum foraging range (when a straight flight line, which passes over land, is used which is not considered representative of the behaviour of a seabird such as kittiwake) with the centre of the wind farm, used in the apportioning approach in Annex H.3 lying outside of the mean-maximum foraging range. As a result the apportioning value calculated for Preferred Project 6 is also 0%.

6.1.86 Preferred Project 4 is within the mean-maximum foraging range of kittiwake and in order to identify the most realistic apportioning value to apply in the breeding season, the three components of the population present at each of the Preferred Projects have been considered (see Annex H.3). The values associated with each of these population components is presented in Table 6.40 and multiplied together to provide an apportioning value for both Preferred Projects.

Table 6.40: Breeding season apportioning values for kittiwake at Bray Head SAC based on the approach applied in Annex H.3

Preferred Project	Proportion of breeding adult birds from SPA	Proportion of immature birds	Proportion of non-breeding birds	Overall breeding season apportioning value
4	0.03	0.44	0.1	0.02

6.1.87 The results of the apportioning approach in Annex H.3 suggest that 2% of the predicted impact at Preferred Project 4 is attributable to Bray Head SAC. As mentioned in Section 5.2, the estimated proportion of immature birds in Table 6.40 does not take account of the distribution of immature birds and may therefore over-estimate this component of the population present at each of the Preferred Projects. If it were to be assumed that no immature birds were to be present at Preferred Project 4, an ecologically invalid assumption, then the apportioning value at Preferred Project 4 would still remain low (3%).

6.1.88 There is no site-specific information in relation to the foraging behaviour of kittiwake from the Bray Head SAC. However, the UK and Eire-wide utilisation distributions presented in Cleasby *et al.* (2018) suggest that the Preferred Projects lie beyond the 75% utilisation distribution band. This suggests limited connectivity between any kittiwake colony and the Preferred Projects and supports the use of a low apportioning value. Therefore if, due to the lack of site-specific data and on a precautionary basis, any impact from Preferred Projects 5 and 6 is to be apportioned to the Bray Head SAC then this should only be a limited amount and it is proposed that this be the same as that calculated for Preferred Project 4.

6.1.89 As there is no information on the proportion of immature birds present at Preferred Project 4 it is proposed that this component of the population be discounted accepting that this is will result in an over-estimation of the impact on the Bray Head SAC. The apportioning value in the breeding season for Preferred Project 4, 5 and 6 would therefore be 0.03.

6.1.90 In the post-breeding and pre-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, and pre-breeding seasons for the Preferred Projects in the Irish Sea are 0.1% and 0.18% and for the Preferred Projects in the North Sea are less than 0.01% in both seasons. The apportioned values from each of the Preferred Projects combined to the Bray Head SAC are presented in Table 6.41.

Table 6.41: Apportioning for kittiwake at Bray Head SAC in the post- and pre-breeding season for the impact from all Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
Option 2	2	13.1	98.9	0.0	0.0
			99.0	0.0	0.0
		8.71	98.9	0.0	0.0
			99.0	0.0	0.0
	3	13.1	98.9	0.0	0.0
			99.0	0.0	0.0
		8.71	98.9	0.0	0.0
			99.0	0.0	0.0

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
Option 3	2	13.1	98	0.0	0.0
		8.71	98	0.0	0.0
	3	13.1	98	0.0	0.0
		8.71	98	0.0	0.0

6.1.91 The annual apportioned impact for kittiwake at Bray Head SAC is provided in Table 6.42

Table 6.42: Calculation of total impact attributable to kittiwake at Bray Head SAC from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding			Post-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP4	PP5	PP6	All projects	All projects		
Option 2	2	13.1	98.9	0.1	0.1	0.1	0.0	0.0	0.2	0.10
			99.0	0.1	0.0	0.1	0.0	0.0	0.2	0.09
		8.71	98.9	0.1	0.0	0.1	0.0	0.0	0.2	0.08
			99.0	0.1	0.0	0.1	0.0	0.0	0.2	0.07
	3	13.1	98.9	0.1	0.1	0.1	0.0	0.0	0.3	0.12
			99.0	0.1	0.1	0.1	0.0	0.0	0.2	0.11
		8.71	98.9	0.1	0.1	0.1	0.0	0.0	0.2	0.09
			99.0	0.1	0.0	0.1	0.0	0.0	0.2	0.08
Option 3	2	13.1	98	0.0	0.0	0.0	0.0	0.0	0.1	0.04
		8.71	98	0.0	0.0	0.0	0.0	0.0	0.1	0.03
	3	13.1	98	0.0	0.0	0.0	0.0	0.0	0.1	0.04
		8.71	98	0.0	0.0	0.0	0.0	0.0	0.1	0.04

6.1.92 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.42 is considered to be 0.1 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that kittiwake densities from the MERP dataset potentially underestimate kittiwake abundance.
- The appropriate apportioning value to apply. It is considered highly unlikely that a significant proportion of kittiwake from Bray Head SAC will forage in the sea areas in which the Preferred Projects will be located. A value of 10% has been applied however, this is considered to be highly precautionary with kittiwakes unlikely to be found foraging at distances offshore commensurate with the distance between Bray Head SAC and the Preferred Projects.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.
- The proportion of immatures present at each of the Preferred Projects.

6.1.93 An impact of 0.1 collisions/annum represents 0.03-0.04% of the baseline mortality of the Bray Head SAC kittiwake population (1,562 breeding adults). When considering the highest impact estimated in Table 6.42 which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 0.2-0.3 collisions/annum represents an increase in baseline mortality of 0.10-0.12%. Under any of the scenarios presented, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.94 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Bray Head SAC.

Guillemot

Alone

6.1.95 Displacement analysis has been undertaken for guillemot using the approach advised in JNCC *et al.* (2017) (Annex H.1). To account for uncertainty in the analysis approach, a range of displacement and mortality rates have been applied following the recommended approach to defining these in JNCC *et al.* (2017). Table 6.43 presents the unapportioned seasonal displacement mortality for guillemot at each of the Preferred Projects using the appropriate range of displacement and mortality rates. In the breeding season, there is only connectivity between the Bray Head SAC and Preferred Project 4 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.43: Displacement mortality for guillemot at each of the Preferred Projects (unapportioned values) (no. of birds)

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
1	30	N/A				7	13	33	67
	50	N/A				11	22	56	112
	70	N/A				16	31	78	156
2	30	N/A				6	12	30	60
	50	N/A				10	20	50	100
	70	N/A				14	28	70	140
3	30	N/A				6	11	29	57
	50	N/A				10	19	48	95
	70	N/A				13	27	67	134
4	30	2	3	8	17	2	4	10	20
	50	3	6	14	28	3	7	17	34
	70	4	8	20	39	5	9	24	47
5	30	N/A				1	1	3	6
	50	N/A				1	2	5	10
	70	N/A				1	3	7	14
6	30	N/A				1	3	7	13

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
	50	N/A				2	4	11	22
	70	N/A				3	6	16	31

6.1.96 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.44.

Table 6.44: Breeding season apportioning for guillemot at Bray Head SAC for the impact from all Preferred Projects with connectivity in the breeding season

Preferred Project	Displacement / mortality rate (%)	Apportioning value (%)									
		10	20	30	40	50	60	70	80	90	100
4	30 / 1	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.7
	50 / 5	1.4	2.8	4.2	5.6	7.0	8.4	9.8	11.2	12.6	14.1
	70 / 10	3.9	7.9	11.8	15.7	19.7	23.6	27.5	31.5	35.4	39.3

6.1.97 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.44. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All of the Preferred Projects are beyond the mean-maximum foraging range of guillemot from the Bray Head SAC and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. Preferred Project 4 is however, within the foraging range of guillemot when using the mean-maximum foraging range plus one standard deviation (153.7 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual guillemots from Bray Head SAC could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of displacement mortality.

6.1.98 There is no site-specific foraging range data available for guillemot from the Bray Head SAC. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Bray Head SAC then this should only be a limited amount (e.g. 10%).

6.1.99 In the non-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning value used for the Preferred Projects in the Irish Sea is 0.03% and for the Preferred Projects in the North Sea is 0%. The apportioned values from each of the Preferred Projects combined to the Bray Head SAC are presented in Table 6.45. In all cases the impact is less than 0.1 birds.

Table 6.45: Apportioned displacement mortality for guillemot at the Bray Head SAC in non-breeding season

Displacement / mortality rate (%)	Preferred Project						Total
	1	2	3	4	5	6	
30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50 / 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70 / 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0

6.1.100 The annual apportioned impact for guillemot at the Bray Head SAC is provided in Table 6.46.

Table 6.46: Calculation of the annual impact attributable to guillemot at the Bray Head SAC from the Round 4 Plan alone

Displacement / mortality assumptions	Breeding season	Non-breeding season						Total	Increase in baseline mortality (%)
	PP4	PP1	PP2	PP3	PP4	PP5	PP6		
30 / 1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.7
50 / 5	1.4	0.0	0.0	0.0	0.0	0.0	0.0	1.4	6.1
70 / 10	3.9	0.0	0.0	0.0	0.0	0.0	0.0	4.0	16.9

6.1.101 The most likely impact (and most realistic worst case) for the Round 4 Plan alone from Table 6.46 is considered to be 1.4 birds. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2 above. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the densities for guillemot from the MERP dataset potentially underestimate guillemot abundance.
- The appropriate apportioning value to apply. It is considered highly unlikely that a significant proportion of guillemot from Bray Head SAC will forage in the sea areas in which the Preferred Projects will be located. A value of 10% has been applied, however, this is considered to be highly precautionary with auks unlikely to be found foraging at distances offshore commensurate with the distance between Bray Head SAC and the Preferred Projects.

6.1.102 Despite the predicted displacement risk exceeding the 1% baseline mortality threshold of the Bray Head SAC population (6.1%), the actual number of birds displaced is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.103 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Bray Head SAC.

Razorbill

Alone

6.1.104 Displacement analysis has been undertaken for razorbill using the approach advised in JNCC *et al.* (2017) (Annex H.1). To account for uncertainty in the analysis approach a range of displacement and mortality rates have been applied following the recommended approach to defining these in JNCC *et al.* (2017). Table 6.47 presents the unapportioned seasonal displacement mortality for razorbill at each of the Preferred Projects using the appropriate range of displacement and mortality rates. In the breeding season, there is only connectivity between the Bray Head SAC and Preferred Projects 4 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.47: Displacement mortality for razorbill at each of the Preferred Projects (unapportioned values) (no. of birds)

Preferred Project	Displacement rate (%)	Mortality rate (%)															
		Breeding				Post-breeding				Non-breeding				Pre-breeding			
		1	2	5	10	1	2	5	10	1	2	5	10	1	2	5	10
1	30	N/A				1	1	4	7	1	2	5	9	1	2	5	11
	40	N/A				1	2	5	10	1	3	6	13	1	3	7	14
	70	N/A				2	3	9	17	2	4	11	22	2	5	12	25
2	30	N/A				1	1	3	6	1	2	4	8	1	2	5	9
	40	N/A				1	2	4	8	1	2	5	10	1	2	6	12
	70	N/A				1	3	7	13	2	4	9	18	2	4	11	21
3	30	N/A				1	1	3	6	1	1	4	7	1	2	4	8
	40	N/A				1	1	4	7	1	2	5	10	1	2	6	11
	70	N/A				1	3	7	13	2	3	9	17	2	4	10	20
4	30	0	0	1	1	0	1	1	3	0	1	2	4	0	1	2	4
	40	0	0	1	2	0	1	2	4	0	1	2	5	1	1	3	5
	70	0	1	2	3	1	1	3	7	1	2	4	8	1	2	5	10
5	30	N/A				0	0	0	1	0	0	1	1	0	0	1	1
	40	N/A				0	0	1	1	0	0	1	2	0	0	1	2
	70	N/A				0	0	1	2	0	1	1	3	0	1	2	3
6	30	0	0	0	1	0	0	1	2	0	0	1	2	0	0	1	2

Preferred Project	Displacement rate (%)	Mortality rate (%)															
		Breeding				Post-breeding				Non-breeding				Pre-breeding			
		1	2	5	10	1	2	5	10	1	2	5	10	1	2	5	10
	40	0	0	1	1	0	0	1	2	0	1	1	3	0	1	2	3
	70	0	0	1	2	0	1	2	4	1	1	3	5	1	1	3	6

6.1.105 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.48.

Table 6.48: Breeding season apportioning for razorbill at Bray Head SAC for the impact from all Preferred Projects with connectivity in the breeding season

Preferred Project	Displacement / mortality rate (%)	Apportioning value (%)									
		10	20	30	40	50	60	70	80	90	100
4	30 / 1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	40 / 5	0.1	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8	0.9
	70 / 10	0.3	0.6	1.0	1.3	1.6	1.9	2.2	2.6	2.9	3.2
6	30 / 1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
	40 / 5	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.6
	70 / 10	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0

6.1.106 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.48. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All of the Preferred Projects are beyond the mean-maximum foraging range of razorbill from the Bray Head SAC and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. Preferred Projects 4 and 6 are however, within the foraging range of razorbill when using the mean-maximum foraging range plus one standard deviation (164.6 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual razorbills from Bray Head SAC could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of displacement mortality.

6.1.107 There is no site-specific foraging range data available for razorbill from the Bray Head SAC. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Bray Head SAC then this should only be a limited amount (e.g. 10%).

6.1.108 In the post-, non- and pre-breeding seasons, the apportioning values presented in Annex H.3 have been applied. In the Irish Sea the apportioning values used in the post-, non- and pre-breeding seasons 0.04%, 0.03% and 0.04%, respectively and for the Preferred Projects in the North Sea the values are less than 0.01% in the post- and pre-breeding season and 0.01% in the non-breeding season. The apportioned values from each of the Preferred Projects combined to the Bray Head SAC are presented in Table 6.49. In all cases the impact is less than 0.1 birds.

Table 6.49: Apportioned displacement mortality for razorbill at the Bray Head SAC in non-breeding seasons

Preferred Project	Displacement rate (%)	Mortality rate (%)	Apportioned values		
			Post-breeding	Non-breeding	Pre-breeding
1	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0

Preferred Project	Displacement rate (%)	Mortality rate (%)	Apportioned values		
			Post-breeding	Non-breeding	Pre-breeding
2	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0
3	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0
4	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0
5	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0
6	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0
Total	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0

6.1.109 The annual apportioned impact for razorbill at the Bray Head SAC is provided in Table 6.50.

Table 6.50: Calculation of the annual impact attributable to razorbill at the Bray Head SAC from the Round 4 Plan alone

Displacement / mortality assumptions	Breeding season		Non-breeding seasons (post-, non- and pre-seasons combined)						Total	Increase in baseline mortality (%)
	PP4	PP6	PP1	PP2	PP3	PP4	PP5	PP6		
30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
40 / 5	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.6
70 / 10	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.5	2.0

6.1.110 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.50 is considered to be less than one bird. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that razorbill densities from the MERP dataset potentially underestimate razorbill abundance.
- The apportioning value applied in the breeding season, it is unlikely that a significant proportion of razorbill from the Bray Head SAC will utilize the Preferred Project areas and the assumption of 10% is likely an over-estimate but is applied on a precautionary basis.

6.1.111 A wider range of displacement rates are defined in JNCC *et al.* (2017) and these have been considered in the displacement analyses conducted. A precautionary approach has also been applied when considering the apportioning value to apply for all Preferred Projects with all three of the Preferred Projects beyond the mean-maximum foraging range of razorbill from Bray Head SAC.

6.1.112 An impact of less than one bird represents 0.6% of the baseline mortality of the Bray Head SAC razorbill population (256 breeding adults). When considering the highest impact in Table 6.50, which is considered unrealistic due to an over-application of precaution, an annual displacement mortality of one bird is estimated. This represents an increase in baseline mortality of 2.0%. Under any of the scenarios presented, the actual displacement mortality is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.113 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Bray Head SAC.

Coquet Island SPA

Lesser black-backed gull

Alone

6.1.114 Collision risk modelling has been undertaken for lesser black-backed gull using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.51. In the breeding season, there is only connectivity between the Coquet Island SPA and Preferred Projects 1 and 2 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.51: Collision risk estimates for lesser black-backed gull (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																						
				Breeding season		Post-breeding							Non-breeding							Pre-breeding						
				PP1	PP2	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	99.5	7	10	1	1	0	1	1	0	5	2	2	1	1	1	1	7	1	1	0	0	0	0	3
		9.8	99.5	6	8	1	1	0	0	1	0	4	1	2	0	1	1	0	6	1	1	0	0	0	0	3
	3	13.1	99.5	8	11	1	2	0	1	1	1	6	2	3	1	1	1	1	9	1	1	0	0	1	0	4
		9.8	99.5	7	9	1	1	0	1	1	0	5	2	3	1	1	1	1	7	1	1	0	0	0	0	3
Option 3	2	13.1	98.9	7	9	1	1	0	0	0	0	4	1	2	0	0	1	0	5	1	1	0	0	0	0	3
			99.3	4	6	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
		9.8	98.9	6	8	1	1	0	0	0	0	3	1	2	0	0	1	0	5	1	1	0	0	0	0	2
			99.3	4	5	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
	3	13.1	98.9	7	10	1	1	0	0	1	0	4	2	3	0	1	1	0	7	1	1	0	0	0	0	3
			99.3	5	6	1	1	0	0	0	0	3	1	2	0	0	0	0	4	1	1	0	0	0	0	2
		9.8	98.9	7	9	1	1	0	0	1	0	4	2	2	0	0	1	0	6	1	1	0	0	0	0	3
			99.3	4	6	1	1	0	0	0	0	2	1	2	0	0	0	0	4	1	1	0	0	0	0	2

6.1.115 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.52 and Table 6.53.

Table 6.52: Breeding season apportioning for lesser black-backed gull at the Coquet Island SPA for the impact from Preferred Project 1

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.7	1.5	2.2	3.0	3.7	4.4	5.2	5.9	6.7	7.4
		9.8	99.5	0.6	1.3	1.9	2.5	3.1	3.8	4.4	5.0	5.7	6.3
	3	13.1	99.5	0.8	1.7	2.5	3.3	4.1	5.0	5.8	6.6	7.4	8.3
		9.8	99.5	0.7	1.4	2.1	2.8	3.5	4.2	4.9	5.6	6.3	7.0
Option 3	2	13.1	98.9	0.7	1.3	2.0	2.6	3.3	3.9	4.6	5.2	5.9	6.5
			99.3	0.4	0.8	1.2	1.7	2.1	2.5	2.9	3.3	3.7	4.2
		9.8	98.9	0.6	1.2	1.8	2.4	3.0	3.6	4.2	4.8	5.4	5.9
			99.3	0.4	0.8	1.1	1.5	1.9	2.3	2.6	3.0	3.4	3.8
	3	13.1	98.9	0.7	1.5	2.2	2.9	3.6	4.4	5.1	5.8	6.6	7.3
			99.3	0.5	0.9	1.4	1.9	2.3	2.8	3.2	3.7	4.2	4.6
		9.8	98.9	0.7	1.3	2.0	2.7	3.3	4.0	4.6	5.3	6.0	6.6
			99.3	0.4	0.8	1.3	1.7	2.1	2.5	3.0	3.4	3.8	4.2

Table 6.53: Breeding season apportioning for lesser black-backed gull at the Coquet Island SPA for the impact from Preferred Project 2

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	1.0	2.0	3.0	4.0	4.9	5.9	6.9	7.9	8.9	9.9
		9.8	99.5	0.8	1.7	2.5	3.4	4.2	5.0	5.9	6.7	7.5	8.4
	3	13.1	99.5	1.1	2.2	3.3	4.4	5.5	6.6	7.7	8.8	9.9	11.0
		9.8	99.5	0.9	1.9	2.8	3.7	4.7	5.6	6.5	7.5	8.4	9.3
Option 3	2	13.1	98.9	0.9	1.7	2.6	3.5	4.4	5.2	6.1	7.0	7.9	8.7
			99.3	0.6	1.1	1.7	2.2	2.8	3.3	3.9	4.4	5.0	5.6
		9.8	98.9	0.8	1.6	2.4	3.2	4.0	4.8	5.6	6.3	7.1	7.9
			99.3	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
	3	13.1	98.9	1.0	1.9	2.9	3.9	4.9	5.8	6.8	7.8	8.8	9.7
			99.3	0.6	1.2	1.9	2.5	3.1	3.7	4.3	5.0	5.6	6.2
		9.8	98.9	0.9	1.8	2.7	3.5	4.4	5.3	6.2	7.1	8.0	8.8
			99.3	0.6	1.1	1.7	2.3	2.8	3.4	3.9	4.5	5.1	5.6

6.1.116 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.52 and Table 6.53. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). Preferred Projects 1 and 2 are beyond the mean-maximum foraging range of lesser black-backed gull from the Coquet Island SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%.

6.1.117 Both projects are however, within the foraging range of lesser black-backed gull when using the mean-maximum foraging range plus one standard deviation (236 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual lesser black-backed gulls from Coquet Island SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.118 There is no site-specific foraging range data available for lesser black-backed gull from Coquet Island SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to Coquet Island SPA then this should only be a limited amount (e.g. 10%).

6.1.119 In the post-, non- and pre-breeding seasons, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, non- and pre-breeding seasons for the Preferred Projects in the North Sea are 0.05%, 0.05% and 0.13%, respectively. For the Preferred Projects in the Irish Sea, 0% has been applied to all seasons. The apportioned values from each of the Preferred Projects combined to the Coquet Island SPA are presented in Table 6.54.

Table 6.54: Apportioned collision risk estimates for lesser black-backed gull at the Coquet Island SPA in non-breeding seasons

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values		
				Post-breeding	Non-breeding	Pre-breeding
Option 2	2	13.1	99.5	0.0	0.0	0.0
		9.8	99.5	0.0	0.0	0.0
	3	13.1	99.5	0.0	0.0	0.0

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values		
				Post-breeding	Non-breeding	Pre-breeding
		9.8	99.5	0.0	0.0	0.0
Option 3	2	13.1	98.9	0.0	0.0	0.0
			99.3	0.0	0.0	0.0
		9.8	98.9	0.0	0.0	0.0
			99.3	0.0	0.0	0.0
	3	13.1	98.9	0.0	0.0	0.0
			99.3	0.0	0.0	0.0
		9.8	98.9	0.0	0.0	0.0
			99.3	0.0	0.0	0.0

6.1.120 The annual apportioned impact for lesser black-backed gull at Coquet Island SPA is provided in Table 6.55.

Table 6.55: Calculation of the annual impact attributable to lesser black-backed gull at Coquet Island SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding		Post-breeding	Non-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP1	PP2	All projects	All projects	All projects		
Option 2	2	13.1	99.5	0.7	1.0	0.0	0.0	0.0	1.7	29.1
		9.8	99.5	0.6	0.8	0.0	0.0	0.0	1.5	24.6
	3	13.1	99.5	0.8	1.1	0.0	0.0	0.0	1.9	32.4
		9.8	99.5	0.7	0.9	0.0	0.0	0.0	1.6	27.4
Option 3	2	13.1	98.9	0.7	0.9	0.0	0.0	0.0	1.5	25.6
			99.3	0.4	0.6	0.0	0.0	0.0	1.0	16.3
		9.8	98.9	0.6	0.8	0.0	0.0	0.0	1.4	23.3
			99.3	0.4	0.5	0.0	0.0	0.0	0.9	14.8
	3	13.1	98.9	0.7	1.0	0.0	0.0	0.0	1.7	28.6
			99.3	0.5	0.6	0.0	0.0	0.0	1.1	18.2
		9.8	98.9	0.7	0.9	0.0	0.0	0.0	1.6	26.0
			99.3	0.4	0.6	0.0	0.0	0.0	1.0	16.5

6.1.121 The most likely impact (and most realistic worst case) for the Round 4 Plan alone from Table 6.55 is considered to be 0.9-1.0 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the densities for lesser black-backed gull from the MERP dataset potentially overestimate lesser black-backed gull abundance.
- The appropriate apportioning value to apply. It is considered highly unlikely that a significant proportion of lesser black-backed gulls from Coquet Island SPA will forage in the sea areas in which the Preferred Projects will be located. A value of 10% has been applied however, this is considered to be highly precautionary with large gulls unlikely to be found foraging at distances offshore commensurate with the distance between Coquet Island SPA and the Preferred Projects.

6.1.122 Despite the predicted collision risk exceeding the 1% baseline mortality threshold of the Coquet Island SPA population (14.8-16.5%), the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.123 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Coquet Island SPA.

Kittiwake

Alone

6.1.124 Collision risk modelling has been undertaken for kittiwake using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.56. In the breeding season, there is only connectivity between the designated site and Preferred Projects 1, 2 and 3 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.56: Collision risk estimates for kittiwake (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)															
				Breeding season				Post-breeding							Pre-breeding						
				PP1	PP2	PP3	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	98.9	73	52	11	136	29	21	5	2	1	2	59	21	15	3	1	0	1	41
			99.0	66	47	10	123	26	19	4	2	1	2	54	19	14	3	1	0	0	37
		8.71	98.9	56	40	8	104	22	16	3	1	1	1	45	16	12	2	0	0	0	31
			99.0	51	36	8	94	20	14	3	1	1	1	41	15	11	2	0	0	0	29
	3	13.1	98.9	82	59	13	154	37	26	6	2	1	2	75	28	20	4	1	0	1	53
			99.0	75	54	12	140	34	24	5	2	1	2	68	25	18	4	1	0	1	49
		8.71	98.9	63	45	9	118	28	20	4	2	1	2	58	21	15	3	1	0	1	41
			99.0	57	41	9	107	26	18	4	2	1	1	52	19	14	3	1	0	0	37
Option 3	2	13.1	98	34	25	4	63	14	10	1	1	0	1	27	10	7	1	0	0	0	19
		8.71	98	30	22	3	55	12	9	1	1	0	0	23	9	6	1	0	0	0	16
	3	13.1	98	39	28	4	71	18	13	2	1	1	1	34	13	9	1	0	0	0	24
		8.71	98	34	24	3	62	15	11	2	1	1	1	30	12	8	1	0	0	0	21

6.1.125 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.57 to Table 6.59.

Table 6.57: Breeding season apportioning for kittiwake at the Coquet Island SPA for the impact from Preferred Project 1

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	7.3	14.5	21.8	29.0	36.3	43.5	50.8	58.0	65.3	72.6
			99.0	6.6	13.2	19.8	26.4	33.0	39.6	46.2	52.8	59.4	66.0
		8.71	98.9	5.6	11.1	16.7	22.3	27.8	33.4	39.0	44.5	50.1	55.7
			99.0	5.1	10.1	15.2	20.2	25.3	30.4	35.4	40.5	45.6	50.6
	3	13.1	98.9	8.2	16.5	24.7	32.9	41.2	49.4	57.6	65.9	74.1	82.3
			99.0	7.5	15.0	22.5	29.9	37.4	44.9	52.4	59.9	67.4	74.9
		8.71	98.9	6.3	12.6	19.0	25.3	31.6	37.9	44.2	50.6	56.9	63.2
			99.0	5.7	11.5	17.2	23.0	28.7	34.5	40.2	46.0	51.7	57.4
Option 3	2	13.1	98	3.4	6.9	10.3	13.8	17.2	20.7	24.1	27.6	31.0	34.5
		8.71	98	3.0	6.0	9.0	12.1	15.1	18.1	21.1	24.1	27.1	30.1
	3	13.1	98	3.9	7.8	11.7	15.6	19.6	23.5	27.4	31.3	35.2	39.1
		8.71	98	3.4	6.8	10.3	13.7	17.1	20.5	23.9	27.4	30.8	34.2

Table 6.58: Breeding season apportioning for kittiwake at the Coquet Island SPA for the impact from Preferred Project 2

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	5.2	10.4	15.6	20.8	25.9	31.1	36.3	41.5	46.7	51.9
			99.0	4.7	9.4	14.2	18.9	23.6	28.3	33.0	37.7	42.5	47.2
		8.71	98.9	4.0	8.0	11.9	15.9	19.9	23.9	27.9	31.9	35.8	39.8
			99.0	3.6	7.2	10.9	14.5	18.1	21.7	25.3	29.0	32.6	36.2
	3	13.1	98.9	5.9	11.8	17.7	23.6	29.5	35.3	41.2	47.1	53.0	58.9
			99.0	5.4	10.7	16.1	21.4	26.8	32.1	37.5	42.8	48.2	53.6
		8.71	98.9	4.5	9.0	13.6	18.1	22.6	27.1	31.6	36.2	40.7	45.2
			99.0	4.1	8.2	12.3	16.4	20.5	24.7	28.8	32.9	37.0	41.1
Option 3	2	13.1	98	2.5	4.9	7.4	9.9	12.3	14.8	17.2	19.7	22.2	24.6
		8.71	98	2.2	4.3	6.5	8.6	10.8	12.9	15.1	17.2	19.4	21.6
	3	13.1	98	2.8	5.6	8.4	11.2	14.0	16.8	19.6	22.4	25.2	28.0
		8.71	98	2.4	4.9	7.3	9.8	12.2	14.7	17.1	19.6	22.0	24.5

Table 6.59: Breeding season apportioning for kittiwake at the Coquet Island SPA for the impact from Preferred Project 3

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	1.1	2.2	3.4	4.5	5.6	6.7	7.9	9.0	10.1	11.2
			99.0	1.0	2.0	3.1	4.1	5.1	6.1	7.2	8.2	9.2	10.2
		8.71	98.9	0.8	1.7	2.5	3.3	4.2	5.0	5.8	6.7	7.5	8.3
			99.0	0.8	1.5	2.3	3.0	3.8	4.5	5.3	6.0	6.8	7.6
	3	13.1	98.9	1.3	2.6	3.8	5.1	6.4	7.7	8.9	10.2	11.5	12.8
			99.0	1.2	2.3	3.5	4.6	5.8	7.0	8.1	9.3	10.5	11.6
		8.71	98.9	0.9	1.9	2.8	3.8	4.7	5.7	6.6	7.6	8.5	9.5
			99.0	0.9	1.7	2.6	3.4	4.3	5.2	6.0	6.9	7.7	8.6
Option 3	2	13.1	98	0.4	0.7	1.1	1.4	1.8	2.1	2.5	2.9	3.2	3.6
		8.71	98	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.8	3.1
	3	13.1	98	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.1
		8.71	98	0.3	0.7	1.0	1.4	1.7	2.1	2.4	2.8	3.1	3.5

6.1.126 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.57, Table 6.58 and Table 6.59. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All three of the Preferred Projects are beyond the mean-maximum foraging range of kittiwake from the Coquet Island SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. Each of the three Preferred Projects is however, within the foraging range of kittiwake when using the mean-maximum foraging range plus one standard deviation from Woodward *et al.* (2019) (300.6 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual kittiwakes from Coquet Island SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.127 The apportioning results in Annex H.3 have been reviewed against relevant site specific data. Tracking data for kittiwake is available for the breeding colony at Coquet Island (Robertson *et al*., 2014). Across two years (2011 and 2012) a total of 36 birds were tagged with data retrieved from 21 birds. This included 26 birds in the chick-rearing period and 10 nests during incubation. These birds provided data from a total of 106 foraging trips. Foraging ranges during both periods were calculated based on 95% volume contours and 25% volume contours (core foraging range) using fixed kernel density estimation. During the chick-rearing periods in 2011 and 2012 maximum foraging ranges of 28.02 ± 3.88 km and 9.03 ± 1.17 km were recorded respectively. During the incubation period in 2012, a maximum foraging range of 50.95 ± 12.99 km was recorded. These ranges are far short of the Preferred Projects and therefore suggest no connectivity between kittiwakes from Coquet Island SPA and the Round 4 Plan in the breeding season. The apportioning value for all of the Preferred Projects in the breeding season is therefore set to 0%.

6.1.128 In the post-breeding and pre-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post- and pre-breeding seasons for the Preferred Projects in the North Sea are, 0.03% and 0.04% respectively. For the Preferred Projects in the Irish Sea the apportioning values are 0.01% and 0.02%, respectively. The apportioned values from each of the Preferred Projects combined to the Coquet Island SPA are presented in Table 6.60.

Table 6.60: Apportioned collision risk estimates for kittiwake at the Coquet Island SPA in non-breeding seasons

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
Option 2	2	13.1	98.9	0.0	0.0
			99.0	0.0	0.0
		8.71	98.9	0.0	0.0
			99.0	0.0	0.0
	3	13.1	98.9	0.0	0.0
			99.0	0.0	0.0
		8.71	98.9	0.0	0.0
			99.0	0.0	0.0
Option 3	2	13.1	98	0.0	0.0
		8.71	98	0.0	0.0
	3	13.1	98	0.0	0.0
		8.71	98	0.0	0.0

6.1.129 The annual apportioned impact for kittiwake at the Coquet Island SPA is provided in Table 6.61.

Table 6.61: Calculation of the annual impact attributable to kittiwake at the Coquet Island SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Post-breeding	Pre-breeding	Total	Baseline mortality (%)
				All projects	All projects		
Option 2	2	13.1	98.9	0.0	0.0	0.0	0.05
			99.0	0.0	0.0	0.0	0.05
		8.71	98.9	0.0	0.0	0.0	0.04
			99.0	0.0	0.0	0.0	0.04
	3	13.1	98.9	0.0	0.0	0.0	0.07
			99.0	0.0	0.0	0.0	0.06
		8.71	98.9	0.0	0.0	0.0	0.05
			99.0	0.0	0.0	0.0	0.05
Option 3	2	13.1	98	0.0	0.0	0.0	0.02
		8.71	98	0.0	0.0	0.0	0.02
	3	13.1	98	0.0	0.0	0.0	0.03
		8.71	98	0.0	0.0	0.0	0.03

6.1.130 The most likely impact (and most realistic worst case) for the Round 4 Plan alone from Table 6.61 is considered to be less than 0.1 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that kittiwake densities from the MERP dataset potentially underestimate kittiwake abundance.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.
- The apportioning value applied in the breeding season, it is unlikely that a significant proportion of kittiwake from Coquet Island SPA will utilize the Preferred Project areas and the assumption of 10% is likely an over-estimate but is applied on a precautionary basis.

6.1.131 An impact of less than one collisions/annum represents 0.02-0.03% of the baseline mortality of the Coquet Island SPA kittiwake population (426 breeding adults). When considering the highest impact estimated in Table 6.61, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of less than one collision/annum represents an increase in baseline mortality of 0.05-0.07%. Under any of the scenarios presented, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.132 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Coquet Island SPA.

Puffin

Alone

6.1.133 Displacement analysis has been undertaken for puffin using the approach advised in JNCC *et al.* (2017) (Annex H.1). To account for uncertainty in the analysis approach a range of displacement and mortality rates have been applied following the recommended approach to defining these in JNCC *et al.* (2017). Table 6.62 presents the unapportioned seasonal displacement mortality for puffin at each of the Preferred Projects using the appropriate range of displacement and mortality rates. In the breeding season, there is only connectivity between the designated site and Preferred Projects 1, 2 and 3 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.62: Displacement mortality for puffin at each of the Preferred Projects (unapportioned values) (no. of birds)

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
1	30	0	1	2	5	1	2	4	8
	50	1	2	4	8	1	3	6	13
	70	1	2	5	11	2	4	9	18
2	30	0	1	2	3	1	1	3	5
	50	1	1	3	5	1	2	5	9
	70	1	1	4	7	1	3	6	13
3	30	0	1	2	3	1	1	3	6
	50	1	1	3	5	1	2	5	9
	70	1	1	4	7	1	3	6	13
4	30	N/A				0	0	0	0
	50	N/A				0	0	0	0
	70	N/A				0	0	0	0
5	30	N/A				0	0	0	0
	50	N/A				0	0	0	0
	70	N/A				0	0	0	0
6	30	N/A				0	0	0	0

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
	50	N/A				0	0	0	0
	70	N/A				0	0	0	0

6.1.134 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.63.

Table 6.63: Breeding season apportioning for puffin at Coquet Island SPA for the impact from all Preferred Projects with connectivity in the breeding season

Preferred Project	Displacement rate (%)	Apportioning value (%)									
		10	20	30	40	50	60	70	80	90	100
1	30	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5
	50	0.4	0.8	1.2	1.5	1.9	2.3	2.7	3.1	3.5	3.8
	70	1.1	2.1	3.2	4.3	5.4	6.4	7.5	8.6	9.7	10.7
2	30	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3
	50	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.0	2.3	2.6
	70	0.7	1.4	2.1	2.9	3.6	4.3	5.0	5.7	6.4	7.2
3	30	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3
	50	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.4	2.6
	70	0.7	1.5	2.2	2.9	3.7	4.4	5.1	5.9	6.6	7.3

6.1.135 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.63. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All three of the Preferred Projects are beyond the mean-maximum foraging range of puffin from the Coquet Island SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. Each of the three projects is however, within the foraging range of puffin when using the mean-maximum foraging range plus one standard deviation (265.4 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual puffins from Coquet Island SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of displacement mortality.

6.1.136 There is no site-specific foraging range data available for puffin from Coquet Island SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to Coquet Island SPA then this should only be a limited amount (e.g. 10%).

6.1.137 In the non-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning value used for the Preferred Projects in the North Sea is 10.6% and for the Preferred Projects in the Irish Sea is 0.6%. The apportioned values from each of the Preferred Projects combined to the Coquet Island SPA are presented in Table 6.64.

Table 6.64: Apportioned displacement mortality for puffin at Coquet Island SPA in the non-breeding season

Displacement / mortality rate (%)	Preferred Project						Total
	1	2	3	4	5	6	
30 / 1	0.1	0.1	0.1	0.0	0.0	0.0	0.2
50 / 5	0.7	0.5	0.5	0.0	0.0	0.0	1.6
70 / 10	1.9	1.3	1.4	0.0	0.0	0.0	4.6

6.1.138 The annual apportioned impact for puffin at the Coquet Island SPA is provided in Table 6.65.

Table 6.65: Calculation of the annual impact attributable puffin at the Coquet Island SPA from the Round 4 Plan alone

Displacement / mortality assumptions	Breeding season			Non-breeding season						Total	Increase in baseline mortality (%)
	PP1	PP2	PP3	PP1	PP2	PP3	PP4	PP5	PP6		
30 / 1	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.3	0.01
50 / 5	0.4	0.3	0.3	0.7	0.5	0.5	0.0	0.0	0.0	2.5	0.09
70 / 10	1.1	0.7	0.7	1.9	1.3	1.4	0.0	0.0	0.0	7.1	0.24

6.1.139 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.65 is considered to be 2.5 birds. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that puffin densities from the MERP dataset potentially over-estimate puffin abundance.
- The apportioning value applied in the breeding season, it is unlikely that a significant proportion of puffin from Coquet Island SPA will utilize the Preferred Project areas and the assumption of 10% is likely an over-estimate but is applied on a precautionary basis.

6.1.140 A wider range of displacement rates are defined in JNCC *et al.* (2017) and these have been considered in the displacement analyses conducted. A precautionary approach has also been applied when considering the apportioning value to apply for all Preferred Projects with all three of the Preferred Projects beyond the mean-maximum foraging range of puffin from Coquet Island SPA.

6.1.141 An impact of 2.5 birds represents 0.09% of the baseline mortality of the Coquet Island SPA puffin population (31,686 breeding adults). When considering the highest impact in Table 6.65, which is considered unrealistic due to an over-application of precaution, an annual displacement mortality of seven birds is estimated. This represents an increase in baseline mortality of 0.24%. However, the actual displacement mortality predicted is low and there are considered to be significant assumptions which lead to over-estimation associated with the predicted displacement mortality.

In-combination

6.1.142 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on Coquet Island SPA.

Duddon Estuary Ramsar

Sandwich tern

6.1.143 Please see the conclusions reached for this feature at the Morecambe Bay and Duddon Estuary SPA.

Duinen en Lage Land Texel SPA

Lesser black-backed gull

Alone

6.1.144 Collision risk modelling has been undertaken for lesser black-backed gull using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.66. In the breeding season, there is only connectivity between the Duinen en Lage Land Texel SPA and Preferred Projects 2 and 3 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.66: Collision risk estimates for lesser black-backed gull (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																					
				Breeding season		Post-breeding							Non-breeding							Pre-breeding						
				PP2	PP3	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	99.5	10	3	1	1	0	1	1	0	5	2	2	1	1	1	1	7	1	1	0	0	0	0	3
		9.8	99.5	8	2	1	1	0	0	1	0	4	1	2	0	1	1	0	6	1	1	0	0	0	0	3
	3	13.1	99.5	11	3	1	2	0	1	1	1	6	2	3	1	1	1	1	9	1	1	0	0	1	0	4
		9.8	99.5	9	2	1	1	0	1	1	0	5	2	3	1	1	1	1	7	1	1	0	0	0	0	3
Option 3	2	13.1	98.9	9	2	1	1	0	0	0	0	4	1	2	0	0	1	0	5	1	1	0	0	0	0	3
			99.3	6	1	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
		9.8	98.9	8	1	1	1	0	0	0	0	3	1	2	0	0	1	0	5	1	1	0	0	0	0	2
			99.3	5	1	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
	3	13.1	98.9	10	2	1	1	0	0	1	0	4	2	3	0	1	1	0	7	1	1	0	0	0	0	3
			99.3	6	1	1	1	0	0	0	0	3	1	2	0	0	0	0	4	1	1	0	0	0	0	2
		9.8	98.9	9	2	1	1	0	0	1	0	4	2	2	0	0	1	0	6	1	1	0	0	0	0	3
			99.3	6	1	1	1	0	0	0	0	2	1	2	0	0	0	0	4	1	1	0	0	0	0	2

6.1.145 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.67 and Table 6.68.

Table 6.67: Breeding season apportioning for lesser black-backed gull at the Duinen en Lage Land Texel SPA for the impact from Preferred Project 2

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	1.0	2.0	3.0	4.0	4.9	5.9	6.9	7.9	8.9	9.9
		9.8	99.5	0.8	1.7	2.5	3.4	4.2	5.0	5.9	6.7	7.5	8.4
	3	13.1	99.5	1.1	2.2	3.3	4.4	5.5	6.6	7.7	8.8	9.9	11.0
		9.8	99.5	0.9	1.9	2.8	3.7	4.7	5.6	6.5	7.5	8.4	9.3
Option 3	2	13.1	98.9	0.9	1.7	2.6	3.5	4.4	5.2	6.1	7.0	7.9	8.7
			99.3	0.6	1.1	1.7	2.2	2.8	3.3	3.9	4.4	5.0	5.6
		9.8	98.9	0.8	1.6	2.4	3.2	4.0	4.8	5.6	6.3	7.1	7.9
			99.3	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
	3	13.1	98.9	1.0	1.9	2.9	3.9	4.9	5.8	6.8	7.8	8.8	9.7
			99.3	0.6	1.2	1.9	2.5	3.1	3.7	4.3	5.0	5.6	6.2
		9.8	98.9	0.9	1.8	2.7	3.5	4.4	5.3	6.2	7.1	8.0	8.8
			99.3	0.6	1.1	1.7	2.3	2.8	3.4	3.9	4.5	5.1	5.6

Table 6.68: Breeding season apportioning for lesser black-backed gull at the Duinen en Lage Land Texel SPA for the impact from Preferred Project 3

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.3	0.5	0.8	1.1	1.3	1.6	1.9	2.1	2.4	2.7
		9.8	99.5	0.2	0.4	0.7	0.9	1.1	1.3	1.5	1.8	2.0	2.2
	3	13.1	99.5	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0
		9.8	99.5	0.2	0.5	0.7	1.0	1.2	1.5	1.7	2.0	2.2	2.5
Option 3	2	13.1	98.9	0.2	0.3	0.5	0.7	0.8	1.0	1.1	1.3	1.5	1.6
			99.3	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		9.8	98.9	0.1	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.3	1.5
			99.3	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.8	0.9
	3	13.1	98.9	0.2	0.4	0.5	0.7	0.9	1.1	1.3	1.5	1.6	1.8
			99.3	0.1	0.2	0.3	0.5	0.6	0.7	0.8	0.9	1.0	1.2
		9.8	98.9	0.2	0.3	0.5	0.7	0.8	1.0	1.1	1.3	1.5	1.6
			99.3	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

6.1.146 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.67 and Table 6.68. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). Preferred Projects 2 and 3 are beyond the mean-maximum foraging range of lesser black-backed gull from the Duinen en Lage Land Texel SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. Both projects are however, within the foraging range of lesser black-backed gull when using the mean-maximum foraging range plus one standard deviation for lesser black-backed gull (236 km) presented in Woodward *et al.* (2019). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual lesser black-backed gulls from Duinen en Lage Land Texel SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.147 There is no site-specific foraging range data available for lesser black-backed gull from the Duinen en Lage Land Texel SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Duinen en Lage Land Texel SPA then this should only be a limited amount (e.g. 10%).

6.1.148 In the post-, non- and pre-breeding seasons, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, non- and pre-breeding seasons for the Preferred Projects in the North Sea are 13.4%, 35.6% and 14.2%, respectively. For the Preferred Projects in the Irish Sea, 0% has been applied to all seasons. The apportioned values from each of the Preferred Projects combined to the Duinen en Lage Land Texel SPA are presented in Table 6.69.

Table 6.69: Apportioned collision risk estimates for lesser black-backed gull at the Duinen en Lage Land Texel SPA in non-breeding seasons

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values		
				Post-breeding	Non-breeding	Pre-breeding
Option 2	2	13.1	99.5	0.4	1.6	0.3

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values		
				Post-breeding	Non-breeding	Pre-breeding
		9.8	99.5	0.3	1.4	0.3
	3	13.1	99.5	0.5	2.1	0.4
		9.8	99.5	0.4	1.8	0.3
Option 3	2	13.1	98.9	0.3	1.4	0.3
			99.3	0.2	0.9	0.2
		9.8	98.9	0.3	1.2	0.3
			99.3	0.2	0.8	0.2
	3	13.1	98.9	0.4	1.8	0.3
			99.3	0.2	1.1	0.2
		9.8	98.9	0.3	1.6	0.3
			99.3	0.2	1.0	0.2

6.1.149 The annual apportioned impact for lesser black-backed gull at Duinen en Lage Land Texel SPA is provided in Table 6.70.

Table 6.70: Calculation of total impact attributable to lesser black-backed gull at Duinen en Lage Land Texel from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding		Post-breeding	Non-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP2	PP3	All projects	All projects	All projects		
Option 2	2	13.1	99.5	1.0	0.3	0.4	1.6	0.3	3.6	0.11
		9.8	99.5	0.8	0.2	0.3	1.4	0.3	3.0	0.09
	3	13.1	99.5	1.1	0.3	0.5	2.1	0.4	4.4	0.14
		9.8	99.5	0.9	0.2	0.4	1.8	0.3	3.7	0.11
Option 3	2	13.1	98.9	0.9	0.2	0.3	1.4	0.3	3.0	0.09
			99.3	0.6	0.1	0.2	0.9	0.2	1.9	0.06
		9.8	98.9	0.8	0.1	0.3	1.2	0.3	2.7	0.08
			99.3	0.5	0.1	0.2	0.8	0.2	1.7	0.05
	3	13.1	98.9	1.0	0.2	0.4	1.8	0.3	3.7	0.11
			99.3	0.6	0.1	0.2	1.1	0.2	2.3	0.07
		9.8	98.9	0.9	0.2	0.3	1.6	0.3	3.3	0.10
			99.3	0.6	0.1	0.2	1.0	0.2	2.1	0.07

6.1.150 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.70 is considered to be 1.7-2.1 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the densities for lesser black-backed gull from the MERP dataset potentially overestimate lesser black-backed gull abundance.
- The appropriate apportioning value to apply. It is considered highly unlikely that a significant proportion of lesser black-backed gulls from Duinen en Lage Land Texel SPA will forage in the sea areas in which the Preferred Projects will be located. A value of 10% has been applied however, this is considered to be highly precautionary with large gulls unlikely to be found foraging at distances offshore commensurate with the distance between Duinen en Lage Land Texel SPA and the Preferred Projects.

6.1.151 An impact of 1.7-2.1 collisions/annum represents 0.05-0.07% of the baseline mortality of the Duinen en Lage Land Texel SPA lesser black-backed gull population (14,000 pairs). When considering the highest impact estimated in Table 6.70, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 3.6-4.4 collisions/annum represents an increase in baseline mortality of less than 0.11-0.14%. Under any of the scenarios presented, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.152 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Duinen en Lage Land Texel SPA.

Duinen Vlieland SPA

Lesser black-backed gull

Alone

6.1.153 Collision risk modelling has been undertaken for lesser black-backed gull using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.71. In the breeding season, there is only connectivity between the Duinen Vlieland SPA and Preferred Projects 2 and 3 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.71: Collision risk estimates for lesser black-backed gull (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																					
				Breeding season		Post-breeding							Non-breeding							Pre-breeding						
				PP2	PP3	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	99.5	10	3	1	1	0	1	1	0	5	2	2	1	1	1	1	7	1	1	0	0	0	0	3
		9.8	99.5	8	2	1	1	0	0	1	0	4	1	2	0	1	1	0	6	1	1	0	0	0	0	3
	3	13.1	99.5	11	3	1	2	0	1	1	1	6	2	3	1	1	1	1	9	1	1	0	0	1	0	4
		9.8	99.5	9	2	1	1	0	1	1	0	5	2	3	1	1	1	1	7	1	1	0	0	0	0	3
Option 3	2	13.1	98.9	9	2	1	1	0	0	0	0	4	1	2	0	0	1	0	5	1	1	0	0	0	0	3
			99.3	6	1	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
		9.8	98.9	8	1	1	1	0	0	0	0	3	1	2	0	0	1	0	5	1	1	0	0	0	0	2
			99.3	5	1	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
	3	13.1	98.9	10	2	1	1	0	0	1	0	4	2	3	0	1	1	0	7	1	1	0	0	0	0	3
			99.3	6	1	1	1	0	0	0	0	3	1	2	0	0	0	0	4	1	1	0	0	0	0	2
		9.8	98.9	9	2	1	1	0	0	1	0	4	2	2	0	0	1	0	6	1	1	0	0	0	0	3
			99.3	6	1	1	1	0	0	0	0	2	1	2	0	0	0	0	4	1	1	0	0	0	0	2

6.1.154 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.72 and Table 6.73.

Table 6.72: Breeding season apportioning for lesser black-backed gull at the Duinen Vlieland SPA for the impact from Preferred Project 2

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	1.0	2.0	3.0	4.0	4.9	5.9	6.9	7.9	8.9	9.9
		9.8	99.5	0.8	1.7	2.5	3.4	4.2	5.0	5.9	6.7	7.5	8.4
	3	13.1	99.5	1.1	2.2	3.3	4.4	5.5	6.6	7.7	8.8	9.9	11.0
		9.8	99.5	0.9	1.9	2.8	3.7	4.7	5.6	6.5	7.5	8.4	9.3
Option 3	2	13.1	98.9	0.9	1.7	2.6	3.5	4.4	5.2	6.1	7.0	7.9	8.7
			99.3	0.6	1.1	1.7	2.2	2.8	3.3	3.9	4.4	5.0	5.6
		9.8	98.9	0.8	1.6	2.4	3.2	4.0	4.8	5.6	6.3	7.1	7.9
			99.3	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
	3	13.1	98.9	1.0	1.9	2.9	3.9	4.9	5.8	6.8	7.8	8.8	9.7
			99.3	0.6	1.2	1.9	2.5	3.1	3.7	4.3	5.0	5.6	6.2
		9.8	98.9	0.9	1.8	2.7	3.5	4.4	5.3	6.2	7.1	8.0	8.8
			99.3	0.6	1.1	1.7	2.3	2.8	3.4	3.9	4.5	5.1	5.6

Table 6.73: Breeding season apportioning for lesser black-backed gull at the Duinen Vlieland SPA for the impact from Preferred Project 3

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.3	0.5	0.8	1.1	1.3	1.6	1.9	2.1	2.4	2.7
		9.8	99.5	0.2	0.4	0.7	0.9	1.1	1.3	1.5	1.8	2.0	2.2
	3	13.1	99.5	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0
		9.8	99.5	0.2	0.5	0.7	1.0	1.2	1.5	1.7	2.0	2.2	2.5
Option 3	2	13.1	98.9	0.2	0.3	0.5	0.7	0.8	1.0	1.1	1.3	1.5	1.6
			99.3	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		9.8	98.9	0.1	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.3	1.5
			99.3	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.8	0.9
	3	13.1	98.9	0.2	0.4	0.5	0.7	0.9	1.1	1.3	1.5	1.6	1.8
			99.3	0.1	0.2	0.3	0.5	0.6	0.7	0.8	0.9	1.0	1.2
		9.8	98.9	0.2	0.3	0.5	0.7	0.8	1.0	1.1	1.3	1.5	1.6
			99.3	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

6.1.155 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.72 and Table 6.73. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). Preferred Projects 2 and 3 are beyond the mean-maximum foraging range of lesser black-backed gull from the Duinen Vlieland SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. Both projects are however, within the foraging range of lesser black-backed gull when using the mean-maximum foraging range plus one standard deviation for lesser black-backed gull (236 km) presented in Woodward *et al.* (2019). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al.* (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual lesser black-backed gulls from Duinen Vlieland SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.156 There is no site-specific foraging range data available for lesser black-backed gull from the Duinen Vlieland SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Duinen Vlieland SPA then this should only be a limited amount (e.g. 10%).

6.1.157 In the post-, non- and pre-breeding seasons, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, non- and pre-breeding seasons for the Preferred Projects in the North Sea are 2.4%, 6.4% and 2.5%, respectively. For the Preferred Projects in the Irish Sea, 0% has been applied to all seasons. The apportioned values from each of the Preferred Projects combined to the Duinen Vlieland SPA are presented in Table 6.74.

Table 6.74: Apportioned collision risk estimates for lesser black-backed gull at the Duinen Vlieland SPA in non-breeding seasons

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values		
				Post-breeding	Non-breeding	Pre-breeding
Option 2	2	13.1	99.5	0.1	0.3	0.1
		9.8	99.5	0.1	0.2	0.0

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values		
				Post-breeding	Non-breeding	Pre-breeding
Option 3	3	13.1	99.5	0.1	0.4	0.1
		9.8	99.5	0.1	0.3	0.1
	2	13.1	98.9	0.1	0.2	0.0
			99.3	0.0	0.2	0.0
		9.8	98.9	0.1	0.2	0.0
			99.3	0.0	0.1	0.0
	3	13.1	98.9	0.1	0.3	0.1
			99.3	0.0	0.2	0.0
		9.8	98.9	0.1	0.3	0.1
			99.3	0.0	0.2	0.0

6.1.158 The annual apportioned impact for lesser black-backed gull at Duinen Vlieland SPA is provided in Table 6.75.

Table 6.75: Calculation of total impact attributable to lesser black-backed gull at Duinen Vlieland SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding		Post-breeding	Non-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP2	PP3	All projects	All projects	All projects		
Option 2	2	13.1	99.5	1.0	0.3	0.1	0.3	0.1	1.7	0.29
		9.8	99.5	0.8	0.2	0.1	0.2	0.0	1.4	0.24
	3	13.1	99.5	1.1	0.3	0.1	0.4	0.1	1.9	0.34
		9.8	99.5	0.9	0.2	0.1	0.3	0.1	1.6	0.28
Option 3	2	13.1	98.9	0.9	0.2	0.1	0.2	0.0	1.4	0.24
			99.3	0.6	0.1	0.0	0.2	0.0	0.9	0.15
		9.8	98.9	0.8	0.1	0.1	0.2	0.0	1.3	0.22
			99.3	0.5	0.1	0.0	0.1	0.0	0.8	0.14
	3	13.1	98.9	1.0	0.2	0.1	0.3	0.1	1.6	0.28
			99.3	0.6	0.1	0.0	0.2	0.0	1.0	0.18
		9.8	98.9	0.9	0.2	0.1	0.3	0.1	1.5	0.25
			99.3	0.6	0.1	0.0	0.2	0.0	0.9	0.16

6.1.159 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.75 is considered to be 0.8-0.9 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the densities for lesser black-backed gull from the MERP dataset potentially overestimate lesser black-backed gull abundance.
- The appropriate apportioning value to apply. It is considered highly unlikely that a significant proportion of lesser black-backed gulls from Duinen Vlieland SPA will forage in the sea areas in which the Preferred Projects will be located. A value of 10% has been applied however, this is considered to be highly precautionary with large gulls unlikely to be found foraging at distances offshore commensurate with the distance between Duinen Vlieland SPA and the Preferred Projects.

6.1.160 An impact of 0.8-0.9 collisions/annum represents 0.14-0.16% of the baseline mortality of the Duinen Vlieland SPA lesser black-backed gull population (2,500 pairs). When considering the highest impact estimated in Table 6.75, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 1.7-1.9 collisions/annum represents an increase in baseline mortality of less than 0.29-0.34%. Under any of the scenarios presented, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.161 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Duinen Vlieland SPA.

Farne Islands SPA

Kittiwake

Alone

6.1.162 Collision risk modelling has been undertaken for kittiwake using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.76. In the breeding season, there is only connectivity between the Farne Islands SPA and Preferred Projects 1, 2 and 3 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.76: Collision risk estimates for kittiwake (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)															
				Breeding season				Post-breeding							Pre-breeding						
				PP1	PP2	PP3	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	98.9	73	52	11	136	29	21	5	2	1	2	59	21	15	3	1	0	1	41
			99.0	66	47	10	123	26	19	4	2	1	2	54	19	14	3	1	0	0	37
		8.71	98.9	56	40	8	104	22	16	3	1	1	1	45	16	12	2	0	0	0	31
			99.0	51	36	8	94	20	14	3	1	1	1	41	15	11	2	0	0	0	29
	3	13.1	98.9	82	59	13	154	37	26	6	2	1	2	75	28	20	4	1	0	1	53
			99.0	75	54	12	140	34	24	5	2	1	2	68	25	18	4	1	0	1	49
		8.71	98.9	63	45	9	118	28	20	4	2	1	2	58	21	15	3	1	0	1	41
			99.0	57	41	9	107	26	18	4	2	1	1	52	19	14	3	1	0	0	37
Option 3	2	13.1	98	34	25	4	63	14	10	1	1	0	1	27	10	7	1	0	0	0	19
		8.71	98	30	22	3	55	12	9	1	1	0	0	23	9	6	1	0	0	0	16
	3	13.1	98	39	28	4	71	18	13	2	1	1	1	34	13	9	1	0	0	0	24
		8.71	98	34	24	3	62	15	11	2	1	1	1	30	12	8	1	0	0	0	21

6.1.163 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.77, Table 6.78 and Table 6.79.

Table 6.77: Breeding season apportioning for kittiwake at the Farne Islands SPA for the impact from Preferred Project 1

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	7.3	14.5	21.8	29.0	36.3	43.5	50.8	58.0	65.3	72.6
			99.0	6.6	13.2	19.8	26.4	33.0	39.6	46.2	52.8	59.4	66.0
		8.71	98.9	5.6	11.1	16.7	22.3	27.8	33.4	39.0	44.5	50.1	55.7
			99.0	5.1	10.1	15.2	20.2	25.3	30.4	35.4	40.5	45.6	50.6
	3	13.1	98.9	8.2	16.5	24.7	32.9	41.2	49.4	57.6	65.9	74.1	82.3
			99.0	7.5	15.0	22.5	29.9	37.4	44.9	52.4	59.9	67.4	74.9
		8.71	98.9	6.3	12.6	19.0	25.3	31.6	37.9	44.2	50.6	56.9	63.2
			99.0	5.7	11.5	17.2	23.0	28.7	34.5	40.2	46.0	51.7	57.4
Option 3	2	13.1	98	3.4	6.9	10.3	13.8	17.2	20.7	24.1	27.6	31.0	34.5
		8.71	98	3.0	6.0	9.0	12.1	15.1	18.1	21.1	24.1	27.1	30.1
	3	13.1	98	3.9	7.8	11.7	15.6	19.6	23.5	27.4	31.3	35.2	39.1
		8.71	98	3.4	6.8	10.3	13.7	17.1	20.5	23.9	27.4	30.8	34.2

Table 6.78: Breeding season apportioning for kittiwake at the Farne Islands SPA for the impact from Preferred Project 2

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	5.2	10.4	15.6	20.8	25.9	31.1	36.3	41.5	46.7	51.9
			99.0	4.7	9.4	14.2	18.9	23.6	28.3	33.0	37.7	42.5	47.2
		8.71	98.9	4.0	8.0	11.9	15.9	19.9	23.9	27.9	31.9	35.8	39.8
			99.0	3.6	7.2	10.9	14.5	18.1	21.7	25.3	29.0	32.6	36.2
	3	13.1	98.9	5.9	11.8	17.7	23.6	29.5	35.3	41.2	47.1	53.0	58.9
			99.0	5.4	10.7	16.1	21.4	26.8	32.1	37.5	42.8	48.2	53.6
		8.71	98.9	4.5	9.0	13.6	18.1	22.6	27.1	31.6	36.2	40.7	45.2
			99.0	4.1	8.2	12.3	16.4	20.5	24.7	28.8	32.9	37.0	41.1
Option 3	2	13.1	98	2.5	4.9	7.4	9.9	12.3	14.8	17.2	19.7	22.2	24.6
		8.71	98	2.2	4.3	6.5	8.6	10.8	12.9	15.1	17.2	19.4	21.6
	3	13.1	98	2.8	5.6	8.4	11.2	14.0	16.8	19.6	22.4	25.2	28.0
		8.71	98	2.4	4.9	7.3	9.8	12.2	14.7	17.1	19.6	22.0	24.5

Table 6.79: Breeding season apportioning for kittiwake at the Farne Islands SPA for the impact from Preferred Project 3

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	1.1	2.2	3.4	4.5	5.6	6.7	7.9	9.0	10.1	11.2
			99.0	1.0	2.0	3.1	4.1	5.1	6.1	7.2	8.2	9.2	10.2
		8.71	98.9	0.8	1.7	2.5	3.3	4.2	5.0	5.8	6.7	7.5	8.3
			99.0	0.8	1.5	2.3	3.0	3.8	4.5	5.3	6.0	6.8	7.6
	3	13.1	98.9	1.3	2.6	3.8	5.1	6.4	7.7	8.9	10.2	11.5	12.8
			99.0	1.2	2.3	3.5	4.6	5.8	7.0	8.1	9.3	10.5	11.6
		8.71	98.9	0.9	1.9	2.8	3.8	4.7	5.7	6.6	7.6	8.5	9.5
			99.0	0.9	1.7	2.6	3.4	4.3	5.2	6.0	6.9	7.7	8.6
Option 3	2	13.1	98	0.4	0.7	1.1	1.4	1.8	2.1	2.5	2.9	3.2	3.6
		8.71	98	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.8	3.1
	3	13.1	98	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.1
		8.71	98	0.3	0.7	1.0	1.4	1.7	2.1	2.4	2.8	3.1	3.5

6.1.164 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.77, Table 6.78 and Table 6.79. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All three of the Preferred Projects are beyond the mean-maximum foraging range of kittiwake from the Farne Islands SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. Each of the three Preferred Projects is however, within the foraging range of kittiwake when using the mean-maximum foraging range plus one standard deviation from Woodward *et al.* (2019) (300.6 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual kittiwakes from the Farne Islands SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.165 The apportioning results in Annex H.3 have been reviewed against relevant site specific data. Site-specific data for kittiwake at the Farne Islands SPA recorded an average maximum trip distance from the colony of 35.6 km and a maximum distance of 111.2 km, a distance significantly shorter than the distance between the Farne Islands SPA and the closest Preferred Project (Redfern and Bevan, 2014). These data therefore suggest no connectivity between kittiwakes from the Farne Islands SPA and the Round 4 Plan in the breeding season. The apportioning value for all of the Preferred Projects in the breeding season is therefore set to 0%.

6.1.166 In the post-breeding and pre-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post- and pre-breeding seasons for the Preferred Projects in the North Sea are 0.5% and 0.7%, respectively. For the Preferred Projects in the Irish Sea, 0.2% and 0.3% have been applied, respectively. The apportioned values from each of the Preferred Projects combined to the Farne Islands SPA are presented in Table 6.80.

Table 6.80: Apportioned collision risk estimates for kittiwake at the Farne Islands SPA in non-breeding seasons

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
Option 2	2	13.1	98.9	0.3	0.3

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
			99.0	0.3	0.2
		8.71	98.9	0.2	0.2
			99.0	0.2	0.2
	3	13.1	98.9	0.4	0.4
			99.0	0.3	0.3
		8.71	98.9	0.3	0.3
			99.0	0.3	0.2
Option 3	2	13.1	98	0.1	0.1
		8.71	98	0.1	0.1
	3	13.1	98	0.2	0.2
		8.71	98	0.1	0.1

6.1.167 The annual apportioned impact for kittiwake at the Farne Islands SPA is provided in Table 6.81.

Table 6.81: Calculation of the annual impact attributable to kittiwake at the Farne Islands SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Post-breeding	Pre-breeding	Total	Baseline mortality (%)
				All projects	All projects		
Option 2	2	13.1	98.9	0.3	0.3	0.6	0.05
			99.0	0.3	0.2	0.5	0.04
		8.71	98.9	0.2	0.2	0.4	0.04
			99.0	0.2	0.2	0.4	0.03
	3	13.1	98.9	0.4	0.4	0.7	0.06
			99.0	0.3	0.3	0.7	0.05
		8.71	98.9	0.3	0.3	0.6	0.05
			99.0	0.3	0.2	0.5	0.04
Option 3	2	13.1	98	0.1	0.1	0.3	0.02
		8.71	98	0.1	0.1	0.2	0.02
	3	13.1	98	0.2	0.2	0.3	0.03
		8.71	98	0.1	0.1	0.3	0.02

6.1.168 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.81 is considered to be 0.2-0.3 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that kittiwake densities from the MERP dataset potentially underestimate kittiwake abundance.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.
- The apportioning value applied in the breeding season, it is unlikely that a significant proportion of kittiwake from the Farne Islands SPA will utilize the Preferred Project areas and the assumption of 10% is likely an over-estimate but is applied on a precautionary basis.

6.1.169 An impact of 0.2-0.3 collisions/annum represents 0.02% of the baseline mortality of the Farne Islands SPA kittiwake population (8,241 breeding adults). When considering the highest impact estimated in Table 6.81, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 0.6-0.7 collisions/annum represents an increase in baseline mortality of 0.05-0.06%. However, the actual number of collisions predicted remains low and there are considered to be significant assumptions which lead to over-estimation associated with the collision risk estimates. Under any of the scenarios presented, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.170 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Farne Islands SPA.

Puffin

Alone

6.1.171 Displacement analysis has been undertaken for puffin using the approach advised in JNCC *et al.* (2017) (Annex H.1). To account for uncertainty in the analysis approach a range of displacement and mortality rates have been applied following the recommended approach to defining these in JNCC *et al.* (2017). Table 6.82 presents the unapportioned seasonal displacement mortality for puffin at each of the Preferred Projects using the appropriate range of displacement and mortality rates. In the breeding season, there is only connectivity between the Farne Islands SPA and Preferred Projects 1 and 2 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.82: Displacement mortality for puffin at each of the Preferred Projects (unapportioned values) (no. of birds)

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
1	30	0	1	2	5	1	2	4	8
	50	1	2	4	8	1	3	6	13
	70	1	2	5	11	2	4	9	18
2	30	0	1	2	3	1	1	3	5
	50	1	1	3	5	1	2	5	9
	70	1	1	4	7	1	3	6	13
3	30	N/A				1	1	3	6
	50	N/A				1	2	5	9
	70	N/A				1	3	6	13
4	30	N/A				0	0	0	0
	50	N/A				0	0	0	0
	70	N/A				0	0	0	0
5	30	N/A				0	0	0	0
	50	N/A				0	0	0	0
	70	N/A				0	0	0	0
6	30	N/A				0	0	0	0

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
	50	N/A				0	0	0	0
	70	N/A				0	0	0	0

6.1.172 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.83.

Table 6.83: Breeding season apportioning for puffin at the Farne Islands SPA for the impact from all Preferred Projects with connectivity in the breeding season

Preferred Project	Displacement rate (%)	Apportioning value (%)									
		10	20	30	40	50	60	70	80	90	100
1	30	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5
	50	0.4	0.8	1.2	1.5	1.9	2.3	2.7	3.1	3.5	3.8
	70	1.1	2.1	3.2	4.3	5.4	6.4	7.5	8.6	9.7	10.7
2	30	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3
	50	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.0	2.3	2.6
	70	0.7	1.4	2.1	2.9	3.6	4.3	5.0	5.7	6.4	7.2

6.1.173 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.83. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). Both of the Preferred Projects are beyond the mean-maximum foraging range of puffin from the Farne Islands SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. Both of the Preferred Projects are however, within the foraging range of puffin when using the mean-maximum foraging range plus one standard deviation from Woodward *et al.* (2019) (265.4 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al.* (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual puffins from the Farne Islands SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of displacement mortality.

6.1.174 There is no site-specific foraging range data available for puffin from the Farne Islands SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Farne Islands SPA then this should only be a limited amount (e.g. 10%).

6.1.175 In the non-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning value used for the Preferred Projects in the North Sea is 17.2% and for the Preferred Projects in the Irish Sea is 1.8%. The apportioned values from each of the Preferred Projects combined to the Farne Islands SPA are presented in Table 6.84.

Table 6.84: Apportioned displacement mortality for puffin at the Farne Islands SPA in non-breeding season

Displacement / mortality rate (%)	Preferred Project						Total
	1	2	3	4	5	6	
30 / 1	0.1	0.1	0.1	0.0	0.0	0.0	0.3
50 / 5	1.1	0.8	0.8	0.0	0.0	0.0	2.7
70 / 10	3.0	2.2	2.2	0.0	0.0	0.0	7.4

6.1.176 The annual apportioned impact for puffin at the Farne Islands SPA is provided in Table 6.85.

Table 6.85: Calculation of the annual impact attributable to puffin at the Farne Islands SPA from the Round 4 Plan alone

Displacement / mortality assumptions	Breeding season		Non-breeding season						Total	Increase in baseline mortality (%)
	PP1	PP2	PP1	PP2	PP3	PP4	PP5	PP6		
30 / 1	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.4	0.01
50 / 5	0.4	0.3	1.1	0.8	0.8	0.0	0.0	0.0	3.3	0.05
70 / 10	1.1	0.7	3.0	2.2	2.2	0.0	0.0	0.0	9.2	0.13

6.1.177 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.85 is considered to be 3.3 birds. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that puffin densities from the MERP dataset potentially over-estimate puffin abundance.
- The apportioning value applied in the breeding season, it is unlikely that a significant proportion of puffin from the Farne Islands SPA will utilize the Preferred Project areas and the assumption of 10% is likely an over-estimate but is applied on a precautionary basis.

6.1.178 A wider range of displacement rates are defined in JNCC *et al.* (2017) and these have been considered in the displacement analyses conducted. A precautionary approach has also been applied when considering the apportioning value to apply for all Preferred Projects with all three of the Preferred Projects beyond the mean-maximum foraging range of puffin from the Farne Islands SPA.

6.1.179 An impact of 3.3 birds represents 0.05% of the baseline mortality of the Farne Islands SPA puffin population (76,798 breeding adults). When considering the impact associated with the most precautionary assumptions considered in Table 6.85, which is considered unrealistic due to an over-application of precaution, an annual displacement mortality of 9.2 birds is estimated. This represents an increase in baseline mortality of 0.13%. However, the actual displacement mortality predicted is low and there are considered to be significant assumptions which lead to over-estimation associated with the predicted displacement mortality. Under any of the scenarios presented, the actual displacement mortality is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.180 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Farne Islands SPA.

Flamborough and Filey Coast SPA

Gannet

Alone

Collision risk

6.1.181 Collision risk modelling has been undertaken for gannet using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.86. In the breeding season, there is only connectivity between the Flamborough and Filey Coast SPA and Preferred Projects 1, 2 and 3 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented on the Natural England designated site viewer for Flamborough and Filey Coast SPA (breeding season) and Furness (2015) (post- and pre-breeding seasons).

Table 6.86: Collision risk estimates for gannet (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																
				Breeding season				Post-breeding							Pre-breeding						
				PP1	PP2	PP3	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	1	14.9	98.9	18	10	2	30	1	1	0	0	0	0	2	2	1	0	0	0	0	4
			99.5	8	5	1	14	0	0	0	0	0	0	1	1	1	0	0	0	0	2
		13.33	98.9	17	10	2	29	1	0	0	0	0	0	2	2	1	0	0	0	0	4
			99.5	8	4	1	13	0	0	0	0	0	0	1	1	1	0	0	0	0	2
	2	14.9	98.9	21	12	3	35	1	1	0	0	0	0	2	3	2	0	0	0	0	6
			99.5	9	5	1	16	1	0	0	0	0	0	1	1	1	0	0	0	0	3
		13.33	98.9	20	11	2	33	1	1	0	0	0	0	2	3	2	0	0	0	0	5
			99.5	9	5	1	15	1	0	0	0	0	0	1	1	1	0	0	0	0	2

6.1.182 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.87, Table 6.88 and Table 6.89.

Table 6.87: Breeding season apportioning for gannet at Flamborough and Filey Coast SPA for the impact from Preferred Project 1

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	1	14.9	98.9	1.8	3.5	5.3	7.1	8.9	10.6	12.4	14.2	16.0	17.7
			99.5	0.8	1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.3	8.1
		13.33	98.9	1.7	3.4	5.0	6.7	8.4	10.1	11.7	13.4	15.1	16.8
			99.5	0.8	1.5	2.3	3.0	3.8	4.6	5.3	6.1	6.9	7.6
	2	14.9	98.9	2.1	4.1	6.2	8.3	10.3	12.4	14.5	16.5	18.6	20.7
			99.5	0.9	1.9	2.8	3.8	4.7	5.6	6.6	7.5	8.5	9.4
		13.33	98.9	2.0	3.9	5.9	7.8	9.8	11.7	13.7	15.6	17.6	19.6
			99.5	0.9	1.8	2.7	3.6	4.4	5.3	6.2	7.1	8.0	8.9

Table 6.88: Breeding season apportioning for gannet at Flamborough and Filey Coast SPA for the impact from Preferred Project 2

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	1	14.9	98.9	1.0	2.1	3.1	4.1	5.2	6.2	7.2	8.3	9.3	10.3
			99.5	0.5	0.9	1.4	1.9	2.3	2.8	3.3	3.8	4.2	4.7
		13.33	98.9	1.0	2.0	2.9	3.9	4.9	5.9	6.8	7.8	8.8	9.8
			99.5	0.4	0.9	1.3	1.8	2.2	2.7	3.1	3.6	4.0	4.4
	2	14.9	98.9	1.2	2.4	3.6	4.8	6.0	7.2	8.4	9.7	10.9	12.1
			99.5	0.5	1.1	1.6	2.2	2.7	3.3	3.8	4.4	4.9	5.5
		13.33	98.9	1.1	2.3	3.4	4.6	5.7	6.8	8.0	9.1	10.3	11.4
			99.5	0.5	1.0	1.6	2.1	2.6	3.1	3.6	4.1	4.7	5.2

Table 6.89: Breeding season apportioning for gannet at Flamborough and Filey Coast SPA for the impact from Preferred Project 3

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	1	14.9	98.9	0.2	0.4	0.7	0.9	1.1	1.3	1.6	1.8	2.0	2.2
			99.5	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		13.33	98.9	0.2	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.9	2.1
			99.5	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
	2	14.9	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.4	2.6
			99.5	0.1	0.2	0.4	0.5	0.6	0.7	0.8	1.0	1.1	1.2
		13.33	98.9	0.2	0.5	0.7	1.0	1.2	1.5	1.7	2.0	2.2	2.5
			99.5	0.1	0.2	0.3	0.4	0.6	0.7	0.8	0.9	1.0	1.1

6.1.183 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.87, Table 6.88 and Table 6.89. The three components of the population present at each of the Preferred Projects in the breeding season have been considered (see Annex H.3). The values associated with each of these population components is presented in Table 6.90 and multiplied together to provide an apportioning value for each of the Preferred Projects.

Table 6.90: Breeding season apportioning values for gannet at Flamborough and Filey Coast SPA based on the approach applied in Annex H.3

Preferred Project	Proportion of breeding adult birds from SPA	Proportion of immature birds	Proportion of non-breeding birds	Overall breeding season apportioning value
1	0.544	0.426	0.1	0.46
2	0.999	0.426	0.1	0.48
3	1	0.426	0.1	0.48

6.1.184 The results of the apportioning approach in Annex H.3 suggest that differing apportioning values are applicable to each of the Preferred Projects. These values differ due to the other colonies that are within foraging range of each Project. Preferred Project 1 is within foraging range of birds from Flamborough and Filey Coast SPA, the non-SPA colony at St Abb's and the Forth Islands SPA, Preferred Project 2 is within foraging range of birds from both Flamborough and Filey Coast SPA and the non-SPA colony at St Abb's and Preferred Project 3 is within foraging range of birds from only Flamborough and Filey Coast SPA.

6.1.185 The apportioning results in Annex H.3 have been reviewed against relevant site specific data. There is strong evidence showing space partitioning between gannet breeding colonies. The results shown in Wakefield *et al.* (2013) suggest that the areas in which the Preferred Projects are located overlap with foraging areas of birds from Flamborough and Filey Coast SPA. It is therefore proposed that the most appropriate apportioning values for the proportion of breeding adult birds at each of the Preferred Projects (column 2 of Table 6.90) is 100%. Site-specific tracking data exists for gannets from Flamborough and Filey Coast SPA (Langston *et al.*, 2013; Figure 6.1) and indicates that the sea areas in which the Preferred Projects are located are utilised by gannet, albeit at varying rates. The sea area in which Preferred Projects 1 and 2 are located generally overlaps with the 95% utilisation contour of gannets from the SPA, suggesting a lower usage. Preferred Project 3 is located in a sea area with even lower usage, lying outside of the 95% utilisation contour in some years.

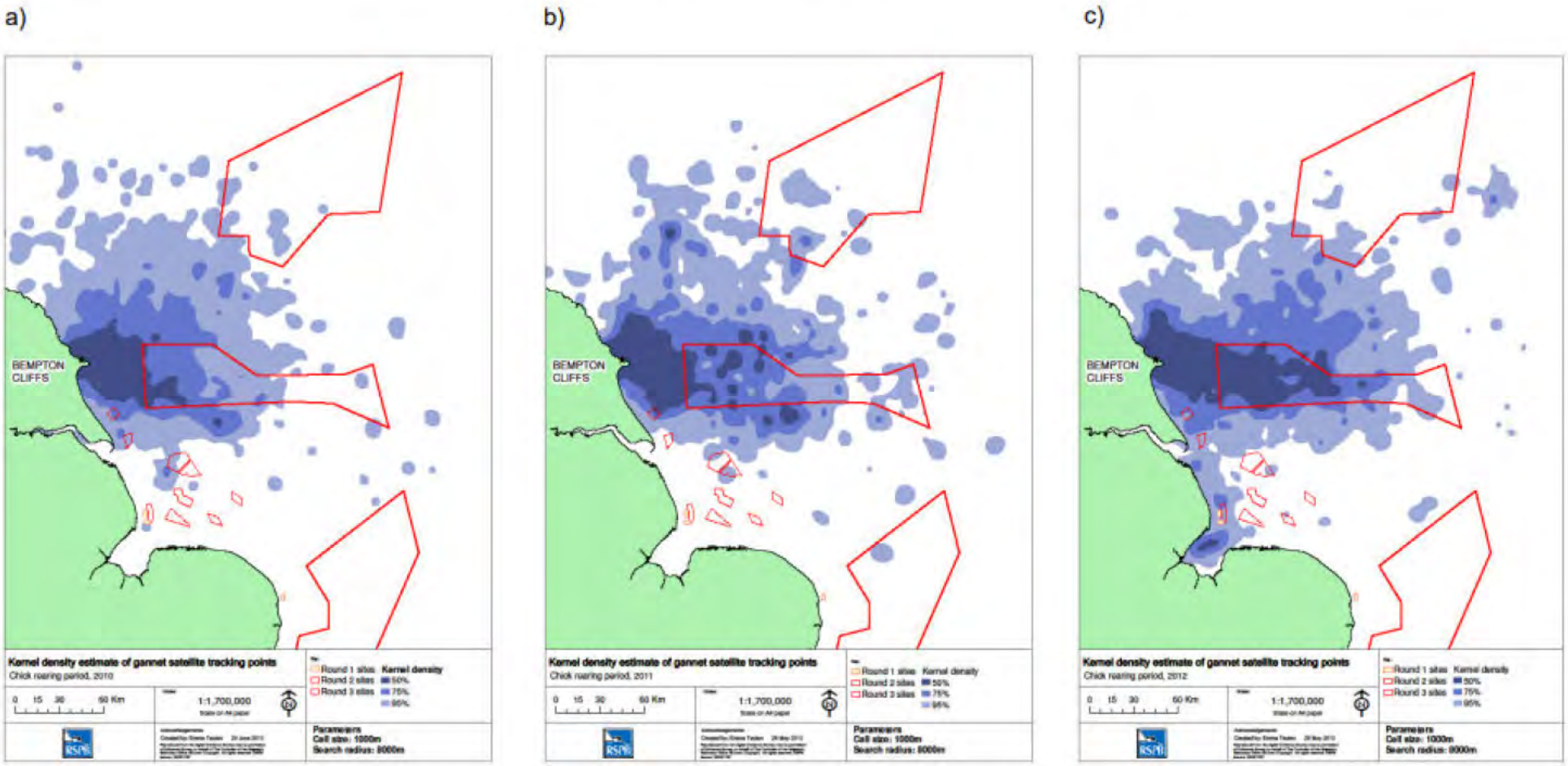


Figure 6.1: Kernel Density Estimation (kernel density tool, ArcGIS Desktop 10) for adult gannets during chick-rearing: a) 2010 (n = 14), b) 2011 (n = 13) & c) 2012 (n = 15), showing the 50%, 75% and 95% density contours. (from Langston *et al.*, 2013)

6.1.186 Breeding adult birds represent only one component of the population present at any of the Preferred Projects in the breeding season, as discussed in paragraph 6.1.182. In order to determine an appropriate apportioning value to apply at each of the Preferred Projects, the proportions of immature and non-breeding birds must also be taken into account. A 10% sabbatical rate has been assumed based on guidance from Scottish Ministers to previous offshore wind farm projects (Marine Scotland, 2017). The estimated proportion of immature birds in Table 6.90 does not take account of the distribution of immature birds and may therefore over-estimate this component of the population present at each of the Preferred Projects. However, immature birds will be present throughout the North Sea in the breeding season as these birds return to natal waters to prospect for future nesting areas and therefore they should be accounted for in the apportioning process. Baseline survey data collected to inform the applications for other offshore wind farms in the North Sea have found high proportions of immature gannets in offshore locations. For example, boat-based surveys used to support the applications for projects in the Hornsea Zone estimated between 16.3-59.6% of the population of gannets present consisted of immature birds, with the proportion increasing as distance offshore increased. The distance between Preferred Project 3 and Flamborough and Filey Coast SPA is the same as the distance between the western edge of the Hornsea Zone and the SPA. It is therefore considered appropriate to apply the immature proportion recorded in this area to Preferred Project 3 (i.e. 16.3-21.5%, with the lowest of these used on a precautionary basis). Preferred Projects 1 and 2 are located approximately 100-125 km from the SPA, a similar distance to Hornsea Projects 1 and 2. The immature proportion recorded at these projects was 39.7-42.8%, with the lowest of these applied for Preferred Projects 1 and 2 on a precautionary basis. Combining the relevant proportions for each population component provides apportioning values of 54% for Preferred Projects 1 and 2 and 75% for Preferred Project 3 (Table 6.91).

Table 6.91: Breeding season apportioning values for gannet at Flamborough and Filey Coast SPA based on information in Wakefield *et al.* (2013) and immature proportions recorded in baseline survey data from the Hornsea Zone

Preferred Project	Proportion of breeding adult birds from SPA	Proportion of immature birds	Proportion of non-breeding birds	Overall breeding season apportioning value
1	1	0.397	0.1	0.54
2	1	0.397	0.1	0.54
3	1	0.163	0.1	0.75

6.1.187 In the post-breeding and pre-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post- and pre-breeding seasons for the Preferred Projects in the North Sea are 4.8% and 6.2% and for the Preferred Projects in the Irish Sea are 0% and 1.0%. The apportioned values from each of the Preferred Projects combined to the Flamborough and Filey Coast SPA are presented in Table 6.92.

Table 6.92: Apportioning for gannet at Flamborough and Filey Coast SPA in the post- and pre-breeding season for the impact from all Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
Option 2	1	14.9	98.9	0.1	0.2
			99.5	0.0	0.1
		13.33	98.9	0.1	0.2
			99.5	0.0	0.1
	2	14.9	98.9	0.1	0.3
			99.5	0.0	0.2
		13.33	98.9	0.1	0.3
			99.5	0.0	0.1

6.1.188 The annual apportioned impact for gannet at the Flamborough and Filey Coast SPA is provided in Table 6.93.

Table 6.93: Calculation of the annual impact attributable to gannet at the Flamborough and Filey Coast SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding			Post-breeding	Pre-breeding	Total	Increase in baseline mortality (%)
				PP1	PP2	PP3	All projects	All projects		
Option 2	1	14.9	98.9	9.6	5.6	1.7	0.1	0.2	17.2	1.25
			99.5	4.4	2.5	0.8	0.0	0.1	7.8	0.57
		13.33	98.9	9.1	5.3	1.6	0.1	0.2	16.3	1.18
			99.5	4.1	2.4	0.7	0.0	0.1	7.4	0.54
	2	14.9	98.9	11.2	6.5	2.0	0.1	0.3	20.2	1.47
			99.5	5.1	3.0	0.9	0.0	0.2	9.2	0.67
		13.33	98.9	10.6	6.2	1.8	0.1	0.3	19.1	1.39
			99.5	4.8	2.8	0.8	0.0	0.1	8.7	0.63

6.1.189 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.93 is considered to be 7.4-8.7 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the gannet densities extracted from the MERP dataset are comparable with the exception of migratory periods where the use of the MERP dataset may underestimate gannet abundance.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.

6.1.190 An impact of 7.4-8.7 collisions/annum represents 0.54-0.63% of the baseline mortality of the Flamborough and Filey Coast SPA gannet population (16,938 breeding adults). When considering the highest impact estimated in Table 6.93, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 17.2-20.2 collisions/annum represents an increase in baseline mortality of 1.25-1.47%.

6.1.191 The population of gannet at the Flamborough and Filey Coast SPA has increased considerably in recent years. The observed rate of increase in the number of gannet at the Flamborough and Filey Coast SPA has averaged approximately 9.9% between 1985 and 2017 and approximately 9.4% between 2000 and 2017. The maximum predicted growth rate for this species is 9.9%, calculated using the method proposed by Niel and Lebreton (2005). Therefore, the population appears to have grown at a rate similar to the predicted maximum. Previous population modelling has suggested that the population has undergone considerable net immigration which has permitted the observed rate of growth (MacArthur Green, 2015b).

6.1.192 The timeframes of the Preferred Projects are not yet known and therefore consideration has been given to a range of project lifetimes when interpreting PVA outputs. Project lifetimes of 20, 40 and 60 years have therefore been considered.

6.1.193 If additional mortality of 7.4-8.7 collisions/annum is assumed then the model predicts a counterfactual of growth rate of 1.000 (a reduction of less than 0.1%) after 20, 40 and 60 years. Under this impact scenario, the predicted counterfactual median impacted population size would be approximately 99.2-99.3% of that which the model predicts would occur in the absence of any additional impact from the Plan alone after 20 years, 98.4-98.6% after 40 years and 97.6-98.0% after 60 years. This is a relative reduction in population size (compared to that which might otherwise have arisen). The model predicts a positive growth rate, and so the impacted population after 60 years would still be larger than that which was assumed for the initiation of the modelling exercise (i.e. the designated population at the Flamborough and Filey Coast SPA).

6.1.194 The current population at the Flamborough and Filey Coast SPA (26,784 individuals) is approximately 58% higher than the cited population and the population has increased 240% since the 2004 gannet census (Wanless *et al.*, 2005). PVA modelling predicts (without any density-dependence taken into account which almost certainly operate) that the population of gannet at the Flamborough and Filey Coast SPA would still continue to increase however, over the lifetime of the Round 4 Plan the resultant population would represent 97.6-

99.3% of the population that would occur without the presence of the Round 4 Plan alone depending on the lifetimes of the Preferred Projects. Therefore there is no indication, based on the results of the PVA, that additional mortality from the Round 4 Plan alone would result in the population declining below the cited population.

6.1.195 It is important to note that the PVA modelling conducted does not give consideration to density dependent compensation of demographic parameters within the modelled population, nor immigration, both of which could reduce the magnitude of any population change.

Displacement

6.1.196 Displacement analysis has been undertaken for gannet using the approach advised in JNCC *et al.* (2017) (Annex H.1). To account for uncertainty in the analysis approach a range of displacement and mortality rates have been applied following the recommended approach to defining these in JNCC *et al.* (2017). Table 6.94 presents the unapportioned seasonal displacement mortality for gannet at each of the Preferred Projects using the appropriate range of displacement and mortality rates. The seasons used are those presented on Natural England's designated site viewer (breeding season) and in Furness (2015) (non-breeding season).

Table 6.94: Displacement mortality for gannet at each of the Preferred Projects (unapportioned values) (no. of birds)

Preferred Project	Displacement rate (%)	Mortality rate (%)											
		Breeding				Post-breeding				Pre-breeding			
		1	2	5	10	1	2	5	10	1	2	5	10
1	60	1	3	6	13	1	2	4	9	1	1	4	7
	80	2	3	8	17	1	2	6	12	1	2	5	10
2	60	1	2	4	9	1	1	3	6	1	1	3	5
	80	1	2	6	12	1	2	4	8	1	1	3	7
3	60	1	2	6	12	1	2	4	8	1	1	4	7
	80	2	3	8	16	1	2	6	11	1	2	5	9
4	60	N/A				0	0	0	1	0	0	0	1
	80	N/A				0	0	1	1	0	0	0	1
5	60	N/A				0	0	0	0	0	0	0	0
	80	N/A				0	0	0	0	0	0	0	0
6	60	N/A				0	0	0	1	0	0	0	0
	80	N/A				0	0	0	1	0	0	0	1

6.1.197 In the breeding season, the population of birds present in an area of sea can be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.95

Table 6.95: Breeding season apportioning for gannet at Flamborough and Filey Coast SPA for the impact from all Preferred Projects with connectivity in the breeding season

Preferred Project	Displacement / mortality rate (%)	Apportioning value (%)									
		10	20	30	40	50	60	70	80	90	100
1	60 / 1	0.1	0.3	0.4	0.5	0.6	0.8	0.9	1.0	1.1	1.3
	80 / 10	1.7	3.4	5.1	6.7	8.4	10.1	11.8	13.5	15.2	16.9
2	60 / 1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	80 / 10	1.2	2.3	3.5	4.6	5.8	6.9	8.1	9.2	10.4	11.5
3	60 / 1	0.1	0.2	0.4	0.5	0.6	0.7	0.9	1.0	1.1	1.2
	80 / 10	1.6	3.3	4.9	6.5	8.2	9.8	11.4	13.1	14.7	16.3

6.1.198 Discussion on the appropriate apportioning values to apply for gannet is provided in paragraphs 6.1.183 to 6.1.186 and those apportioning values to be applied in the breeding season at each of the Preferred Projects for gannet at Flamborough and Filey Coast SPA are summarised in Table 6.92.

6.1.199 In the post-breeding and pre-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, and pre-breeding seasons for the Preferred Projects in the North Sea are 4.8% and 6.2% and for the Preferred Projects in the Irish Sea are 0% and 1.0%. The apportioned values from each of the Preferred Projects combined to the Flamborough and Filey Coast SPA are presented in Table 6.96.

Table 6.96: Apportioned displacement mortality for gannet at the Flamborough and Filey Coast SPA in non-breeding seasons

Preferred Project	Displacement rate (%)	Mortality rate (%)	Apportioned values	
			Post-breeding	Non-breeding
1	60	1	0.0	0.0
	80	10	0.6	0.6
2	60	1	0.0	0.0
	80	10	0.4	0.4
3	60	1	0.0	0.0
	80	10	0.5	0.6
4	60	1	0.0	0.0
	80	10	0.0	0.0
5	60	1	0.0	0.0
	80	10	0.0	0.0
6	60	1	0.0	0.0
	80	10	0.0	0.0
Total	60	1	0.1	0.1
	80	10	1.5	1.6

6.1.200 The annual apportioned impact for gannet at the Flamborough and Filey Coast SPA is provided in Table 6.97.

Table 6.97: Calculation of the annual impact attributable to gannet at the Flamborough and Filey Coast SPA from the Round 4 Plan alone

Displacement / mortality assumptions	Breeding season			Post-breeding season						Pre-breeding season						Total	Increase in baseline mortality (%)
	PP1	PP2	PP3	PP1	PP2	PP3	PP4	PP5	PP6	PP1	PP2P	PP3	PP4	PP5	PP6		
60 / 1	0.7	0.5	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.17
80 / 10	9.2	6.2	12.3	0.6	0.4	0.5	0.0	0.0	0.0	0.6	0.4	0.6	0.0	0.0	0.0	30.8	2.25

6.1.201 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.97 is considered to be 2.3-30.8 birds. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the gannet densities extracted from the MERP dataset are comparable with the exception of migratory periods where the use of the MERP dataset may underestimate gannet abundance.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.

6.1.202 An impact of 2.3-30.8 birds represents 0.17-2.25% of the baseline mortality of the Flamborough and Filey Coast SPA gannet population (16,938 breeding adults).

6.1.203 The population of gannet at the Flamborough and Filey Coast SPA has increased considerably in recent years. The observed rate of increase in the number of gannet at the Flamborough and Filey Coast SPA has averaged approximately 9.9% between 1985 and 2017 and approximately 9.4% between 2000 and 2017. The maximum predicted growth rate for this species is 9.9%, calculated using the method proposed by Niel and Lebreton (2005). Therefore, the population appears to have grown at a rate similar to the predicted maximum. Previous population modelling has suggested that the population has undergone considerable net immigration which has permitted the observed rate of growth (MacArthur Green, 2015b).

6.1.204 The timeframes of the Preferred Projects are not yet known and therefore consideration has been given to a range of project lifetimes when interpreting PVA outputs. Project lifetimes of 20, 40 and 60 years have therefore been considered.

6.1.205 If additional mortality of 2.3-30.8 birds/annum is assumed then the model predicts a counterfactual of growth rate of 0.999-1.000 (a reduction of less than 0.1%-0.1%) after 20, 40 and 60 years. Under this impact scenario, the predicted counterfactual median impacted population size would be approximately 97.2-99.8% of that which the model predicts would occur in the absence of any additional impact from the Plan alone after 20 years, 94.6-99.6% after 40 years and 92-99.3% after 60 years. This is a relative reduction in population size (compared to that which might otherwise have arisen). The model predicts a positive growth rate, and so the impacted population after 60 years would still be larger than that which was assumed for the initiation of the modelling exercise (i.e. the designated population at the Flamborough and Filey Coast SPA).

6.1.206 The current population at the Flamborough and Filey Coast SPA (26,784 individuals) is approximately 58% higher than the cited population and the population has increased 240% since the 2004 gannet census (Wanless *et al.*, 2005). PVA modelling predicts (without any density-dependence taken into account which almost certainly operate) that the population of gannet at the Flamborough and Filey Coast SPA would still continue to increase however, over the lifetime of the Round 4 Plan the resultant population would represent 92-99.8% of the population that would occur without the presence of the Round 4 Plan alone depending on the lifetimes of the Preferred Projects. Therefore there is no indication, based on the results of the PVA, that additional mortality from the

Round 4 Plan alone would result in the population declining below the cited population.

6.1.207 It is important to note that the PVA modelling conducted does not give consideration to density dependent compensation of demographic parameters within the modelled population, nor immigration, both of which could reduce the magnitude of any population change.

Collision and displacement

6.1.208 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.93 in relation to collision risk is considered to be 7.4-8.7 collisions/annum. The most likely impact and most realistic worst case) from the Round 4 Plan alone from Table 6.97 in relation to displacement is considered to be 2.3-30.8 birds. This provides a combined value of 9.7-39.5 birds/annum. This represents 0.69-2.88% of the baseline mortality of the gannet population at Flamborough and Filey Coast SPA.

6.1.209 The population of gannet at the Flamborough and Filey Coast SPA has increased considerably in recent years. The observed rate of increase in the number of gannet at the Flamborough and Filey Coast SPA has averaged approximately 9.9% between 1985 and 2017 and approximately 9.4% between 2000 and 2017. The maximum predicted growth rate for this species is 9.9%, calculated using the method proposed by Niel and Lebreton (2005). Therefore, the population appears to have grown at a rate similar to the predicted maximum. Previous population modelling has suggested that the population has undergone considerable net immigration which has permitted the observed rate of growth (MacArthur Green, 2015b).

6.1.210 The timeframes of the Preferred Projects are not yet known and therefore consideration has been given to a range of project lifetimes when interpreting PVA outputs. Project lifetimes of 20, 40 and 60 years have therefore been considered.

6.1.211 If additional mortality of 9.7-39.5 collisions/annum is assumed then the model predicts a counterfactual of growth rate of 0.998-1.000 (a 0-0.02% reduction) after 20, 40 and 60 years. Under this impact scenario, the predicted counterfactual median impacted population size would be approximately 96.4-99.1% of that which the model predicts would occur in the absence of any additional impact from the Plan alone after 20 years, 93.0-98.2% after 40 years and 89.8-97.4% after 60 years. This is a relative reduction in population size (compared to that which might otherwise have arisen). The model predicts a positive growth rate, and so the impacted population after 60 years would still be larger than that which was assumed for the initiation of the modelling exercise (i.e. the designated population at the Flamborough and Filey Coast SPA).

6.1.212 The current population at the Flamborough and Filey Coast SPA (26,784 individuals) is approximately 58% higher than the cited population and the population has increased 240% since the 2004 gannet census (Wanless *et al.*, 2005). PVA modelling predicts (without any density-dependence taken into account which almost certainly operate) that the population of gannet at the Flamborough and Filey Coast SPA would still continue to increase however, over the lifetime of the Round 4 Plan the resultant population would represent 89.8-99.1% of the population that would occur without the presence of the Round 4 Plan alone depending on the lifetimes of the Preferred Projects. Therefore there is no indication, based on the results of the PVA, that additional mortality from the Round 4 Plan alone would result in the population declining below the cited population.

6.1.213 It is important to note that the PVA modelling conducted does not give consideration to density dependent compensation of demographic parameters within the modelled population, nor immigration, both of which could reduce the magnitude of any population change.

In-combination

Collision

6.1.214 Seasonal collision risk estimates for all projects considered in-combination, where available, are presented in Annex H.4. The projects considered in the breeding season are those within the English North Sea, reflecting the space partitioning exhibited by gannets from different breeding colonies in the breeding season (Wakefield *et al.,* 2013). Apportioning values applied in the breeding season for each relevant project have been sourced from project-specific documentation. Where a project-specific apportioning value is unavailable an apportioning value of 100% was assumed. The total in-combination values are presented in Table 6.98 for each of the cumulative tiers considered in the HRA (see Appendix A and B).

Table 6.98: Calculation of the in-combination impact attributable to the gannet feature at the Flamborough and Filey Coast SPA

Tier	Breeding	Post-breeding	Pre-breeding	Total
Round 4 Plan	7.3-8.5	0	0.1	7.4-8.7
1	119	12	6	137
2	32	28	17	77
3	12	4	2	18
4	44	4	1	49
Total	215-217	48	25	288-290

6.1.215 The total in-combination collision risk value represents 21.01-21.10% of the baseline mortality of the Flamborough and Filey Coast SPA population. There are considerable uncertainties associated with the values for projects considered in-combination presented in Table 6.98. These include:

- Compounding high levels of precaution. Many of the in-combination values presented are those advocated by Natural England, which incorporated high levels of precaution throughout the assessment which has the potential to compound precaution and lead to highly inflated impact magnitudes. If high levels of precaution are applied across the assessments for all projects considered in-combination this can lead to highly inflated in-combination impacts.
- The apportioning values associated with many projects are considered to be highly precautionary, not accounting for immature birds, non-breeding birds and adult breeding birds from other colonies. The first of these two components will be present throughout the North Sea and should therefore be accounted for in apportioning values derived for the breeding season.

- The changes to turbine scenarios that occur between consent decisions and eventual as-built designs. This can lead to significant reductions in the collision risk estimates associated with a Project. For example, for gannet Ørsted (2018b) estimated that changes to turbine scenarios at those projects considered in-combination could lead to a reduction in the in-combination total of 31% for projects that were already built at that time or 25% when including projects that were yet to be built.
- Collision risk modelling undertaken to support the applications of previous offshore wind farm projects have had to use information that, based on evidence that has subsequently been collected, leads to an over-estimation of the project's effect on certain species. This is especially relevant to flight speed and nocturnal activity factors.
- Future impacts associated with plans and projects in Tiers 5 and 6 are not included in the in-combination assessment due to the development stage of the plan or project (and therefore the uncertainty as to whether the plan or project will come to fruition and therefore contribute to the in-combination impact) and/or high levels of uncertainty associated with the available impacts.

6.1.216 The population of gannet at the Flamborough and Filey Coast SPA has increased considerably in recent years. The observed rate of increase in the number of gannet at the Flamborough and Filey Coast SPA has averaged approximately 9.9% between 1985 and 2017 and approximately 9.4% between 2000 and 2017. The maximum predicted growth rate for this species is 9.9%, calculated using the method proposed by Niel and Lebreton (2005). Therefore, the population appears to have grown at a rate similar to the predicted maximum. Previous population modelling has suggested that the population has undergone considerable net immigration which has permitted the observed rate of growth (MacArthur Green, 2015b).

6.1.217 The timeframes of the Preferred Projects are not yet known and therefore consideration has been given to a range of project lifetimes when interpreting PVA outputs. Project lifetimes of 20, 40 and 60 years have therefore been considered.

6.1.218 If additional mortality of 288-291 collisions/annum is assumed then the model predicts a counterfactual of growth rate of 0.987 (a 1.3% reduction) after 20, 40 and 60 years. Under this impact scenario, the predicted counterfactual median impacted population size would be approximately 76.1-76.3% of that which the model predicts would occur in the absence of any additional impact from the Plan alone in-combination with other Plans and Projects after 20 years, 58.7-59.0% after 40 years and 45.3-45.5% after 60 years. This is a relative reduction in population size (compared to that which might otherwise have arisen). The model predicts a positive growth rate, and so the impacted population after 60 years would still be larger than that which was assumed for the initiation of the modelling exercise (i.e. the designated population at the Flamborough and Filey Coast SPA).

6.1.219 The current population at the Flamborough and Filey Coast SPA (26,784 individuals) is approximately 58% higher than the cited population and the population has increased 240% since the 2004 gannet census (Wanless *et al.*, 2005). PVA modelling predicts (without any density-dependence taken into account which almost certainly operate) that the population of gannet at the Flamborough and Filey Coast SPA would still continue to increase however, over the lifetime of the Round 4 Plan the resultant population would represent 45.3-76.3% of the population that would occur without the presence of the Round 4 Plan in-combination with other Plans and Projects depending on the lifetimes of the Preferred Projects. Therefore there is no indication, based on the results of

the PVA, that additional mortality from the Round 4 Plan alone or in-combination would result in the population declining below the cited population.

6.1.220 There are a number of uncertainties associated with the PVA modelling, these include:

- Over-estimation of in-combination impacts. The PVA modelling does not account for changes in the predicted in-combination due to the decommissioning of projects considered in-combination. Over the lifetime of the Round 4 Plan the in-combination impact will reduce significantly when licences for current projects expire and decommissioning occurs. The PVA metrics are therefore highly precautionary.
- No consideration has been made for density dependent compensation of demographic parameters within the modelled population, nor immigration, both of which could reduce the magnitude of any population change.

6.1.221 Despite the uncertainty associated with the in-combination estimate, the impact from the Round 4 Plan does not contribute a significant proportion to the in-combination impact.

Displacement

6.1.222 The most recent appraisal of in-combination displacement was presented as part of the application for the Hornsea Four offshore wind farm. This estimated the current level of in-combination displacement as being 51-68 birds/annum using displacement rates of 60-80% and a mortality rate of 1%. When the predicted impact from the Round 4 Plan is included the in-combination displacement mortality increases to 53.3-71.1 birds/annum when using equivalent displacement and mortality rates. A total in-combination impact of this magnitude represents 3.9-5.2% of the baseline mortality of the gannet population of the Flamborough and Filey Coast SPA.

6.1.223 The population of gannet at the Flamborough and Filey Coast SPA has increased considerably in recent years. The observed rate of increase in the number of gannet at Bempton has averaged approximately 9.9% between 1985 and 2017 and approximately 9.4% between 2000 and 2017. The maximum predicted growth rate for this species is 9.9%, calculated using the method proposed by Niel and Lebreton (2005). Therefore, the population appears to have grown at a rate similar to the predicted maximum. Previous population modelling has suggested that the population has undergone considerable net immigration which has permitted the observed rate of growth (MacArthur Green, 2015b).

6.1.224 The timeframes of the Preferred Projects are not yet known and therefore consideration has been given to a range of project lifetimes when interpreting PVA outputs. Project lifetimes of 20, 40 and 60 years have therefore been considered.

6.1.225 If additional mortality of 53.3-71.1 birds/annum is assumed then the model predicts a counterfactual of growth rate of 0.997-0.998 (a 0.3-0.2% reduction) after 20, 40 and 60 years. Under this impact scenario, the predicted counterfactual median impacted population size would be approximately 93.6-95.1% of that which the model predicts would occur in the absence of any additional impact from the Plan alone in-combination with other Plans and Projects after 20 years, 87.8-90.7% after 40 years and 82.4-86.5% after 60 years. This is a relative reduction in population size (compared to that which might otherwise have arisen). The model predicts a positive growth rate, and so the impacted population after 60 years would still be larger than that which was assumed for

the initiation of the modelling exercise (i.e. the designated population at the Flamborough and Filey Coast SPA).

6.1.226 The current population at the Flamborough and Filey Coast SPA (26,784 individuals) is approximately 58% higher than the cited population and the population has increased 240% since the 2004 gannet census (Wanless *et al*., 2005). PVA modelling predicts (without any density-dependence taken into account which almost certainly operate) that the population of gannet at the Flamborough and Filey Coast SPA would still continue to increase however, over the lifetime of the Round 4 Plan the resultant population would represent 82.4-95.1% of the population that would occur without the presence of the Round 4 Plan in-combination with other Plans and Projects depending on the lifetimes of the Preferred Projects. Therefore there is no indication, based on the results of the PVA, that additional mortality from the Round 4 Plan alone or in-combination would result in the population declining below the cited population.

6.1.227 There are a number of uncertainties associated with the PVA modelling, these include:

- Over-estimation of in-combination impacts. The PVA modelling does not account for changes in the predicted in-combination due to the decommissioning of projects considered in-combination. Over the lifetime of the Round 4 Plan the in-combination impact will reduce significantly when licences for current projects expire and decommissioning occurs. The PVA metrics are therefore highly precautionary.
- No consideration has been made for density dependent compensation of demographic parameters within the modelled population, nor immigration, both of which could reduce the magnitude of any population change.

6.1.228 Despite the uncertainty associated with the in-combination estimate, the impact from the Round 4 Plan does not contribute a significant proportion to the in-combination impact.

Collision and displacement

6.1.229 The in-combination collision risk impact is estimated in Table 6.98 as 288-290 collisions/annum. The in-combination displacement impact is estimated as 53.3-71.1 birds/annum. When combined this provides a total in-combination impact of 341.3-361.1 birds/annum. This represents 24.9-26.2% of the baseline mortality of the gannet population at Flamborough and Filey Coast SPA.

6.1.230 The population of gannet at the Flamborough and Filey Coast SPA has increased considerably in recent years. The observed rate of increase in the number of gannet at Bempton has averaged approximately 9.9% between 1985 and 2017 and approximately 9.4% between 2000 and 2017. The maximum predicted growth rate for this species is 9.9%, calculated using the method proposed by Niel and Lebreton (2005). Therefore, the population appears to have grown at a rate similar to the predicted maximum. Previous population modelling has suggested that the population has undergone considerable net immigration which has permitted the observed rate of growth (MacArthur Green, 2015b).

6.1.231 The timeframes of the Preferred Projects are not yet known and therefore consideration has been given to a range of project lifetimes when interpreting PVA outputs. Project lifetimes of 20, 40 and 60 years have therefore been considered.

6.1.232 If additional mortality of 341.3-361.1 birds/annum is assumed then the model predicts a counterfactual of growth rate of 0.984-0.985 (a 1.5-1.6% reduction)

after 20, 40 and 60 years. Under this impact scenario, the predicted counterfactual median impacted population size would be approximately 71.2-72.5% of that which the model predicts would occur in the absence of any additional impact from the Plan alone in-combination with other Plans and Projects after 20 years, 51.5-53.4% after 40 years and 37.2-39.3% after 60 years. This is a relative reduction in population size (compared to that which might otherwise have arisen). The model predicts a positive growth rate, and so the impacted population after 60 years would still be larger than that which was assumed for the initiation of the modelling exercise (i.e. the designated population at the Flamborough and Filey Coast SPA).

6.1.233 The current population at the Flamborough and Filey Coast SPA (26,784 individuals) is approximately 58% higher than the cited population and the population has increased 240% since the 2004 gannet census (Wanless *et al*., 2005). PVA modelling predicts (without any density-dependence taken into account which almost certainly operate) that the population of gannet at the Flamborough and Filey Coast SPA would still continue to increase however, over the lifetime of the Round 4 Plan the resultant population would represent 37.2-72.5% of the population that would occur without the presence of the Round 4 Plan in-combination with other Plans and Projects depending on the lifetimes of the Preferred Projects. Therefore there is no indication, based on the results of the PVA, that additional mortality from the Round 4 Plan alone or in-combination would result in the population declining below the cited population.

6.1.234 There are a number of uncertainties associated with the PVA modelling, these include:

- Over-estimation of in-combination impacts. The PVA modelling does not account for changes in the predicted in-combination due to the decommissioning of projects considered in-combination. Although it is noted that some Tier 5 and 6 projects could be commissioned, over the lifetime of the Round 4 Plan the in-combination impact will reduce when licences for current projects expire and decommissioning occurs. The PVA metrics are therefore precautionary.
- No consideration has been made for density dependent compensation of demographic parameters within the modelled population, nor immigration, both of which could reduce the magnitude of any population change.

6.1.235 Despite the uncertainty associated with the in-combination estimate, the impact from the Round 4 Plan does not contribute a significant proportion to the in-combination impact.

Kittiwake

Alone

6.1.236 Collision risk modelling has been undertaken for kittiwake using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.99. In the breeding season, there is only connectivity between the Flamborough and Filey Coast SPA and Preferred Projects 1, 2 and 3 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented on the Natural England designated site viewer for Flamborough and Filey Coast SPA (breeding season) and Furness (2015) (post- and pre-breeding seasons).

Table 6.99: Collision risk estimates for kittiwake (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																
				Breeding season				Post-breeding							Pre-breeding						
				PP1	PP2	PP3	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	98.9	73	52	11	136	29	21	5	2	1	2	59	21	15	3	1	0	1	41
			99.0	66	47	10	123	26	19	4	2	1	2	54	19	14	3	1	0	0	37
		8.71	98.9	56	40	8	104	22	16	3	1	1	1	45	16	12	2	0	0	0	31
			99.0	51	36	8	94	20	14	3	1	1	1	41	15	11	2	0	0	0	29
	3	13.1	98.9	82	59	13	154	37	26	6	2	1	2	75	28	20	4	1	0	1	53
			99.0	75	54	12	140	34	24	5	2	1	2	68	25	18	4	1	0	1	49
		8.71	98.9	63	45	9	118	28	20	4	2	1	2	58	21	15	3	1	0	1	41
			99.0	57	41	9	107	26	18	4	2	1	1	52	19	14	3	1	0	0	37
Option 3	2	13.1	98	34	25	4	63	14	10	1	1	0	1	27	10	7	1	0	0	0	19
		8.71	98	30	22	3	55	12	9	1	1	0	0	23	9	6	1	0	0	0	16
	3	13.1	98	39	28	4	71	18	13	2	1	1	1	34	13	9	1	0	0	0	24
		8.71	98	34	24	3	62	15	11	2	1	1	1	30	12	8	1	0	0	0	21

6.1.237 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.100, Table 6.101 and Table 6.102.

Table 6.100: Breeding season apportioning for kittiwake at Flamborough and Filey Coast SPA for the impact from Preferred Project 1

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	7.3	14.5	21.8	29.0	36.3	43.5	50.8	58.0	65.3	72.6
			99.0	6.6	13.2	19.8	26.4	33.0	39.6	46.2	52.8	59.4	66.0
		8.71	98.9	5.6	11.1	16.7	22.3	27.8	33.4	39.0	44.5	50.1	55.7
			99.0	5.1	10.1	15.2	20.2	25.3	30.4	35.4	40.5	45.6	50.6
	3	13.1	98.9	8.2	16.5	24.7	32.9	41.2	49.4	57.6	65.9	74.1	82.3
			99.0	7.5	15.0	22.5	29.9	37.4	44.9	52.4	59.9	67.4	74.9
		8.71	98.9	6.3	12.6	19.0	25.3	31.6	37.9	44.2	50.6	56.9	63.2
			99.0	5.7	11.5	17.2	23.0	28.7	34.5	40.2	46.0	51.7	57.4
Option 3	2	13.1	98	3.4	6.9	10.3	13.8	17.2	20.7	24.1	27.6	31.0	34.5
		8.71	98	3.0	6.0	9.0	12.1	15.1	18.1	21.1	24.1	27.1	30.1
	3	13.1	98	3.9	7.8	11.7	15.6	19.6	23.5	27.4	31.3	35.2	39.1
		8.71	98	3.4	6.8	10.3	13.7	17.1	20.5	23.9	27.4	30.8	34.2

Table 6.101: Breeding season apportioning for kittiwake at Flamborough and Filey Coast SPA for the impact from Preferred Project 2

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	5.2	10.4	15.6	20.8	25.9	31.1	36.3	41.5	46.7	51.9
			99.0	4.7	9.4	14.2	18.9	23.6	28.3	33.0	37.7	42.5	47.2
		8.71	98.9	4.0	8.0	11.9	15.9	19.9	23.9	27.9	31.9	35.8	39.8
			99.0	3.6	7.2	10.9	14.5	18.1	21.7	25.3	29.0	32.6	36.2
	3	13.1	98.9	5.9	11.8	17.7	23.6	29.5	35.3	41.2	47.1	53.0	58.9
			99.0	5.4	10.7	16.1	21.4	26.8	32.1	37.5	42.8	48.2	53.6
		8.71	98.9	4.5	9.0	13.6	18.1	22.6	27.1	31.6	36.2	40.7	45.2
			99.0	4.1	8.2	12.3	16.4	20.5	24.7	28.8	32.9	37.0	41.1
Option 3	2	13.1	98	2.5	4.9	7.4	9.9	12.3	14.8	17.2	19.7	22.2	24.6
		8.71	98	2.2	4.3	6.5	8.6	10.8	12.9	15.1	17.2	19.4	21.6
	3	13.1	98	2.8	5.6	8.4	11.2	14.0	16.8	19.6	22.4	25.2	28.0
		8.71	98	2.4	4.9	7.3	9.8	12.2	14.7	17.1	19.6	22.0	24.5

Table 6.102: Breeding season apportioning for kittiwake at Flamborough and Filey Coast SPA for the impact from Preferred Project 3

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	1.1	2.2	3.4	4.5	5.6	6.7	7.9	9.0	10.1	11.2
			99.0	1.0	2.0	3.1	4.1	5.1	6.1	7.2	8.2	9.2	10.2
		8.71	98.9	0.8	1.7	2.5	3.3	4.2	5.0	5.8	6.7	7.5	8.3
			99.0	0.8	1.5	2.3	3.0	3.8	4.5	5.3	6.0	6.8	7.6
	3	13.1	98.9	1.3	2.6	3.8	5.1	6.4	7.7	8.9	10.2	11.5	12.8
			99.0	1.2	2.3	3.5	4.6	5.8	7.0	8.1	9.3	10.5	11.6
		8.71	98.9	0.9	1.9	2.8	3.8	4.7	5.7	6.6	7.6	8.5	9.5
			99.0	0.9	1.7	2.6	3.4	4.3	5.2	6.0	6.9	7.7	8.6
Option 3	2	13.1	98	0.4	0.7	1.1	1.4	1.8	2.1	2.5	2.9	3.2	3.6
		8.71	98	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.8	3.1
	3	13.1	98	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.1
		8.71	98	0.3	0.7	1.0	1.4	1.7	2.1	2.4	2.8	3.1	3.5

6.1.238 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.100, Table 6.101 and Table 6.102. The three components of the population present at each of the Preferred Projects in the breeding season have been considered (see Annex H.3). The values associated with each of these population components is presented in Table 6.103 and multiplied together to provide an apportioning value for each of the Preferred Projects.

Table 6.103: Breeding season apportioning values for kittiwake at Flamborough and Filey Coast SPA based on the approach applied in Annex H.3

Preferred Project	Proportion of breeding adult birds from SPA	Proportion of immature birds	Proportion of non-breeding birds	Overall breeding season apportioning value
1	0.91	0.44	0.1	0.46
2	0.95	0.44	0.1	0.48
3	0.95	0.44	0.1	0.48

6.1.239 The results of the apportioning approach in Annex H.3 suggest that between 46-48% of the predicted impact at each of the Preferred Projects is attributable to Flamborough and Filey Coast SPA. As mentioned in Section 5.2, the estimated proportion of immature birds in Table 6.103 does not take account of the distribution of immature birds and may therefore over-estimate this component of the population present at each of the Preferred Projects.

6.1.240 The apportioning results in Annex H.3 have been reviewed against relevant site specific data. The estimated proportion of immature birds in Table 6.103 does not take account of the distribution of immature birds and may therefore over-estimate this component of the population present at each of the Preferred Projects. However, immature birds will be present throughout the North Sea in the breeding season as these birds return to natal waters to prospect for future nesting areas and therefore they should be accounted for in the apportioning process. Baseline survey data collected to inform the applications for other offshore wind farms in the North Sea have found high proportions of immature kittiwakes in offshore locations. For example, boat-based surveys used to support the applications for projects in the Hornsea Zone estimated between 4.3-22.5% of the population of kittiwake present consisted of immature birds, with the proportion increasing as distance offshore increased. The distance between Preferred Project 3 and Flamborough and Filey Coast SPA is the same as the distance between the western edge of the Hornsea Zone and the SPA. It is therefore considered appropriate to apply the immature proportion recorded in this area to Preferred Project 3 (i.e. 4.3%, with the lowest of these used on a precautionary basis). Preferred Projects 1 and 2 are located approximately 100-125 km from the SPA, a similar distance to Hornsea Projects 1 and 2. The immature proportion recorded at these projects was 8.9-11.1%, with the lowest of these applied for Preferred Projects 1 and 2 on a precautionary basis. However, with the exception of immatures in their first summer, to which the proportions of immature birds recorded in boat-based surveys of the Hornsea Zone apply, it is not possible to distinguish immature birds from adult birds. To calculate the proportion of these older age classes the approach applied at previous offshore

wind farms (see Ørsted 2018a) has been used. This provides immature proportions of 11.1% (Preferred Project 3) and 23.0-28.7% (Preferred Projects 1 and 2) with the lowest of these used on a precautionary basis.

6.1.241 Combining the relevant proportions for each population component provides apportioning values of 63% for Preferred Project 1 and 66% for Preferred Project 2 and 76% for Preferred Project 3 (Table 6.104).

Table 6.104: Breeding season apportioning values for kittiwake at Flamborough and Filey Coast SPA based on immature proportions recorded in baseline survey data from the Hornsea Zone

Preferred Project	Proportion of breeding adult birds from SPA	Proportion of immature birds	Proportion of non-breeding birds	Overall breeding season apportioning value
1	0.91	0.23	0.1	0.63
2	0.95	0.23	0.1	0.66
3	0.95	0.111	0.1	0.76

6.1.242 The values presented in Table 6.104 are supported by the information presented in Cleasby *et al.* (2018). For Flamborough and Filey Coast SPA, tracking of kittiwake has been undertaken providing information on the foraging areas used by breeding adult birds from the colony. The data associated with Cleasby *et al.* (2018) suggests that all three of the Preferred Projects considered here are located in areas utilised by kittiwake however, Projects 1 and 2 are located in an area outside of the 75% utilisation distribution for kittiwake from the SPA (Figure 6.2) suggesting that the main components of any population found at these two projects may consist of immature and non-breeding birds. Preferred Project 3 intersects an area that is of more importance for kittiwake (Figure 6.2) and therefore a higher apportioning value is considered to be more appropriate.

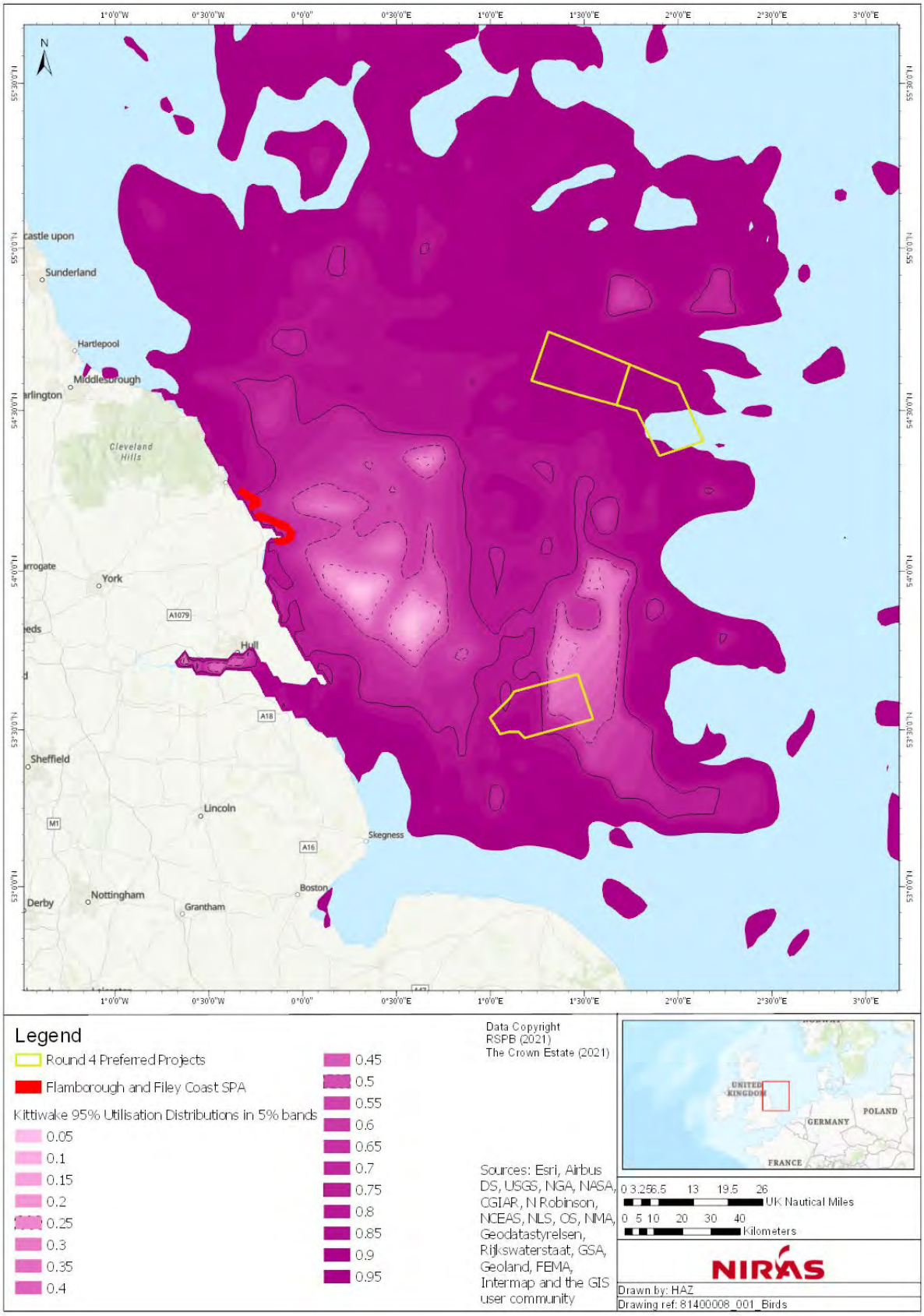


Figure 6.2: Utilisation distributions of kittiwake from Flamborough and Filey Coast SPA (data from Cleasby *et al.*, 2018)

6.1.243 In the post-breeding and pre-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, and pre-breeding seasons for the Preferred Projects in the North Sea are 5.4% and 7.2% and for the Preferred Projects in the Irish Sea are 1.7% and 3.3%. The apportioned values from each of the Preferred Projects combined to the Flamborough and Filey Coast SPA are presented in Table 6.105.

Table 6.105: Apportioning for kittiwake at Flamborough and Filey Coast SPA in the post- and pre-breeding season for the impact from all Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
Option 2	2	13.1	98.9	3.0	2.9
			99.0	2.8	2.6
		8.71	98.9	2.3	2.2
			99.0	2.1	2.0
	3	13.1	98.9	3.9	3.8
			99.0	3.5	3.4
		8.71	98.9	3.0	2.9
			99.0	2.7	2.6
Option 3	2	13.1	98	1.4	1.3
		8.71	98	1.2	1.2
	3	13.1	98	1.8	1.7
		8.71	98	1.6	1.5

6.1.244 The annual apportioned impact for kittiwake at Flamborough and Filey Coast SPA is provided in Table 6.106.

Table 6.106: Calculation of total impact attributable to kittiwake at Flamborough and Filey Coast from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding			Post-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP1	PP2	PP3	All projects	All projects		
Option 2	2	13.1	98.9	45.6	34.2	8.5	3.0	2.9	94.3	0.63
			99.0	41.5	31.1	7.8	2.8	2.6	85.8	0.57
		8.71	98.9	35.0	26.3	6.3	2.3	2.2	72.1	0.48
			99.0	31.8	23.9	5.7	2.1	2.0	65.6	0.44
	3	13.1	98.9	51.8	38.9	9.7	3.9	3.8	108.0	0.72
			99.0	47.1	35.3	8.8	3.5	3.4	98.2	0.65
		8.71	98.9	39.7	29.8	7.2	3.0	2.9	82.6	0.55
			99.0	36.1	27.1	6.5	2.7	2.6	75.1	0.50
Option 3	2	13.1	98	21.7	16.3	2.7	1.4	1.3	43.4	0.29
		8.71	98	19.0	14.2	2.3	1.2	1.2	37.9	0.25
	3	13.1	98	24.6	18.5	3.1	1.8	1.7	49.6	0.33
		8.71	98	21.5	16.2	2.6	1.6	1.5	43.4	0.29

6.1.245 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.106 is considered to be 37.9 – 43.4 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that kittiwake densities from the MERP dataset potentially underestimate kittiwake abundance.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.

6.1.246 An impact of 37.9 – 43.4 collisions/annum represents 0.25-0.29% of the baseline mortality of the Flamborough and Filey Coast SPA kittiwake population (51,535 pairs). When considering the highest impact estimated in Table 6.106, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 94.3-108.0 collisions/annum represents an increase in baseline mortality of 0.63-0.72%.

6.1.247 There is some uncertainty about how the kittiwake population that is designated as part of the Flamborough and Filey Coast SPA has changed since the 1970s (http://jncc.defra.gov.uk/page-2889) and it has been argued that the population may have been somewhat higher than it is now (see submissions during the Hornsea Project One and Hornsea Project Two examinations and critique of these counts provided in Coulson (2011)). However, since the Seabird 2000 census the number of kittiwake at the Flamborough and Filey Coast SPA has increased by 7.8% (JNCC, 2021). It has, however, been assumed for the purposes of modelling that the population has recently been relatively stable, perhaps showing a slight increase.

6.1.248 A maximum growth rate of 13.3% has been calculated for kittiwake (following Niel and Lebreton, 2005).

6.1.249 The timeframes of the Preferred Projects are not yet known and therefore consideration has been given to a range of project lifetimes when interpreting PVA outputs. Project lifetimes of 20, 40 and 60 years have therefore been considered.

6.1.250 If additional mortality of 37.9 – 43.4 collisions/annum is assumed then the model predicts a counterfactual of growth rate of 0.999-1.000 (a reduction of 0.1% or less) after 20, 40 and 60 years. Under this impact scenario, the predicted counterfactual median impacted population size would be approximately 98.9-99.1% of that which the model predicts would occur in the absence of any additional impact from the Plan alone after 20 years, 98.0-98.2% after 40 years and 97.0-97.4% after 60 years. This is a relative reduction in population size (compared to that which might otherwise have arisen). The model predicts a positive growth rate, and so the impacted population after 60 years would still be larger than that which was assumed for the initiation of the modelling exercise (i.e. the designated population at the Flamborough and Filey Coast SPA).

6.1.251 The current population at the Flamborough and Filey Coast SPA is nearly 16% higher than the cited population and for those years for which complete colony counts exist the population has increased approximately 8% since the Seabird 2000. Recent years suggest a positive growth rate (e.g. 2.1% between 2008 and 2017 and 1.0% between 2016 and 2017, although note that this is only two years). PVA modelling predicts (without any density-dependence taken into

account which almost certainly operate) that the population of kittiwake at the Flamborough and Filey Coast SPA would still continue to increase however, over the assumed lifetimes of the Preferred Projects that comprise the Round 4 Plan the resultant population would represent 97.0-99.1% of the population that would occur without the presence of additional in-combination mortality. Therefore there is no indication, based on the results of the PVA, that additional mortality from the Round 4 Plan alone would result in the population declining below the cited population.

6.1.252 It is important to note that the PVA modelling conducted does not give consideration to density dependent compensation of demographic parameters within the modelled population, nor immigration, both of which could reduce the magnitude of any population change.

6.1.253 On the basis of the above, the impact from the Round 4 Plan is considered to be sustainable. However, in light of advice from Natural England on the most recent offshore windfarm planning applications, and the decision made by the Secretary of State in relation to Hornsea Three's impacts on the kittiwake feature of the Flamborough and Filey Coast SPA, consideration has been given to available mitigation options to reduce the impacts associated with the Round 4 Plan. This analysis is presented in Annex H.6 and indicates that the predicted impact of the Round 4 Plan can be reduced to an impact representing less than a 0.5% increase in baseline mortality under all of the scenarios considered by changing the turbine design (increasing hub height) at Preferred Projects 1 and 2.

In-combination

6.1.254 Natural England have previously advised that the current level of in-combination mortality estimated for the kittiwake feature of the Flamborough and Filey Coast SPA represents an adverse effect on the integrity of the SPA. On this basis, it should be assumed the in-combination contribution from the Round 4 Plan would not be indiscernible. Therefore, the in-combination impact of the Round 4 Plan alone has been explored further, below.

6.1.255 Seasonal collision risk estimates for all projects considered in-combination, where available, are presented in Annex H.4. The projects considered in the breeding season are those within the mean-maximum foraging range plus one standard deviation of kittiwake from the Flamborough and Filey Coast SPA. Apportioning values applied in the breeding season for each relevant project have been sourced from relevant project-specific documentation where available. Where a project-specific apportioning value is unavailable, and the project is within the mean-maximum foraging range of kittiwake from the Flamborough and Filey Coast SPA an apportioning value of 100% has been assumed. For projects within the mean-maximum foraging range plus one standard deviation it is considered highly unlikely that a significant proportion of birds from the SPA will occur at the projects considered in-combination. However, on a precautionary basis a 10% apportioning rate has been applied unless a site-specific rate is available. The total in-combination values are presented in Table 6.107 for each of the cumulative tiers considered in the HRA (see Appendix A and B).

Table 6.107: Calculation of the in-combination impact attributable to the kittiwake feature at the Flamborough and Filey Coast SPA

Tier	Breeding	Post-breeding	Pre-breeding	Total
Round 4 Plan	35.5-40.3	1.2-1.6	1.2-1.5	37.9 – 43.4

Tier	Breeding	Post-breeding	Pre-breeding	Total
1	95	13	9	117
2	127	62	69	257
3	46	20	9	75
4	59	6	5	70
Total	362-367	102-103	93	557-563

6.1.256 Natural England have previously advised that the current level of in-combination mortality estimated for the kittiwake feature of the Flamborough and Filey Coast SPA represents an adverse effect on the integrity of the SPA. It is however, worth considering a number of considerable uncertainties associated with the values for projects considered in-combination that are incorporated into the totals presented in Table 6.98. These include:

- Compounding high levels of precaution. Many of the in-combination values presented are those advocated by Natural England, which incorporated high levels of precaution throughout the assessment which has the potential to compound precaution and lead to highly inflated impact magnitudes. If high levels of precaution are applied across the assessments for all projects considered in-combination this can lead to highly inflated in-combination impacts.
- The apportioning values associated with many projects are considered to be highly precautionary, not accounting for immature birds, non-breeding birds and adult breeding birds from other colonies. The first of these two components will be present throughout the North Sea and should therefore be accounted for in apportioning values derived for the breeding season.
- The collision mortality associated with Hornsea Three is included in the values in Table 6.107 however, the impact associated with Hornsea Three is subject to compensation measures and it is expected that this impact will therefore be fully compensated for.
- The changes to turbine scenarios that occur between consent decisions and eventual as-built designs. This can lead to significant reductions in the collision risk estimates associated with a Project. For example, for kittiwake Ørsted (2018b) estimated that changes to turbine scenarios at those projects considered in-combination could lead to a reduction in the in-combination total of 38% for projects that were already built at that time or 15% when including projects that were yet to be built.
- Collision risk modelling undertaken to support the applications of previous offshore wind farm projects have had to use information that, based on evidence that has subsequently been collected, leads to an over-estimation of the project's effect on certain species. This is especially relevant to flight speed and nocturnal activity factors.
- Future impacts associated with plans and projects in Tiers 5 and 6 are not included in the in-combination assessment due to the development stage of the plan or project (and therefore the uncertainty as to whether the plan or project will come to fruition and therefore contribute to the in-combination impact) and/or high levels of uncertainty associated with the available impacts.

6.1.257 There is some uncertainty about how the kittiwake population that is designated as part of the Flamborough and Filey Coast SPA has changed since the 1970s (http://jncc.defra.gov.uk/page-2889) and it has been argued that the population may have been somewhat higher than it is now (see submissions during the Hornsea Project One and Hornsea Project Two examinations and critique of these counts provided in Coulson (2011)). However, since the Seabird 2000 census the number of kittiwake at the Flamborough and Filey Coast SPA has increased by 7.8% (JNCC, 2021). It has, however, been assumed for the purposes of modelling that the population has recently been relatively stable, perhaps showing a slight increase.

6.1.258 A maximum growth rate of 13.3% has been calculated for kittiwake (following Niel and Lebreton, 2005).

6.1.259 The timeframes of the Preferred Projects are not yet known and therefore consideration has been given to a range of project lifetimes when interpreting PVA outputs. Project lifetimes of 20, 40 and 60 years have therefore been considered.

6.1.260 If additional mortality of 557-563 birds/annum is assumed then the model predicts a counterfactual of growth rate of 0.994 (a 0.6% reduction) after 20, 40 and 60 years. Under this impact scenario, the predicted counterfactual median impacted population size would be approximately 87.2-87.4% of that which the model predicts would occur in the absence of any additional impact from the Plan alone in-combination with other Plans and Projects after 20 years, 76.6-76.9% after 40 years and 67.3-67.5% after 60 years. This is a relative reduction in population size (compared to that which might otherwise have arisen). The model predicts a positive growth rate, and so the impacted population after 60 years would still be larger than that which was assumed for the initiation of the modelling exercise (i.e. the designated population at the Flamborough and Filey Coast SPA).

6.1.261 The current population at the Flamborough and Filey Coast SPA is nearly 16% higher than the cited population and for those years for which complete colony counts exist the population has increased approximately 8% since the Seabird 2000. Recent years suggest a positive growth rate (e.g. 2.1% between 2008 and 2017 and 1.0% between 2016 and 2017, although note that this is only two years). PVA modelling predicts (without any density-dependence taken into account which almost certainly operate) that the population of kittiwake at the Flamborough and Filey Coast SPA would still continue to increase however, over the assumed lifetimes of the Preferred Projects that comprise the Round 4 Plan the resultant population would represent 67.3-87.4% of the population that would occur without the presence of additional in-combination mortality. Therefore there is no indication, based on the results of the PVA, that additional mortality from the Round 4 Plan alone or in-combination would result in the population declining below the cited population.

6.1.262 There are a number of uncertainties associated with the PVA modelling, these include:

- Over-estimation of in-combination impacts. The PVA modelling does not account for changes in the predicted in-combination due to the decommissioning of projects considered in-combination. Although it is noted that some Tier 5 and 6 projects could be commissioned, over the lifetime of the Round 4 Plan the in-combination impact will reduce when licences for current projects expire and decommissioning occurs. The PVA metrics are therefore precautionary.

- No consideration has been made for density dependent compensation of demographic parameters within the modelled population, nor immigration, both of which could reduce the magnitude of any population change.

6.1.263 Notwithstanding the above, the predicted impact of the Round 4 Plan in-combination exceeds that assumed by the Secretary of State for the Department for Business Energy and Industrial Strategy when concluding, recently, that the application for the Hornsea Three offshore windfarm would lead to an adverse effect on the integrity of the Flamborough and Filey Coast SPA. This decision was made in view of advice from Natural England, who consider that the Flamborough and Filey Coast SPA has a restore conservation objective and that the in-combination effects of other wind farms is already unsustainable. As such, in Natural England's view, there is no safe limit for any additional impact arising from projects or plans when considered together with the existing scale of in-combination effects. In line with the Secretary of State's decision, and notwithstanding the results of the population modelling and the reduction in collisions expected from mitigation, the impact calculated for the Round 4 Plan in-combination is also considered to be unsustainable.

Guillemot

Alone

6.1.264 Displacement analysis has been undertaken for guillemot using the approach advised in JNCC *et al.* (2017) (Annex H.1). To account for uncertainty in the analysis approach a range of displacement and mortality rates have been applied following the recommended approach to defining these in JNCC *et al.* (2017). Table 6.108 presents the unapportioned seasonal displacement mortality for guillemot at each of the Preferred Projects using the appropriate range of displacement and mortality rates. In the breeding season, there is only connectivity between the Flamborough and Filey Coast SPA and Preferred Projects 1, 2 and 3 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented on Natural England's designated site viewer (breeding season) and in Furness (2015) (non-breeding season).

Table 6.108: Displacement mortality for guillemot at each of the Preferred Projects (unapportioned values) (no. of birds)

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
1	30	5	11	27	55	7	13	33	67
	50	9	18	45	91	11	22	56	112
	70	13	25	64	127	16	31	78	156
2	30	5	9	24	47	6	12	30	60
	50	8	16	40	79	10	20	50	100
	70	11	22	55	111	14	28	70	140
3	30	5	9	23	46	6	11	29	57
	50	8	15	38	76	10	19	48	95
	70	11	21	53	107	13	27	67	134
4	30	N/A				2	4	10	20
	50	N/A				3	7	17	34
	70	N/A				5	9	24	47
5	30	N/A				1	1	3	6
	50	N/A				1	2	5	10
	70	N/A				1	3	7	14
6	30	N/A				1	3	7	13

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
	50	N/A				2	4	11	22
	70	N/A				3	6	16	31

6.1.265 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.109.

Table 6.109: Breeding season apportioning for guillemot at Flamborough and Filey Coast SPA for the impact from all Preferred Projects with connectivity in the breeding season

Preferred Project	Displacement / mortality rate (%)	Apportioning value (%)									
		10	20	30	40	50	60	70	80	90	100
1	30 / 1	0.5	1.1	1.6	2.2	2.7	3.3	3.8	4.4	4.9	5.5
	50 / 5	4.5	9.1	13.6	18.2	22.7	27.3	31.8	36.3	40.9	45.4
	70 / 10	12.7	25.4	38.2	50.9	63.6	76.3	89.0	101.8	114.5	127.2
2	30 / 1	0.5	0.9	1.4	1.9	2.4	2.8	3.3	3.8	4.3	4.7
	50 / 5	4.0	7.9	11.9	15.8	19.8	23.7	27.7	31.6	35.6	39.6
	70 / 10	11.1	22.2	33.2	44.3	55.4	66.5	77.5	88.6	99.7	110.8
3	30 / 1	0.5	0.9	1.4	1.8	2.3	2.7	3.2	3.7	4.1	4.6
	50 / 5	3.8	7.6	11.4	15.3	19.1	22.9	26.7	30.5	34.3	38.1
	70 / 10	10.7	21.4	32.0	42.7	53.4	64.1	74.8	85.4	96.1	106.8

6.1.266 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.109. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All of the Preferred Projects are beyond the mean-maximum foraging range of guillemot from the Flamborough and Filey Coast SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. All of the Preferred Projects are however, within the foraging range of guillemot when using the mean-maximum foraging range plus one standard deviation (153.7 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual guillemots from the Flamborough and Filey Coast SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of displacement mortality.

6.1.267 There is no site-specific foraging range data available for guillemot from the Flamborough and Filey Coast SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Flamborough and Filey Coast SPA then this should only be a limited amount (e.g. 10%).

6.1.268 In the non-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning value used for the Preferred Projects in the North Sea is 4.4% and for the Preferred Projects in the Irish Sea is 0%. The apportioned values from each of the Preferred Projects combined to the Flamborough and Filey Coast SPA are presented in Table 6.110.

Table 6.110: Apportioned displacement mortality for guillemot at the Flamborough and Filey Coast SPA in non-breeding season

Displacement / mortality rate (%)	Preferred Project						Total
	1	2	3	4	5	6	
30 / 1	0.3	0.3	0.3	0.0	0.0	0.0	0.8
50 / 5	2.5	2.2	2.1	0.0	0.0	0.0	6.8
70 / 10	6.9	6.2	5.9	0.0	0.0	0.0	18.9

6.1.269 The annual apportioned impact for guillemot at the Flamborough and Filey Coast SPA is provided in Table 6.111.

Table 6.111: Calculation of the annual impact attributable to guillemot at the Flamborough and Filey Coast SPA from the Round 4 Plan alone

Displacement / mortality assumptions	Breeding season			Non-breeding season						Total	Increase in baseline mortality (%)
	PP1	PP2	PP3	PP1	PP2	PP3	PP4	PP5	PP6		
30 / 1	0.5	0.5	0.5	0.3	0.3	0.3	0.0	0.0	0.0	2.3	0.0
50 / 5	4.5	4.0	3.8	2.5	2.2	2.1	0.0	0.0	0.0	19.1	0.4
70 / 10	12.7	11.1	10.7	6.9	6.2	5.9	0.0	0.0	0.0	53.4	1.1

6.1.270 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.111 is considered to be 19.1 birds. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that guillemot densities from the MERP dataset potentially underestimate guillemot abundance.
- The apportioning value applied in the breeding season, it is unlikely that a significant proportion of guillemot from the Flamborough and Filey Coast SPA will utilize the Preferred Project areas and the assumption of 10% is likely an over-estimate but is applied on a precautionary basis.

6.1.271 A wider range of displacement rates are defined in JNCC *et al.* (2017) and these have been considered in the displacement analyses conducted. A precautionary approach has also been applied when considering the apportioning value to apply for all Preferred Projects with all three of the Preferred Projects beyond the mean-maximum foraging range of guillemot from Flamborough and Filey Coast SPA.

6.1.272 An impact of 19.1 birds represents 0.4% of the baseline mortality of the Flamborough and Filey Coast SPA guillemot population (83,214 breeding adults). When considering the impact associated with the most precautionary assumptions considered in Table 6.111, which is considered unrealistic due to an over-application of precaution, an annual displacement mortality of 53.4 birds is estimated. This represents an increase in baseline mortality of 1.1%. However, there are considered to be significant assumptions which lead to over-estimation associated with the predicted displacement mortality.

6.1.273 The population of guillemot at the Flamborough and Filey Coast SPA has increased considerably in recent years. The observed rate of increase in the number of guillemot at the Flamborough and Filey Coast SPA was approximately 3.2% per year between 1987 and 2017 and 3.6% per year between 2000 and 2017. The maximum predicted growth rate for this species is 7.1%, calculated using the method proposed by Niel & Lebreton (2005).

6.1.274 The timeframes of the Preferred Projects are not yet known and therefore consideration has been given to a range of project lifetimes when interpreting PVA outputs. Project lifetimes of 20, 40 and 60 years have therefore been considered.

6.1.275 If additional mortality of 19.1 birds/annum is assumed then the model predicts a counterfactual of growth rate of 1.000 (a reduction of less than 0.1%) after 20, 40 and 60 years. Under this impact scenario, the predicted counterfactual median impacted population size would be approximately 99.6% of that which the model predicts would occur in the absence of any additional impact from the Plan alone after 20 years, 99.3% after 40 years and 98.9% after 60 years. This is a relative reduction in population size (compared to that which might otherwise have arisen). The model predicts a positive growth rate, and so the impacted population after 60 years would still be larger than that which was assumed for the initiation of the modelling exercise (i.e. the designated population at the Flamborough and Filey Coast SPA).

6.1.276 The current population at the Flamborough and Filey Coast SPA (60,887 pairs) is approximately 46% higher than the cited population and the population has increased 95% since the Seabird 2000. PVA modelling predicts that the population of guillemot at the Flamborough and Filey Coast SPA would still continue to increase however, over the lifetime of the Round 4 Plan the resultant population

would represent 98.9-99.6% of the population that would occur without the presence of the Round 4 Plan alone. Therefore there is no indication, based on the results of the PVA, that additional mortality from the Round 4 Plan alone would result in the population declining below the cited population.

6.1.277 It is important to note that the PVA modelling conducted does not give consideration to density dependent compensation of demographic parameters within the modelled population, nor immigration, both of which could reduce the magnitude of any population change.

In-combination

6.1.278 Seasonal population estimates for all projects considered in-combination, where available, are presented in Annex H.4. The projects considered in the breeding season are those within the mean-maximum foraging range plus one standard deviation of guillemot from Flamborough and Filey Coast SPA as presented in Woodward *et al.* (2019). Apportioning values applied in the breeding season for each relevant project have been sourced from relevant project-specific documentation where available. Where a project-specific apportioning value is unavailable, and the project is within the mean-maximum foraging range of guillemot from the Flamborough and Filey Coast SPA an apportioning value of 100% has been assumed. For projects within the mean-maximum foraging range plus one standard deviation it is considered highly unlikely that a significant proportion of birds from the SPA will occur at the projects considered in-combination. However, on a precautionary basis a 10% apportioning rate has been applied unless a site-specific rate is available. The total in-combination values are presented in Table 6.107 for each of the cumulative tiers considered in the HRA (see Appendix A and B). A displacement rate of 50% and mortality rate of 5% have been applied for all projects. The apportioning rates presented in Annex H.3 have been applied in the non-breeding season.

Table 6.112: Calculation of the in-combination impact attributable to the guillemot feature at the Flamborough and Filey Coast SPA

Tier	Breeding	Non-breeding	Total
Round 4 Plan	12.3	6.8	19.1
1	49	26	75
2	155	46	200
3	0	63	63
4	119	43	163
Total	335	185	520

6.1.279 The total in-combination displacement mortality represents 7.5% of the baseline mortality of the Flamborough and Filey Coast SPA population. There are, however, uncertainties associated with the values for projects considered in-combination presented in Table 6.107. These include:

- Compounding high levels of precaution. Many of the in-combination values presented are those advocated by Natural England, which incorporated high levels of precaution throughout the assessment which

has the potential to compound precaution and lead to highly inflated impact magnitudes. If high levels of precaution are applied across the assessments for all projects considered in-combination this can lead to highly inflated in-combination impacts.

- The apportioning values associated with many projects are considered to be highly precautionary, not accounting for immature birds, non-breeding birds and adult breeding birds from other colonies. The first of these two components will be present throughout the North Sea and should therefore be accounted for in apportioning values derived for the breeding season.
- Future impacts associated with plans and projects in Tiers 5 and 6 are not included in the in-combination assessment due to the development stage of the plan or project (and therefore the uncertainty as to whether the plan or project will come to fruition and therefore contribute to the in-combination impact) and/or high levels of uncertainty associated with the available impacts.

6.1.280 The population of guillemot at the Flamborough and Filey Coast SPA has increased considerably in recent years. The observed rate of increase in the number of guillemot at the Flamborough and Filey Coast SPA was approximately 3.2% per year between 1987 and 2017 and 3.6% per year between 2000 and 2017. The maximum predicted growth rate for this species is 7.1%, calculated using the method proposed by Niel & Lebreton (2005).

6.1.281 The timeframes of the Preferred Projects are not yet known and therefore consideration has been given to a range of project lifetimes when interpreting PVA outputs. Project lifetimes of 20, 40 and 60 years have therefore been considered.

6.1.282 If additional mortality of 520 birds/annum is assumed then the model predicts a counterfactual of growth rate of 0.995 (a 0.5% reduction) after 20, 40 and 60 years. Under this impact scenario, the predicted counterfactual median impacted population size would be approximately 90.4% of that which the model predicts would occur in the absence of any additional impact from the Plan alone in-combination with other Plans and Projects after 20 years, 82.1% after 40 years and 74.5% after 60 years. This is a relative reduction in population size (compared to that which might otherwise have arisen). The model predicts a positive growth rate, and so the impacted population after 60 years would still be larger than that which was assumed for the initiation of the modelling exercise (i.e. the designated population at the Flamborough and Filey Coast SPA).

6.1.283 There are a number of uncertainties associated with the PVA modelling, these include:

- Over-estimation of in-combination impacts. The PVA modelling does not account for changes in the predicted in-combination due to the decommissioning of projects considered in-combination. Although it is noted that some Tier 5 and 6 projects could be commissioned, over the lifetime of the Round 4 Plan the in-combination impact will reduce when licences for current projects expire and decommissioning occurs. The PVA metrics are therefore precautionary.
- No consideration has been made for density dependent compensation of demographic parameters within the modelled population, nor immigration, both of which could reduce the magnitude of any population change.

6.1.284 The current population at the Flamborough and Filey Coast SPA (60,887 pairs) is approximately 46% higher than the cited population and the population has

increased 95% since the Seabird 2000. PVA modelling predicts that the population of guillemot at the Flamborough and Filey Coast SPA would still continue to increase however, over the lifetime of the Round 4 Plan the resultant population would represent 74.5-90.4% of the population that would occur without the presence of the Round 4 Plan in-combination with other Plans and Projects. Therefore there is no indication, based on the results of the PVA, that additional mortality from the Round 4 Plan alone or in-combination would result in the population declining below the cited population.

Razorbill

Alone

6.1.285 Displacement analysis has been undertaken for razorbill using the approach advised in JNCC *et al.* (2017) (Annex H.1). To account for uncertainty in the analysis approach a range of displacement and mortality rates have been applied following the recommended approach to defining these in JNCC *et al.* (2017). Table 6.113 presents the unapportioned seasonal displacement mortality for razorbill at each of the Preferred Projects using the appropriate range of displacement and mortality rates. In the breeding season, there is only connectivity between the Flamborough and Filey Coast SPA and Preferred Projects 1, 2 and 3 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) (non-breeding seasons).

Table 6.113: Displacement mortality for razorbill at each of the Preferred Projects (unapportioned values) (no. of birds)

Preferred Project	Displacement rate (%)	Mortality rate (%)															
		Breeding				Post-breeding				Non-breeding				Pre-breeding			
		1	2	5	10	1	2	5	10	1	2	5	10	1	2	5	10
1	30	0	1	2	3	1	1	4	7	1	2	5	9	1	2	5	11
	40	0	1	2	4	1	2	5	10	1	3	6	13	1	3	7	14
	70	1	2	4	8	2	3	9	17	2	4	11	22	2	5	12	25
2	30	0	1	1	3	1	1	3	6	1	2	4	8	1	2	5	9
	40	0	1	2	4	1	2	4	8	1	2	5	10	1	2	6	12
	70	1	1	3	6	1	3	7	13	2	4	9	18	2	4	11	21
3	30	0	1	1	3	1	1	3	6	1	1	4	7	1	2	4	8
	40	0	1	2	3	1	1	4	7	1	2	5	10	1	2	6	11
	70	1	1	3	6	1	3	7	13	2	3	9	17	2	4	10	20
4	30	N/A				0	1	1	3	0	1	2	4	0	1	2	4
	40	N/A				0	1	2	4	0	1	2	5	1	1	3	5
	70	N/A				1	1	3	7	1	2	4	8	1	2	5	10
5	30	N/A				0	0	0	1	0	0	1	1	0	0	1	1
	40	N/A				0	0	1	1	0	0	1	2	0	0	1	2

Preferred Project	Displacement rate (%)	Mortality rate (%)															
		Breeding				Post-breeding				Non-breeding				Pre-breeding			
		1	2	5	10	1	2	5	10	1	2	5	10	1	2	5	10
	70	N/A				0	0	1	2	0	1	1	3	0	1	2	3
6	30	N/A				0	0	1	2	0	0	1	2	0	0	1	2
	40	N/A				0	0	1	2	0	1	1	3	0	1	2	3
	70	N/A				0	1	2	4	1	1	3	5	1	1	3	6

6.1.286 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.114.

Table 6.114: Breeding season apportioning for razorbill at Flamborough and Filey Coast SPA for the impact from all Preferred Projects with connectivity in the breeding season

Preferred Project	Displacement / mortality rate (%)	Apportioning value (%)									
		10	20	30	40	50	60	70	80	90	100
1	30 / 1	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3
	40 / 5	0.2	0.4	0.7	0.9	1.1	1.3	1.6	1.8	2.0	2.2
	70 / 10	0.8	1.6	2.3	3.1	3.9	4.7	5.4	6.2	7.0	7.8
2	30 / 1	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3
	40 / 5	0.2	0.4	0.5	0.7	0.9	1.1	1.3	1.5	1.6	1.8
	70 / 10	0.6	1.3	1.9	2.5	3.2	3.8	4.5	5.1	5.7	6.4
3	30 / 1	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3
	40 / 5	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.6	1.7
	70 / 10	0.6	1.2	1.8	2.4	3.0	3.6	4.2	4.8	5.4	6.0

6.1.287 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.114. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All of the Preferred Projects are beyond the mean-maximum foraging range of razorbill from the Flamborough and Filey Coast SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. All of the Preferred Projects are however, within the foraging range of razorbill when using the mean-maximum foraging range plus one standard deviation (164.6 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al.* (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual razorbills from the Flamborough and Filey Coast SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of displacement mortality.

6.1.288 There is no site-specific foraging range data available for razorbill from the Flamborough and Filey Coast SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Flamborough and Filey Coast SPA then this should only be a limited amount (e.g. 10%).

6.1.289 In the post-, non- and pre-breeding seasons, the apportioning values presented in Annex H.3 have been applied. In the North Sea the apportioning values used in the post-, non- and pre-breeding seasons 3.4%, 2.7% and 3.4%, respectively and for the Preferred Projects in the Irish Sea the values are 0%, 0.06% and 0%, respectively. The apportioned values from each of the Preferred Projects combined to the Flamborough and Filey Coast SPA are presented in Table 6.115.

Table 6.115: Apportioned displacement mortality for razorbill at the Flamborough and Filey Coast SPA in non-breeding seasons

Preferred Project	Displacement rate (%)	Mortality rate (%)	Apportioned values		
			Post-breeding	Non-breeding	Pre-breeding
1	30	1	0.0	0.0	0.0
	40	5	0.2	0.2	0.2
	70	10	0.6	0.6	0.8

Preferred Project	Displacement rate (%)	Mortality rate (%)	Apportioned values		
			Post-breeding	Non-breeding	Pre-breeding
2	30	1	0.0	0.0	0.0
	40	5	0.1	0.1	0.2
	70	10	0.4	0.5	0.7
3	30	1	0.0	0.0	0.0
	40	5	0.1	0.1	0.2
	70	10	0.4	0.5	0.7
4	30	1	0.0	0.0	0.0
	40	5	0.1	0.1	0.1
	70	10	0.2	0.2	0.3
5	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.1	0.1	0.1
6	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.1
	70	10	0.1	0.1	0.2
Total	30	1	0.1	0.1	0.1
	40	5	0.5	0.6	0.8
	70	10	1.9	2.0	2.8

6.1.290 The annual apportioned impact for razorbill at the Flamborough and Filey Coast SPA is provided in Table 6.116.

Table 6.116: Calculation of the annual impact attributable to razorbill at the Flamborough and Filey Coast SPA from the Round 4 Plan alone

Displacement / mortality assumptions	Breeding season			Non-breeding seasons (post-, non- and pre-seasons combined)						Total	Increase in baseline mortality (%)
	PP1	PP2	PP3	PP1	PP2	PP3	PP4	PP5	PP6		
30 / 1	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.4	0.0
40 / 5	0.2	0.2	0.2	0.6	0.5	0.4	0.2	0.1	0.1	2.5	0.1
70 / 10	0.8	0.6	0.6	2.0	1.7	1.6	0.8	0.2	0.5	8.8	0.4

6.1.291 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.116 is considered to be 2.5 birds. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that razorbill densities from the MERP dataset potentially underestimate razorbill abundance.
- The apportioning value applied in the breeding season, it is unlikely that a significant proportion of razorbill from the Flamborough and Filey Coast SPA will utilize the Preferred Project areas and the assumption of 10% is likely an over-estimate but is applied on a precautionary basis.

6.1.292 A wider range of displacement rates are defined in JNCC *et al.* (2017) and these have been considered in the displacement analyses conducted. A precautionary approach has also been applied when considering the apportioning value to apply for all Preferred Projects with all three of the Preferred Projects beyond the mean-maximum foraging range of razorbill from Flamborough and Filey Coast SPA.

6.1.293 An impact of 2.5 birds represents 0.1% of the baseline mortality of the Flamborough and Filey Coast SPA razorbill population (21,140 breeding adults). When considering the impact associated with the most precautionary assumptions considered in Table 6.116, which is considered unrealistic due to an over-application of precaution, an annual displacement mortality of six birds is estimated. This represents an increase in baseline mortality of 0.3%. Under any of the scenarios presented, the actual displacement mortality is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.294 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Flamborough and Filey Coast SPA.

Puffin

Alone

6.1.295 Displacement analysis has been undertaken for puffin using the approach advised in JNCC *et al.* (2017) (Annex H.1). To account for uncertainty in the analysis approach a range of displacement and mortality rates have been applied following the recommended approach to defining these in JNCC *et al.* (2017). Table 6.117 presents the unapportioned seasonal displacement mortality for puffin at each of the Preferred Projects using the appropriate range of displacement and mortality rates. In the breeding season, there is only connectivity between the Flamborough and Filey Coast SPA and Preferred Projects 1, 2 and 3 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.117: Displacement mortality for puffin at each of the Preferred Projects (unapportioned values) (no. of birds)

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
1	30	0	1	2	5	1	2	4	8
	50	1	2	4	8	1	3	6	13
	70	1	2	5	11	2	4	9	18
2	30	0	1	2	3	1	1	3	5
	50	1	1	3	5	1	2	5	9
	70	1	1	4	7	1	3	6	13
3	30	0	1	2	3	1	1	3	6
	50	1	1	3	5	1	2	5	9
	70	1	1	4	7	1	3	6	13
4	30	N/A				0	0	0	0
	50	N/A				0	0	0	0
	70	N/A				0	0	0	0
5	30	N/A				0	0	0	0
	50	N/A				0	0	0	0
	70	N/A				0	0	0	0
6	30	N/A				0	0	0	0

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
	50	N/A				0	0	0	0
	70	N/A				0	0	0	0

6.1.296 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.118.

Table 6.118: Breeding season apportioning for puffin at Flamborough and Filey Coast SPA for the impact from all Preferred Projects with connectivity in the breeding season

Preferred Project	Displacement / mortality rate (%)	Apportioning value (%)									
		10	20	30	40	50	60	70	80	90	100
1	30 / 1	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5
	50 / 5	0.4	0.8	1.2	1.5	1.9	2.3	2.7	3.1	3.5	3.8
	70 / 10	1.1	2.1	3.2	4.3	5.4	6.4	7.5	8.6	9.7	10.7
2	30 / 1	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3
	50 / 5	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.0	2.3	2.6
	70 / 10	0.7	1.4	2.1	2.9	3.6	4.3	5.0	5.7	6.4	7.2
3	30 / 1	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3
	50 / 5	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.4	2.6
	70 / 10	0.7	1.5	2.2	2.9	3.7	4.4	5.1	5.9	6.6	7.3

6.1.297 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.118. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All three of the Preferred Projects are within the mean-maximum foraging range of puffin from Flamborough and Filey Coast SPA. Preferred Project 2 is on the edge of the mean-maximum foraging range, with the centre of the wind farm, used in the apportioning approach in Annex H.3 lying outside of the mean-maximum foraging range. As a result the apportioning value calculated for Preferred Project 2 is 0%. For the remaining two Preferred Projects, the three components of the population present at each project have been considered (see Annex H.3). The values associated with each of these population components are presented in Table 6.119 and multiplied together to provide an apportioning value for each of the Preferred Projects.

Table 6.119: Breeding season apportioning values for puffin at Flamborough and Filey Coast SPA based on the approach applied in Annex H.3

Preferred Project	Proportion of breeding adult birds from SPA	Proportion of immature birds	Proportion of non-breeding birds	Overall breeding season apportioning value
1	1	0.48	0.07	0.49
3	1	0.48	0.07	0.49

6.1.298 The results of the apportioning approach in Annex H.3 suggest that approximately 49% of the predicted impact at each of the Preferred Projects is attributable to Flamborough and Filey Coast SPA. As mentioned in Section 5.2, the estimated proportion of immature birds in Table 6.119 does not take account of the distribution of immature birds and may therefore over-estimate this component of the population present at each of the Preferred Projects. However, baseline survey data collected to support the applications for projects in the Hornsea Zone have found significant numbers of immature puffins (those birds in their first year) in the areas in the Hornsea Zone at a distance from the coast similar to the Preferred Projects (50.0-58.6%). These proportions represent only birds in their first year and as puffins do not breed until their fifth year and show increasing fidelity to natal waters as age increases, the actual proportion of immature birds present in the North Sea is likely to be much higher. On a precautionary basis however, the apportioning value calculated in Table 6.119, which is the same for Preferred Project 1 and 3 is applied to all three of the Preferred Projects.

6.1.299 In the non-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning value used for the Preferred Projects in the North Sea is 0.4% and for the Preferred Projects in the Irish Sea is 0.04%. The apportioned values from each of the Preferred Projects combined to the Flamborough and Filey Coast SPA are presented in Table 6.120.

Table 6.120: Apportioned displacement mortality for puffin at the Flamborough and Filey Coast SPA in non-breeding season

Displacement / mortality rate (%)	Preferred Project						Total
	1	2	3	4	5	6	
30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50 / 5	0.0	0.0	0.0	0.0	0.0	0.0	0.1
70 / 10	0.1	0.1	0.1	0.0	0.0	0.0	0.2

6.1.300 The annual apportioned impact for puffin at the Flamborough and Filey Coast SPA is provided in Table 6.121.

Table 6.121: Calculation of the annual impact attributable to puffin at the Flamborough and Filey Coast SPA from the Round 4 Plan alone

Displacement / mortality assumptions	Breeding season			Non-breeding season						Total	Increase in baseline mortality (%)	
	PP1	PP2	PP3	PP1	PP2	PP3	PP4	PP5	PP6		Citation	Most recent
30 / 1	0.2	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.29	0.13
50 / 5	1.9	1.2	1.3	0.0	0.0	0.0	0.0	0.0	0.0	4.5	2.42	1.11
70 / 10	5.2	3.5	3.6	0.1	0.1	0.1	0.0	0.0	0.0	12.5	6.77	3.10

6.1.301 The most likely impact (and most realistic worst case) from the Round 4 Plan alone is considered to be at the lower end of the range of the impacts estimated in Table 6.121 (i.e. between 0.5 and 4.5 birds) when applying displacement and mortality rates advised for previous projects in the North Sea (Natural England, 2015). The lower end of this range is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that puffin densities from the MERP dataset potentially over-estimate puffin abundance.
- The apportioning value applied in the breeding season, it is considered likely that the population of puffin at the Preferred Projects will consist of predominantly immature birds based on information from boat-based surveys of the Hornsea Zone and our understanding of the behaviour of immature puffin.

6.1.302 A wider range of displacement rates are defined in JNCC *et al.* (2017) and these have been considered in the displacement analyses conducted. A precautionary approach has also been applied when considering the apportioning value to apply for all Preferred Projects especially when the likely proportions of immature birds present at the Preferred Projects is considered.

6.1.303 An impact of 0.5-4.5 birds represents 0.29-2.42% of the baseline mortality of the Flamborough and Filey Coast SPA designated puffin population (1,960 breeding adults). However, the counts undertaken to estimate this population are highly likely to have underestimated the population of puffin present at the SPA. In recent years a different surveying approach has been applied and has resulted in higher population estimates. Comparisons against the baseline mortality of the most recent population estimated using the new survey approach are also presented in Table 6.121 and suggest an impact of four birds actually represents 0.13-1.11% of the baseline mortality of the puffin population at the SPA. When considering the highest impact in Table 6.121, which is considered unrealistic due to an over-application of precaution, an annual displacement mortality of 12 birds is estimated. This represents an increase in baseline mortality of 3.10-6.77%. However, the actual displacement mortality predicted is low and there are considered to be significant assumptions which lead to over-estimation associated with the predicted displacement mortality.

6.1.304 The population of puffin at the Flamborough and Filey Coast SPA appears to have declined in recent years. The breeding population of puffins at the Flamborough and Filey Coast SPA had previously been estimated using standard colony counts. In recent years the methodology has changed with birds counted staging on the sea before the breeding season has started. This methodology suggests that between 2017 and 2018 there was an increase in the number of puffins at the Flamborough and Filey Coast SPA however it is not known how these counts translate to breeding birds.

6.1.305 The timeframes of the Preferred Projects are not yet known and therefore consideration has been given to a range of project lifetimes when interpreting PVA outputs. Project lifetimes of 20, 40 and 60 years have therefore been considered.

6.1.306 If additional mortality of 0.5-4.5 birds/annum is assumed then the model predicts a counterfactual of growth rate of 0.998-1.000 (a 0-0.2% reduction) after 20, 40 and 60 years. Under this impact scenario, the predicted counterfactual median impacted population size would be approximately 96.9-99.7% of that which the

model predicts would occur in the absence of any additional impact from the Plan alone after 20 years, 94.0-99.4% after 40 years and 91.2-99.1% after 60 years. This is a relative reduction in population size (compared to that which might otherwise have arisen). The model predicts a negative growth rate, and so the impacted population after 60 years would be lower than that which was assumed for the initiation of the modelling exercise (i.e. the designated population at the Flamborough and Filey Coast SPA).

6.1.307 The current population at the Flamborough and Filey Coast SPA (3,579 birds assumed for the purposes of PVA) is higher than the cited population but has been estimated using a different census methodology. PVA modelling predicts that the population of puffin at the Flamborough and Filey Coast SPA would decrease and, over the lifetime of the Round 4 Plan the resultant population would represent 91.2-99.7% of the population that would occur without the presence of the Round 4 Plan alone.

6.1.308 Natural England have previously advised that puffin have a lower sensitivity to disturbance that razorbill or guillemot and that they therefore consider that the appropriate displacement rate to apply to puffin is at the lower end of the 10-70% range advised in JNCC et al. (2017) and Wade et al. (2016) (Natural England, 2015). Natural England have previously suggested that the mortality rates to apply in displacement analyses at projects that are located in areas of the North Sea in which densities of puffin are low would not be at the top of the range (1-10%) considered. None of the projects are located in areas of the North Sea that support high densities of puffin and this therefore suggests that the in-combination impact estimated above based on a displacement rate of 50% and a mortality rate of 5% is an over-estimate.

6.1.309 In previous in-combination assessments (e.g. Natural England, 2015) Natural England have concluded that the predicted mortality of puffin resulting from displacement would not exceed a level where the population growth rate would decline by more than 0.25% per annum (an impact of approximately eight birds). Natural England's overall conclusion was that there was no indication that the predicted potential decline in the growth rate of the puffin population would mean that either the abundance or richness of the breeding seabird assemblage at the Flamborough and Filey Coast SPA would be reduced to the extent that it would cause an adverse effect on site integrity.

6.1.310

In-combination

6.1.311 Seasonal population estimates for all projects considered in-combination, where available, are presented in Annex H.4. The projects considered in the breeding season are those within the mean-maximum foraging range plus one standard deviation of puffin from Flamborough and Filey Coast SPA as presented in Woodward *et al.* (2019). Apportioning values applied in the breeding season for each relevant project have been sourced from relevant project-specific documentation where available. Where a project-specific apportioning value is unavailable, and the project is within the mean-maximum foraging range of puffin from the Flamborough and Filey Coast SPA an apportioning value of 100% has been assumed. For projects within the mean-maximum foraging range plus one standard deviation it is considered highly unlikely that a significant proportion of birds from the SPA will occur at the projects considered in-combination. However, on a precautionary basis a 10% apportioning rate has been applied unless a site-specific rate is available. The total in-combination values are presented in Table 6.123 for each of the cumulative tiers considered in the HRA (see Appendix A and

B). Displacement and mortality rates of 30%/1% (Table 6.122) and 50%/5% (Table 6.123) have been applied for all projects. The apportioning rates presented in Annex H.3 have been applied in the non-breeding season.

Table 6.122: Calculation of the in-combination impact attributable to the puffin feature at the Flamborough and Filey Coast SPA using a displacement rate of 30% and a mortality rate of 1%

Tier	Breeding	Non-breeding	Total
Round 4 Plan	0.5	0.0	0.5
1	2	1	3
2	1	1	2
3	0	1	1
4	0	0	0
Total	4	2	6

Table 6.123: Calculation of the in-combination impact attributable to the puffin feature at the Flamborough and Filey Coast SPA using a displacement rate of 50% and a mortality rate of 5%

Tier	Breeding	Non-breeding	Total
Round 4 Plan	4.4	0.1	4.5
1	19	1	20
2	7	1	7
3	1	0	1
4	4	0	4
Total	34	2	36

6.1.312 The total in-combination displacement mortality represents 3.2-17.9% of the baseline mortality of the Flamborough and Filey Coast SPA population. There are, however, uncertainties associated with the values for projects considered in-combination presented in Table 6.123, these include:

- Compounding high levels of precaution. Many of the in-combination values presented are those advocated by Natural England, which incorporated high levels of precaution throughout the assessment which has the potential to compound precaution and lead to highly inflated impact magnitudes. If high levels of precaution are applied across the assessments for all projects considered in-combination this can lead to highly inflated in-combination impacts.
- The apportioning values associated with many projects are considered to be highly precautionary, not accounting for immature birds, non-breeding

birds and adult breeding birds from other colonies. The first of these two components will be present throughout the North Sea and should therefore be accounted for in apportioning values derived for the breeding season.

- Future impacts associated with plans and projects in Tiers 5 and 6 are not included in the in-combination assessment due to the development stage of the plan or project (and therefore the uncertainty as to whether the plan or project will come to fruition and therefore contribute to the in-combination impact) and/or high levels of uncertainty associated with the available impacts.

6.1.313 The population of puffin at the Flamborough and Filey Coast SPA appears to have declined in recent years. However, the breeding population of puffins at that site was previously estimated using standard colony counts, which is now considered to underestimate the population size for this species. In recent years the methodology has changed, with birds counted staging on the sea before the breeding season has started. This methodology suggests that between 2017 and 2018 there was an increase in the number of puffins at the Flamborough and Filey Coast SPA however it is not known how these counts translate to breeding birds.

6.1.314 The timeframes of the Preferred Projects are not yet known and therefore consideration has been given to a range of project lifetimes when interpreting PVA outputs. Project lifetimes of 20, 40 and 60 years have therefore been considered.

6.1.315 If additional mortality of 6-36 birds/annum is assumed then the model predicts a counterfactual of growth rate of 0.988-0.998 (a 0.2-1.2% reduction) after 20, 40 and 60 years. Under this impact scenario, the predicted counterfactual median impacted population size would be approximately 77.9-95.8% of that which the model predicts would occur in the absence of any additional impact from the Plan alone in-combination with other Plans and Projects after 20 years, 61.2-92.2% after 40 years and 48.3-88.4% after 60 years. This is a relative reduction in population size (compared to that which might otherwise have arisen). The model predicts a negative growth rate, and so the impacted population after 60 years would be lower than that which was assumed for the initiation of the modelling exercise (i.e. the designated population at the Flamborough and Filey Coast SPA).

6.1.316 Natural England have previously advised that puffin have a lower sensitivity to disturbance that razorbill or guillemot and that they therefore consider that the appropriate displacement rate to apply to puffin is at the lower end of the 10-70% range advised in JNCC *et al.* (2017) and Wade *et al.* (2016) (Natural England, 2015). As part of their assessment for the Hornsea Project Two offshore wind farm for puffin at FFC SPA Natural England considered an impact range of 1-54 birds/annum. Natural England suggested that various projects included as part of the in-combination assessment lie in areas of the North Sea in which densities of puffin are low to medium during both the breeding and non-breeding seasons and as such Natural England did not consider that mortality rates would be at the top of the range (1-10%) considered. This suggests that the in-combination impact estimated above based on a displacement rate of 50% and a mortality rate of 5% is an over-estimate. As a result, they believed that the predicted mortality of puffin resulting from displacement would not exceed a level where the population growth rate would decline by more than 0.25% per annum (an impact of approximately eight birds). Natural England's overall conclusion was that there was no indication that the predicted potential decline in the growth rate of the puffin population would mean that either the abundance or richness of the breeding seabird assemblage at the Flamborough and Filey Coast SPA would be reduced to the extent that it would cause an adverse effect on site integrity.

6.1.317 Projects that have been proposed (and in some cases consented) since Hornsea Project Two are located considerable distances from the FFC SPA and therefore lie in areas that contain low densities of puffins. The logic outlined by Natural England in their assessments at Hornsea Project Two (i.e. displacement and mortality rates at the lower end of the proposed ranges) is considered applicable to those projects and the Round 4 Plan. It is therefore considered that the in-combination impact at Hornsea Project Two, which Natural England considered would not represent a decline in the puffin population of 0.25% will not have increased significantly and may still lie below or close to a 0.25% decline in the population growth rate.

6.1.318 There are a number of uncertainties associated with the PVA modelling, these include:

- Over-estimation of in-combination impacts. The PVA modelling does not account for changes in the predicted in-combination due to the decommissioning of projects considered in-combination. Although it is noted that some Tier 5 and 6 projects could be commissioned, over the lifetime of the Round 4 Plan the in-combination impact will reduce when licences for current projects expire and decommissioning occurs. The PVA metrics are therefore precautionary.
- No consideration has been made for density dependent compensation of demographic parameters within the modelled population, nor immigration, both of which could reduce the magnitude of any population change.

6.1.319 The current population at the Flamborough and Filey Coast SPA (3,579 birds assumed for the purposes of PVA) is higher than the cited population but has been estimated using a different census methodology. PVA modelling predicts that the population of puffin at the Flamborough and Filey Coast SPA would decrease and, over the lifetime of the Round 4 Plan the resultant population would represent 48.3-95.8% of the population that would occur without the presence of the Round 4 Plan in-combination with other Plans and Projects.

Forth Islands SPA

Gannet

Alone

Collision risk

6.1.320 Collision risk modelling has been undertaken for gannet using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.124. In the breeding season, there is only connectivity between the Forth Islands SPA and Preferred Projects 1, 2 and 3 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.124: Collision risk estimates for gannet (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																
				Breeding season				Post-breeding							Pre-breeding						
				PP1	PP2	PP3	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	1	14.9	98.9	18	10	2	30	1	1	0	0	0	0	2	2	1	0	0	0	0	4
			99.5	8	5	1	14	0	0	0	0	0	0	1	1	1	0	0	0	0	2
		13.33	98.9	17	10	2	29	1	0	0	0	0	0	2	2	1	0	0	0	0	4
			99.5	8	4	1	13	0	0	0	0	0	0	1	1	1	0	0	0	0	2
	2	14.9	98.9	21	12	3	35	1	1	0	0	0	0	2	3	2	0	0	0	0	6
			99.5	9	5	1	16	1	0	0	0	0	0	1	1	1	0	0	0	0	3
		13.33	98.9	20	11	2	33	1	1	0	0	0	0	2	3	2	0	0	0	0	5
			99.5	9	5	1	15	1	0	0	0	0	0	1	1	1	0	0	0	0	2

6.1.321 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.125, Table 6.126 and Table 6.127.

Table 6.125: Breeding season apportioning for gannet at the Forth Islands SPA for the impact from Preferred Project 1

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	1	14.9	98.9	1.8	3.5	5.3	7.1	8.9	10.6	12.4	14.2	16.0	17.7
			99.5	0.8	1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.3	8.1
		13.33	98.9	1.7	3.4	5.0	6.7	8.4	10.1	11.7	13.4	15.1	16.8
			99.5	0.8	1.5	2.3	3.0	3.8	4.6	5.3	6.1	6.9	7.6
	2	14.9	98.9	2.1	4.1	6.2	8.3	10.3	12.4	14.5	16.5	18.6	20.7
			99.5	0.9	1.9	2.8	3.8	4.7	5.6	6.6	7.5	8.5	9.4
		13.33	98.9	2.0	3.9	5.9	7.8	9.8	11.7	13.7	15.6	17.6	19.6
			99.5	0.9	1.8	2.7	3.6	4.4	5.3	6.2	7.1	8.0	8.9

Table 6.126: Breeding season apportioning for gannet at the Forth Islands SPA for the impact from Preferred Project 2

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	1	14.9	98.9	1.0	2.1	3.1	4.1	5.2	6.2	7.2	8.3	9.3	10.3
			99.5	0.5	0.9	1.4	1.9	2.3	2.8	3.3	3.8	4.2	4.7
		13.33	98.9	1.0	2.0	2.9	3.9	4.9	5.9	6.8	7.8	8.8	9.8
			99.5	0.4	0.9	1.3	1.8	2.2	2.7	3.1	3.6	4.0	4.4
	2	14.9	98.9	1.2	2.4	3.6	4.8	6.0	7.2	8.4	9.7	10.9	12.1
			99.5	0.5	1.1	1.6	2.2	2.7	3.3	3.8	4.4	4.9	5.5
		13.33	98.9	1.1	2.3	3.4	4.6	5.7	6.8	8.0	9.1	10.3	11.4
			99.5	0.5	1.0	1.6	2.1	2.6	3.1	3.6	4.1	4.7	5.2

Table 6.127: Breeding season apportioning for gannet at the Forth Islands SPA for the impact from Preferred Project 3

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	1	14.9	98.9	0.2	0.4	0.7	0.9	1.1	1.3	1.6	1.8	2.0	2.2
			99.5	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		13.33	98.9	0.2	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.9	2.1
			99.5	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
	2	14.9	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.4	2.6
			99.5	0.1	0.2	0.4	0.5	0.6	0.7	0.8	1.0	1.1	1.2
		13.33	98.9	0.2	0.5	0.7	1.0	1.2	1.5	1.7	2.0	2.2	2.5
			99.5	0.1	0.2	0.3	0.4	0.6	0.7	0.8	0.9	1.0	1.1

6.1.322 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.125, Table 6.126 and Table 6.127. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). Preferred Project 1 is within the mean-maximum foraging range of gannet from the Forth Islands with the apportioning approach presented in Annex H.3 suggesting a breeding adult proportion of 45.6%. This value has been combined with the relevant proportions for immature birds and sabbatical birds presented in Annex H.3 to calculate an apportioning value in Table 6.128 for gannet at the Forth Islands SPA. Preferred Projects 2 and 3 are beyond the mean-maximum foraging range of gannet from the Forth Islands SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%.

Table 6.128: Breeding season apportioning values for gannet at the Forth Islands SPA based on the approach applied in Annex H.3

Preferred Project	Proportion of breeding adult birds from SPA	Proportion of immature birds	Proportion of non-breeding birds	Overall breeding season apportioning value
1	0.456	0.426	0.1	0.24

6.1.323 The apportioning results in Annex H.3 have been reviewed against relevant site specific data. The use of 0% breeding season apportioning rate for Preferred Projects 2 and 3 is supported by the information in Wakefield *et al.* (2013) which provides evidence for space partitioning between gannet colonies. All three of the Preferred Projects are located closer to the Flamborough and Filey Coast SPA with Preferred Project 3 south of that SPA. This suggests that, based on the evidence presented in Wakefield *et al.* (2013), that gannets from the Forth Islands are highly unlikely to utilise the Preferred Project 3 area for foraging purposes and therefore an apportioning value of 0% is considered appropriate. Preferred Project 2 is located to the north of the Flamborough and Filey Coast SPA, with site-specific tracking data from that SPA showing that the sea area in which Preferred Project 2 is located is utilised by birds from the Flamborough and Filey Coast SPA. Tracking data from the Forth Islands SPA does however also show that birds from the colony do utilise the sea areas in which Preferred Project 2 is located (Hamer *et al.,* 2007; Wakefield *et al.,* 2013) and therefore it is considered appropriate to apportion some of the impact from Preferred Project 2 to the Forth Islands SPA. As Preferred Project 2 is located adjacent to Preferred Project 1, the value for breeding adults calculated for Preferred Project 1 has been applied to Preferred Project 2.

6.1.324 The proportion of immature birds estimated for gannet in Annex H.3 does not take into account the distribution of immature birds and may therefore under- or over-estimate the proportion of immature birds present. However, baseline survey data collected to support the applications for offshore wind farm projects in the Hornsea Zone suggest that, at a distance from the coast equivalent to that between Preferred Projects 1 and 2 and comparable areas in the Hornsea Zone, the proportion of immature birds present was 39.7-42.8%. The lower of these proportions has therefore been applied for Preferred Projects 1 and 2. Calculation of apportioning values taking account of a breeding adult component at Preferred Project 2 and the immature proportions derived from baseline survey data collected in the Hornsea Zone are presented in Table 6.129.

Table 6.129: Breeding season apportioning values for gannet at the Forth Islands SPA based on the approach applied in Annex H.3 and immature proportions from Hornsea Zone baseline survey data

Preferred Project	Proportion of breeding adult birds from SPA	Proportion of immature birds	Proportion of non-breeding birds	Overall breeding season apportioning value
1	0.456	0.397	0.1	0.25
2	0.456	0.397	0.1	0.25

6.1.325 In the post-breeding and pre-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post- and pre-breeding seasons for the Preferred Projects in the North Sea are 24.3% and 31.3%, respectively and for the Preferred Projects in the Irish Sea are 0% and 5.0%, respectively. The apportioned values from each of the Preferred Projects combined to the Forth Islands SPA are presented in Table 6.130.

Table 6.130: Apportioning for gannet at the Forth Islands SPA in the post- and pre-breeding season for the impact from all Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
Option 2	1	14.9	98.9	0.4	1.1
			99.5	0.2	0.5
		13.33	98.9	0.4	1.1
			99.5	0.2	0.5
	2	14.9	98.9	0.5	1.7
			99.5	0.2	0.8
		13.33	98.9	0.5	1.6
			99.5	0.2	0.7

6.1.326 The annual apportioned impact for gannet at the Forth Islands SPA is provided in Table 6.131.

Table 6.131: Calculation of the annual impact attributable to gannet at the Forth Islands SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding		Post-breeding	Pre-breeding	Total	Increase in baseline mortality (%)
				PP1	PP2	All projects	All projects		
Option 2	1	14.9	98.9	4.4	2.6	0.4	1.1	8.4	0.24
			99.5	2.0	1.2	0.2	0.5	3.8	0.11
		13.33	98.9	4.1	2.4	0.4	1.1	8.0	0.23
			99.5	1.9	1.1	0.2	0.5	3.6	0.10
	2	14.9	98.9	5.1	3.0	0.5	1.7	10.3	0.29
			99.5	2.3	1.4	0.2	0.8	4.7	0.13
		13.33	98.9	4.8	2.8	0.5	1.6	9.7	0.28
			99.5	2.2	1.3	0.2	0.7	4.4	0.13

6.1.327 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.131 is considered to be 3.6-4.4 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the gannet densities extracted from the MERP dataset are comparable with the exception of migratory periods where the use of the MERP dataset may underestimate gannet abundance.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.

6.1.328 An impact of 3.6-4.4 collisions/annum represents 0.10-0.13% of the baseline mortality of the Forth Islands SPA gannet population (21,600 pairs). When considering the highest impact estimated in Table 6.131, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 8.4-10.3 collisions/annum represents an increase in baseline mortality of 0.24-0.29%. Under all scenarios the impact is therefore considered to be negligible.

Displacement

6.1.329 Consideration of displacement impacts on gannet at the Forth Islands SPA is not recommended by Marine Scotland Science, Scottish Natural Heritage (now Nature Scot) and the RSPB (Marine Scotland Science, 2017). Based on the findings of Searle *et al.* (2014). Searle *et al.* (2014) estimated that the in-combination impact predicted did not exceed 0.5% of the baseline mortality for gannets at the Forth Islands SPA and although the proportion of birds interacting with wind farms was comparatively high, when compared to other species, the associated costs of doing so were small relative to the overall cost of foraging trips. This resulted in overall effects that were negligible. The potential impact from the Plan alone has however, been estimated in the following section.

6.1.330 Displacement analysis has been undertaken for gannet using the approach advised in JNCC *et al.* (2017) (Annex H.1). To account for uncertainty in the analysis approach a range of displacement and mortality rates have been applied following the recommended approach to defining these in JNCC *et al.* (2017). Table 6.132 presents the unapportioned seasonal displacement mortality for gannet at each of the Preferred Projects using the appropriate range of displacement and mortality rates. The seasons used are those presented on Natural England's designated site viewer (breeding season) and in Furness (2015) (non-breeding season).

Table 6.132: Displacement mortality for gannet at each of the Preferred Projects (unapportioned values) (no. of birds)

Preferred Project	Displacement rate (%)	Mortality rate (%)											
		Breeding				Post-breeding				Pre-breeding			
		1	2	5	10	1	2	5	10	1	2	5	10
1	60	1	3	6	13	1	2	4	9	1	1	4	7
	80	2	3	8	17	1	2	6	12	1	2	5	10
2	60	1	2	4	9	1	1	3	6	1	1	3	5
	80	1	2	6	12	1	2	4	8	1	1	3	7
3	60	1	2	6	12	1	2	4	8	1	1	4	7
	80	2	3	8	16	1	2	6	11	1	2	5	9
4	60	N/A				0	0	0	1	0	0	0	1
	80	N/A				0	0	1	1	0	0	0	1
5	60	N/A				0	0	0	0	0	0	0	0
	80	N/A				0	0	0	0	0	0	0	0
6	60	N/A				0	0	0	1	0	0	0	0
	80	N/A				0	0	0	1	0	0	0	1

6.1.331 In the breeding season, the population of birds present in an area of sea can be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.133.

Table 6.133: Breeding season apportioning for gannet at the Forth Islands SPA for the impact from all Preferred Projects with connectivity in the breeding season

Preferred Project	Displacement / mortality rate (%)	Apportioning value (%)									
		10	20	30	40	50	60	70	80	90	100
1	60 / 1	0.1	0.3	0.4	0.5	0.6	0.8	0.9	1.0	1.1	1.3
	80 / 10	1.7	3.4	5.1	6.7	8.4	10.1	11.8	13.5	15.2	16.9
2	60 / 1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	80 / 10	1.2	2.3	3.5	4.6	5.8	6.9	8.1	9.2	10.4	11.5
3	60 / 1	0.1	0.2	0.4	0.5	0.6	0.7	0.9	1.0	1.1	1.2
	80 / 10	1.6	3.3	4.9	6.5	8.2	9.8	11.4	13.1	14.7	16.3

6.1.332 Discussion on the appropriate breeding season apportioning values to apply for gannet is provided in paragraphs 6.1.322 to 6.1.324 and those apportioning values to be applied in the breeding season at each of the Preferred Projects for gannet at the Forth Islands SPA are summarised in Table 6.129.

6.1.333 In the post-breeding and pre-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post- and pre-breeding seasons for the Preferred Projects in the North Sea are 24.3% and 31.3%, respectively and for the Preferred Projects in the Irish Sea are 0% and 5.0%, respectively. The apportioned values from each of the Preferred Projects combined to the Forth Islands SPA are presented in Table 6.134.

Table 6.134: Apportioned displacement mortality for gannet at the Forth Islands SPA in non-breeding seasons

Preferred Project	Displacement rate (%)	Mortality rate (%)	Apportioned values	
			Post-breeding	Non-breeding
1	60	1	0.2	0.2
	80	10	2.9	3.1
2	60	1	0.1	0.2
	80	10	1.9	2.1
3	60	1	0.2	0.2
	80	10	2.7	2.9
4	60	1	0.0	0.0
	80	10	0.0	0.0
5	60	1	0.0	0.0
	80	10	0.0	0.0
6	60	1	0.0	0.0
	80	10	0.0	0.0
Total	60	1	0.6	0.6
	80	10	7.5	8.2

6.1.334 The annual apportioned impact for gannet at the Forth Islands SPA is provided in Table 6.135.

Table 6.135: Calculation of the annual impact attributable to gannet at the Forth Islands SPA from the Round 4 Plan alone

Displacement / mortality assumptions	Breeding season		Post-breeding season						Pre-breeding season						Total	Increase in baseline mortality (%)
	PP1	PP2	PP1	PP2	PP3	PP4	PP5	PP6	PP1	PP2	PP3	PP4	PP5	PP6		
60 / 1	0.3	0.2	0.2	0.1	0.2	0.0	0.0	0.0	0.2	0.2	0.2	0.0	0.0	0.0	1.6	0.05
80 / 10	4.2	2.9	2.9	1.9	2.7	0.0	0.0	0.0	3.1	2.1	2.9	0.0	0.0	0.0	22.8	0.65

6.1.335 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.135 is considered to be 1.6-22.8 birds. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the gannet densities extracted from the MERP dataset are comparable with the exception of migratory periods where the use of the MERP dataset may underestimate gannet abundance.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.

6.1.336 An impact of 1.6-22.8 birds represents 0.05-0.65% of the baseline mortality of the Forth Islands SPA gannet population (43,200 breeding adults).

Collision and displacement

6.1.337 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.131 in relation to collision risk is considered to be 3.6-4.4 collisions/annum. The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.135 in relation to displacement is considered to be 1.6-22.8 birds. This provides a combined value of 5.2 -27.2 birds/annum. This represents 0.16-0.78% of the baseline mortality of the gannet population at the Forth Islands SPA.

6.1.338 However, Marine Scotland Science and NatureScot have previously advised that, consideration of displacement impacts for gannet is not required as such impacts are not considered likely to result in an adverse effect on the site integrity of an SPA based on the findings of Searle *et al* (2014).

In-combination

Collision

6.1.339 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Forth Islands SPA.

Displacement

6.1.340 Consideration of displacement impacts on gannet at the Forth Islands SPA is not recommended by Marine Scotland Science, Scottish Natural Heritage (now Nature Scot) and the RSPB (Marine Scotland Science, 2017) based on the findings of Searle *et al.* (2014). Searle *et al.* (2014) estimated that the in-combination impact predicted did not exceed 0.5% of the baseline mortality for gannets at the Forth Islands SPA and although the proportion of birds interacting with wind farms was comparatively high, when compared to other species, the associated costs of doing so were small relative to the overall cost of foraging trips. This resulted in overall effects that were negligible.

6.1.341 In any case, due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Forth Islands SPA.

Collision and displacement

6.1.342 The number of bird collisions apportioned to this Forth Islands SPA from the Round 4 Plan is estimated to be 3.6-4.4 birds/annum. This represents between 0.10% and 0.13% of the baseline mortality at this Forth Islands SPA. The number of mortalities associated with displaced birds apportioned to this Forth Islands SPA from the Round 4 Plan is estimated to between 2 and 23 birds/annum. This represents between 0.05 and 0.65% of the baseline mortality at this Forth Islands SPA. However, Marine Scotland Science and NatureScot have previously advised that in reality, displacement impacts for gannet would be unlikely to represent an increase in baseline mortality above 0.5% based on the findings of Searle *et al* (2014). Searle *et al.* (2014) concluded that the proportion of birds interacting with wind farms from the Forth Islands SPA is comparatively high, but associated costs are small relative to the overall cost of foraging trips, so overall effects are negligible. This conclusion is still considered valid as the contribution of the Round 4 Plan is considered negligible.

Kittiwake

Alone

6.1.343 Collision risk modelling has been undertaken for kittiwake using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.136. In the breeding season, there is only connectivity between the Forth Islands SPA and Preferred Project 1 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.136: Collision risk estimates for kittiwake (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)														
				Breeding season	Post-breeding							Pre-breeding						
				PP1	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	98.9	73	52	11	136	29	21	5	2	1	2	59	21	15	3	1
			99.0	66	47	10	123	26	19	4	2	1	2	54	19	14	3	1
		8.71	98.9	56	40	8	104	22	16	3	1	1	1	45	16	12	2	0
			99.0	51	36	8	94	20	14	3	1	1	1	41	15	11	2	0
	3	13.1	98.9	82	59	13	154	37	26	6	2	1	2	75	28	20	4	1
			99.0	75	54	12	140	34	24	5	2	1	2	68	25	18	4	1
		8.71	98.9	63	45	9	118	28	20	4	2	1	2	58	21	15	3	1
			99.0	57	41	9	107	26	18	4	2	1	1	52	19	14	3	1
Option 3	2	13.1	98	34	25	4	63	14	10	1	1	0	1	27	10	7	1	0
		8.71	98	30	22	3	55	12	9	1	1	0	0	23	9	6	1	0
	3	13.1	98	39	28	4	71	18	13	2	1	1	1	34	13	9	1	0
		8.71	98	34	24	3	62	15	11	2	1	1	1	30	12	8	1	0

6.1.344 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.137.

Table 6.137: Breeding season apportioning for kittiwake at the Forth Islands SPA for the impact from Preferred Project 1

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	7.3	14.5	21.8	29.0	36.3	43.5	50.8	58.0	65.3	72.6
			99.0	6.6	13.2	19.8	26.4	33.0	39.6	46.2	52.8	59.4	66.0
		8.71	98.9	5.6	11.1	16.7	22.3	27.8	33.4	39.0	44.5	50.1	55.7
			99.0	5.1	10.1	15.2	20.2	25.3	30.4	35.4	40.5	45.6	50.6
	3	13.1	98.9	8.2	16.5	24.7	32.9	41.2	49.4	57.6	65.9	74.1	82.3
			99.0	7.5	15.0	22.5	29.9	37.4	44.9	52.4	59.9	67.4	74.9
		8.71	98.9	6.3	12.6	19.0	25.3	31.6	37.9	44.2	50.6	56.9	63.2
			99.0	5.7	11.5	17.2	23.0	28.7	34.5	40.2	46.0	51.7	57.4
Option 3	2	13.1	98	3.4	6.9	10.3	13.8	17.2	20.7	24.1	27.6	31.0	34.5
		8.71	98	3.0	6.0	9.0	12.1	15.1	18.1	21.1	24.1	27.1	30.1
	3	13.1	98	3.9	7.8	11.7	15.6	19.6	23.5	27.4	31.3	35.2	39.1
		8.71	98	3.4	6.8	10.3	13.7	17.1	20.5	23.9	27.4	30.8	34.2

6.1.345 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.137. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). Preferred Project 1 is beyond the mean-maximum foraging range of kittiwake from the Forth Islands SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. Preferred Project 1 is however, within the foraging range of kittiwake when using the mean-maximum foraging range plus one standard deviation from Woodward *et al.* (2019) (300.6 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al.* (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual kittiwakes from the Forth Islands SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.346 There is no site-specific foraging range data available for kittiwake from the Forth Islands SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Forth Islands SPA then this should only be a limited amount (e.g. 10%).

6.1.347 In the post-breeding and pre-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post- and pre-breeding seasons for the Preferred Projects in the North Sea are 0.5% and 0.6%, respectively and for the Preferred Projects in the Irish Sea are 0.1% and 0.3%, respectively. The apportioned values from each of the Preferred Projects combined to the Forth Islands SPA are presented in Table 6.138.

Table 6.138: Apportioned collision risk estimates for kittiwake at the Forth Islands SPA in non-breeding seasons

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
Option 2	2	13.1	98.9	0.2	0.2
			99.0	0.2	0.2
		8.71	98.9	0.2	0.2
			99.0	0.2	0.2

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
	3	13.1	98.9	0.3	0.3
			99.0	0.3	0.3
		8.71	98.9	0.2	0.2
			99.0	0.2	0.2
Option 3	2	13.1	98	0.1	0.1
		8.71	98	0.1	0.1
	3	13.1	98	0.1	0.1
		8.71	98	0.1	0.1

6.1.348 The annual apportioned impact for kittiwake at the Forth Islands SPA is provided in Table 6.139.

Table 6.139: Calculation of total impact attributable to kittiwake at the Forth Islands SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding	Post-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP1	All projects	All projects		
Option 2	2	13.1	98.9	7.3	0.2	0.2	7.7	0.32
			99.0	6.6	0.2	0.2	7.0	0.29
		8.71	98.9	5.6	0.2	0.2	5.9	0.24
			99.0	5.1	0.2	0.2	5.4	0.22
	3	13.1	98.9	8.2	0.3	0.3	8.9	0.36
			99.0	7.5	0.3	0.3	8.1	0.33
		8.71	98.9	6.3	0.2	0.2	6.8	0.28
			99.0	5.7	0.2	0.2	6.2	0.25
Option 3	2	13.1	98	3.4	0.1	0.1	3.7	0.15
		8.71	98	3.0	0.1	0.1	3.2	0.13
	3	13.1	98	3.9	0.1	0.1	4.2	0.17
		8.71	98	3.4	0.1	0.1	3.7	0.15

6.1.349 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.139 is considered to be 3.2-3.7 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that kittiwake densities from the MERP dataset potentially underestimate kittiwake abundance.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.
- The apportioning value applied in the breeding season; it is unlikely that a significant proportion of kittiwake from Forth Islands SPA will utilize the Preferred Project areas and the assumption of 10% is likely an over-estimate but is applied on a precautionary basis.

6.1.350 An impact of 3.2-3.7 collisions/annum represents 0.13-0.15% of the baseline mortality of the Forth Islands SPA kittiwake population (8,400 pairs). Even if the highest impact presented in Table 6.139 is applied, which is considered unrealistic due to an over-application of precaution, the associated impact represents 0.24-0.32% of baseline mortality. When considering the highest impact estimated in Table 6.139, an annual collision risk estimate of 7.7-8.9 collisions/annum represents an increase in baseline mortality of 0.32-0.36%. However, the actual number of collisions predicted remains low and there are considered to be significant assumptions which lead to over-estimation associated with the collision risk estimates. Under all scenarios the impact is therefore considered to be negligible.

In-combination

6.1.351 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Forth Islands SPA.

Greater Wash SPA

Sandwich tern

Alone

6.1.352 The Greater Wash SPA is designated to protect the foraging areas of the population of Sandwich tern the breeding colonies for which are designated as part of the North Norfolk Coast SPA. As a result the predicted impacts and the assessment conclusions drawn for the North Norfolk Coast SPA are considered equally applicable to the Greater Wash SPA.

6.1.353 The assessment presented for the North Norfolk Coast SPA concluded that it is highly unlikely that Preferred Project 3 will have any impact on the Sandwich tern feature of the North Norfolk Coast SPA and this conclusion is therefore considered applicable to the Greater Wash SPA.

In-combination

6.1.354 The Round 4 Plan is considered highly unlikely to contribute any impact to the in-combination impact on the Sandwich tern feature of the Greater Wash SPA.

Howth Head SAC and Howth Head Coast SPA

Kittiwake

Alone

6.1.355 Collision risk modelling has been undertaken for kittiwake using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.140. In the breeding season, there is only connectivity between the Howth Head Coast SPA and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.140: Collision risk estimates for kittiwake (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																
				Breeding season				Post-breeding							Pre-breeding						
				PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	98.9	3	2	3	8	29	21	5	2	1	2	59	21	15	3	1	0	1	41
			99.0	3	2	3	7	26	19	4	2	1	2	54	19	14	3	1	0	0	37
		8.71	98.9	2	2	2	6	22	16	3	1	1	1	45	16	12	2	0	0	0	31
			99.0	2	1	2	5	20	14	3	1	1	1	41	15	11	2	0	0	0	29
	3	13.1	98.9	4	2	3	9	37	26	6	2	1	2	75	28	20	4	1	0	1	53
			99.0	3	2	3	8	34	24	5	2	1	2	68	25	18	4	1	0	1	49
		8.71	98.9	3	2	2	7	28	20	4	2	1	2	58	21	15	3	1	0	1	41
			99.0	2	2	2	6	26	18	4	2	1	1	52	19	14	3	1	0	0	37
Option 3	2	13.1	98	1	1	1	3	14	10	1	1	0	1	27	10	7	1	0	0	0	19
		8.71	98	1	1	1	2	12	9	1	1	0	0	23	9	6	1	0	0	0	16
	3	13.1	98	1	1	1	3	18	13	2	1	1	1	34	13	9	1	0	0	0	24
		8.71	98	1	1	1	3	15	11	2	1	1	1	30	12	8	1	0	0	0	21

6.1.356 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.141, Table 6.142 and Table 6.143.

Table 6.141: Breeding season apportioning for kittiwake at Howth Head Coast SPA for the impact from Preferred Project 4

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.3	0.6	0.9	1.2	1.6	1.9	2.2	2.5	2.8	3.1
			99.0	0.3	0.6	0.8	1.1	1.4	1.7	2.0	2.3	2.5	2.8
		8.71	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.3
			99.0	0.2	0.4	0.6	0.8	1.1	1.3	1.5	1.7	1.9	2.1
	3	13.1	98.9	0.4	0.7	1.1	1.4	1.8	2.1	2.5	2.8	3.2	3.5
			99.0	0.3	0.6	1.0	1.3	1.6	1.9	2.2	2.6	2.9	3.2
		8.71	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
			99.0	0.2	0.5	0.7	0.9	1.2	1.4	1.7	1.9	2.1	2.4
Option 3	2	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		8.71	98	0.1	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.8	0.9
	3	13.1	98	0.1	0.2	0.3	0.5	0.6	0.7	0.8	0.9	1.0	1.2
		8.71	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

Table 6.142: Breeding season apportioning for kittiwake at Howth Head Coast SPA for the impact from Preferred Project 5

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.9
			99.0	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.4	1.5	1.7
		8.71	98.9	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.6
			99.0	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4
	3	13.1	98.9	0.2	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.9	2.1
			99.0	0.2	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9
		8.71	98.9	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.6	1.7
			99.0	0.2	0.3	0.5	0.6	0.8	1.0	1.1	1.3	1.4	1.6
Option 3	2	13.1	98	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
		8.71	98	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
	3	13.1	98	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8
		8.71	98	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8

Table 6.143: Breeding season apportioning for kittiwake at Howth Head Coast SPA for the impact from Preferred Project 6

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.3	0.6	0.8	1.1	1.4	1.7	2.0	2.2	2.5	2.8
			99.0	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.0	2.3	2.6
		8.71	98.9	0.2	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.9	2.1
			99.0	0.2	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9
	3	13.1	98.9	0.3	0.6	0.9	1.3	1.6	1.9	2.2	2.5	2.8	3.2
			99.0	0.3	0.6	0.9	1.2	1.4	1.7	2.0	2.3	2.6	2.9
		8.71	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.4
			99.0	0.2	0.4	0.6	0.9	1.1	1.3	1.5	1.7	1.9	2.1
Option 3	2	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.8	0.9
		8.71	98	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.6	0.7	0.8
	3	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		8.71	98	0.1	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8	0.9

6.1.357 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.141, Table 6.142 and Table 6.143. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). Preferred Project 5 is beyond the mean-maximum foraging range of kittiwake from the Howth Head Coast SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%.

6.1.358 Preferred Project 5 is however, within the foraging range of kittiwake when using the mean-maximum foraging range plus one standard deviation (300.5 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual kittiwakes from the Howth Head Coast SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.359 Preferred Projects 4 and 6 are within the mean-maximum foraging range of kittiwake and in order to identify the most realistic apportioning value to apply in the breeding season, the three components of the population present at each of the Preferred Projects have been considered (see Annex H.3). The values associated with each of these population components is presented in Table 6.144 and multiplied together to provide an apportioning value for both Preferred Projects.

Table 6.144: Breeding season apportioning values for kittiwake at Howth Head Coast SPA based on the approach applied in Annex H.3

Preferred Project	Proportion of breeding adult birds from SPA	Proportion of immature birds	Proportion of non-breeding birds	Overall breeding season apportioning value
4	0.05	0.44	0.1	0.02
6	0.05	0.44	0.1	0.03

6.1.360 The results of the apportioning approach in Annex H.3 suggest that 2% and 3% of the predicted impact at Preferred Projects 4 and 6 respectively are attributable to the Howth Head Coast SPA. As mentioned in Section 5.2, the estimated proportion of immature birds in Table 6.144 does not take account of the distribution of immature birds and may therefore over-estimate this component

of the population present at each of the Preferred Projects. If it were to be assumed that no immature birds were to be present at Preferred Projects 4 and 6, an ecologically invalid assumption, then the apportioning value at Preferred Projects 4 and 6 would still remain low (4% and 5% respectively).

6.1.361 There is no site-specific information in relation to the foraging behaviour of kittiwake from the Howth Head Coast SPA. However, the UK and Eire-wide utilisation distributions presented in Cleasby *et al.* (2018) suggest that the Preferred Projects lie beyond the 75% utilisation distribution band. This suggests limited connectivity between any kittiwake colony and the Preferred Projects and supports the use of a low apportioning value. Therefore if, due to the lack of site-specific data and on a precautionary basis, any impact from Preferred Projects 5 is to be apportioned to the Howth Head Coast SPA then this should only be a limited amount and it is proposed that this be the same as that calculated for Preferred Project 6.

6.1.362 As there is no information on the proportion of immature birds present at Preferred Project 4 or 6 it is proposed that this component of the population be discounted accepting that this is will result in an over-estimation of the impact on the Howth Head SPA. The apportioning value in the breeding season for Preferred Project 4 would therefore be 0.04 and for Preferred Projects 5 and 6 would therefore be 0.05.

6.1.363 In the post-breeding and pre-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, and pre-breeding seasons for the Preferred Projects in the Irish Sea are 0.3% and 0.5% and for the Preferred Projects in the North Sea are 0.01% in both seasons. The apportioned values from each of the Preferred Projects combined to the Howth Head Coast SPA are presented in Table 6.145.

Table 6.145: Apportioning for kittiwake at Howth Head Coast SPA in the post- and pre-breeding season for the impact from all Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
Option 2	2	13.1	98.9	0.0	0.0
			99.0	0.0	0.0
		8.71	98.9	0.0	0.0
			99.0	0.0	0.0
	3	13.1	98.9	0.0	0.0
			99.0	0.0	0.0
		8.71	98.9	0.0	0.0
			99.0	0.0	0.0
Option 3	2	13.1	98	0.0	0.0

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
		8.71	98	0.0	0.0
	3	13.1	98	0.0	0.0
		8.71	98	0.0	0.0

6.1.364 The annual apportioned impact for kittiwake at Howth Head Coast SPA is provided in Table 6.146.

Table 6.146: Calculation of total impact attributable to kittiwake at Howth Head Coast SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding			Post-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP4	PP5	PP6	All projects	All projects		
Option 2	2	13.1	98.9	0.1	0.1	0.1	0.0	0.0	0.4	0.06
			99.0	0.1	0.1	0.1	0.0	0.0	0.3	0.05
		8.71	98.9	0.1	0.1	0.1	0.0	0.0	0.3	0.04
			99.0	0.1	0.1	0.1	0.0	0.0	0.3	0.04
	3	13.1	98.9	0.1	0.1	0.1	0.0	0.0	0.4	0.06
			99.0	0.1	0.1	0.1	0.0	0.0	0.4	0.06
		8.71	98.9	0.1	0.1	0.1	0.0	0.0	0.3	0.05
			99.0	0.1	0.1	0.1	0.0	0.0	0.3	0.04
Option 3	2	13.1	98	0.0	0.0	0.0	0.0	0.0	0.1	0.02
		8.71	98	0.0	0.0	0.0	0.0	0.0	0.1	0.02
	3	13.1	98	0.0	0.0	0.0	0.0	0.0	0.1	0.02
		8.71	98	0.0	0.0	0.0	0.0	0.0	0.1	0.02

6.1.365 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.146 is considered to be 0.1 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that kittiwake densities from the MERP dataset potentially underestimate kittiwake abundance.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.
- The proportion of immatures present at each of the Preferred Projects.

6.1.366 An impact of 0.1 collisions/annum represents 0.02% of the baseline mortality of the Howth Head SPA kittiwake population (4,658 breeding adults). When considering the highest impact estimated in Table 6.146, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 0.4 collisions/annum represents an increase in baseline mortality of 0.06%. Under all scenarios the impact is therefore considered to be negligible.

In-combination

6.1.367 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Howth Head SPA.

Guillemot

Alone

6.1.368 Displacement analysis has been undertaken for guillemot using the approach advised in JNCC *et al.* (2017) (Annex H.1). To account for uncertainty in the analysis approach, a range of displacement and mortality rates have been applied following the recommended approach to defining these in JNCC *et al.* (2017). Table 6.147 presents the unapportioned seasonal displacement mortality for guillemot at each of the Preferred Projects using the appropriate range of displacement and mortality rates. In the breeding season, there is only connectivity between the Howth Head Coast SPA and Preferred Projects 4 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.147: Displacement mortality for guillemot at each of the Preferred Projects (unapportioned values) (no. of birds)

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
1	30	N/A				7	13	33	67
	50	N/A				11	22	56	112
	70	N/A				16	31	78	156
2	30	N/A				6	12	30	60
	50	N/A				10	20	50	100
	70	N/A				14	28	70	140
3	30	N/A				6	11	29	57
	50	N/A				10	19	48	95
	70	N/A				13	27	67	134
4	30	2	3	8	17	2	4	10	20
	50	3	6	14	28	3	7	17	34
	70	4	8	20	39	5	9	24	47
5	30	N/A				1	1	3	6
	50	N/A				1	2	5	10
	70	N/A				1	3	7	14
6	30	1	2	6	11	1	3	7	13

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
	50	2	4	9	18	2	4	11	22
	70	3	5	13	26	3	6	16	31

6.1.369 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.148.

Table 6.148: Breeding season apportioning for guillemot at Howth Head Coast SPA for the impact from all Preferred Projects with connectivity in the breeding season

Preferred Project	Displacement / mortality rate (%)	Apportioning value (%)									
		10	20	30	40	50	60	70	80	90	100
4	30 / 1	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.7
	50 / 5	1.4	2.8	4.2	5.6	7.0	8.4	9.8	11.2	12.6	14.1
	70 / 10	3.9	7.9	11.8	15.7	19.7	23.6	27.5	31.5	35.4	39.3
6	30 / 1	0.1	0.2	0.3	0.4	0.6	0.7	0.8	0.9	1.0	1.1
	50 / 5	0.9	1.8	2.8	3.7	4.6	5.5	6.4	7.3	8.3	9.2
	70 / 10	2.6	5.1	7.7	10.3	12.8	15.4	18.0	20.5	23.1	25.7

6.1.370 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.148. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All of the Preferred Projects are beyond the mean-maximum foraging range of guillemot from the Howth Head Coast SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. Preferred Projects 4 and 6 are however, within the foraging range of guillemot when using the mean-maximum foraging range plus one standard deviation (153.7 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al.* (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual guillemots from the Howth Head Coast SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of displacement mortality.

6.1.371 There is no site-specific foraging range data available for guillemot from the Howth Head Coast SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Howth Head Coast SPA then this should only be a limited amount (e.g. 10%).

6.1.372 In the non-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning value used for the Preferred Projects in the Irish Sea is 0.1% and for the Preferred Projects in the North Sea is 0%. The apportioned values from each of the Preferred Projects combined to the Howth Head Coast SPA are presented in Table 6.149.

Table 6.149: Apportioned displacement mortality for guillemot at the Howth Head Coast SPA in non-breeding season

Displacement / mortality rate (%)	Preferred Project						Total
	1	2	3	4	5	6	
30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50 / 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70 / 10	0.0	0.0	0.0	0.0	0.0	0.0	0.1

6.1.373 The annual apportioned impact for guillemot at the Howth Head Coast SPA is provided in Table 6.150.

Table 6.150: Calculation of the annual impact attributable to guillemot at the Howth Head Coast SPA from the Round 4 Plan alone

Displacement / mortality assumptions	Breeding season		Non-breeding season						Total	Increase in baseline mortality (%)
	PP4	PP6	PP1	PP2	PP3	PP4	PP5	PP6		
30 / 1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3
50 / 5	1.4	0.9	0.0	0.0	0.0	0.0	0.0	0.0	2.4	2.9
70 / 10	3.9	2.6	0.0	0.0	0.0	0.0	0.0	0.0	6.6	8.1

6.1.374 The most likely impact (and most realistic worst case) for the Round 4 Plan alone from Table 6.150 is considered to be 2.4 birds. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the densities for guillemot from the MERP dataset potentially underestimate guillemot abundance.
- The appropriate apportioning value to apply. It is considered highly unlikely that a significant proportion of guillemot from Howth Head SPA will forage in the sea areas in which the Preferred Projects will be located. A value of 10% has been applied however, this is considered to be highly precautionary with auks unlikely to be found foraging at distances offshore commensurate with the distance between Howth Head SPA and the Preferred Projects.

6.1.375 Despite the predicted increase in baseline mortality exceeding the 1% baseline mortality threshold of the Howth Head SPA population (2.9%), the actual number of birds displaced is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.376 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Howth Head SPA.

Razorbill

Alone

6.1.377 Displacement analysis has been undertaken for razorbill using the approach advised in JNCC *et al.* (2017) (Annex H.1). To account for uncertainty in the analysis approach a range of displacement and mortality rates have been applied following the recommended approach to defining these in JNCC *et al.* (2017). Table 6.151 presents the unapportioned seasonal displacement mortality for razorbill at each of the Preferred Projects using the appropriate range of displacement and mortality rates. In the breeding season, there is connectivity between the Howth Head Coast SPA and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.151: Displacement mortality for razorbill at each of the Preferred Projects (unapportioned values) (no. of birds)

Preferred Project	Displacement rate (%)	Mortality rate (%)															
		Breeding				Post-breeding				Non-breeding				Pre-breeding			
		1	2	5	10	1	2	5	10	1	2	5	10	1	2	5	10
1	30	N/A				1	1	4	7	1	2	5	9	1	2	5	11
	40	N/A				1	2	5	10	1	3	6	13	1	3	7	14
	70	N/A				2	3	9	17	2	4	11	22	2	5	12	25
2	30	N/A				1	1	3	6	1	2	4	8	1	2	5	9
	40	N/A				1	2	4	8	1	2	5	10	1	2	6	12
	70	N/A				1	3	7	13	2	4	9	18	2	4	11	21
3	30	N/A				1	1	3	6	1	1	4	7	1	2	4	8
	40	N/A				1	1	4	7	1	2	5	10	1	2	6	11
	70	N/A				1	3	7	13	2	3	9	17	2	4	10	20
4	30	0	0	1	1	0	1	1	3	0	1	2	4	0	1	2	4
	40	0	0	1	2	0	1	2	4	0	1	2	5	1	1	3	5
	70	0	1	2	3	1	1	3	7	1	2	4	8	1	2	5	10
5	30	0	0	0	0	0	0	0	1	0	0	1	1	0	0	1	1
	40	0	0	0	1	0	0	1	1	0	0	1	2	0	0	1	2
	70	0	0	0	1	0	0	1	2	0	1	1	3	0	1	2	3
6	30	0	0	0	1	0	0	1	2	0	0	1	2	0	0	1	2

Preferred Project	Displacement rate (%)	Mortality rate (%)															
		Breeding				Post-breeding				Non-breeding				Pre-breeding			
		1	2	5	10	1	2	5	10	1	2	5	10	1	2	5	10
	40	0	0	1	1	0	0	1	2	0	1	1	3	0	1	2	3
	70	0	0	1	2	0	1	2	4	1	1	3	5	1	1	3	6

6.1.378 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.152.

Table 6.152: Breeding season apportioning for razorbill at Howth Head Coast SPA for the impact from all Preferred Projects with connectivity in the breeding season

Preferred Project	Displacement / mortality rate (%)	Apportioning value (%)									
		10	20	30	40	50	60	70	80	90	100
4	30 / 1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	40 / 5	0.1	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8	0.9
	70 / 10	0.3	0.6	1.0	1.3	1.6	1.9	2.2	2.6	2.9	3.2
5	30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	40 / 5	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3
	70 / 10	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
6	30 / 1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
	40 / 5	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.6
	70 / 10	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0

6.1.379 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.152. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All of the Preferred Projects are beyond the mean-maximum foraging range of razorbill from the Howth Head Coast SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. All of the Preferred Projects are however, within the foraging range of razorbill when using the mean-maximum foraging range plus one standard deviation (164.6 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al.* (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual razorbills from the Howth Head Coast SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of displacement mortality.

6.1.380 There is no site-specific foraging range data available for razorbill from the Howth Head Coast SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Howth Head Coast SPA then this should only be a limited amount (e.g. 10%).

6.1.381 In the post-, non- and pre-breeding seasons, the apportioning values presented in Annex H.3 have been applied. In the Irish Sea the apportioning values used in the post-, non- and pre-breeding seasons less than 0.09% in the post- and pre-breeding seasons and 0.07% in the non-breeding season and for the Preferred Projects in the North Sea the values are less than 0.01% in the pre-and post-breeding seasons and 0.01% in the non-breeding season. The apportioned values from each of the Preferred Projects combined to the Howth Head Coast SPA are presented in Table 6.153. In all cases the impact is less than 0.1 birds.

Table 6.153: Apportioned displacement mortality for razorbill at the Howth Head Coast SPA in non-breeding seasons

Preferred Project	Displacement rate (%)	Mortality rate (%)	Apportioned values		
			Post-breeding	Non-breeding	Pre-breeding
1	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0

Preferred Project	Displacement rate (%)	Mortality rate (%)	Apportioned values		
			Post-breeding	Non-breeding	Pre-breeding
	70	10	0.0	0.0	0.0
2	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0
3	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0
4	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0
5	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0
6	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0
Total	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0

6.1.382 The annual apportioned impact for razorbill at the Howth Head Coast SPA is provided in Table 6.154.

Table 6.154: Calculation of the annual impact attributable to razorbill at the Howth Head Coast SPA from the Round 4 Plan alone

Displacement / mortality assumptions	Breeding season			Non-breeding seasons (post-, non- and pre-seasons combined)						Total	Increase in baseline mortality (%)
	PP4	PP5	PP6	PP1	PP2	PP3	PP4	PP5	PP6		
30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40 / 5	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.3
70 / 10	0.3	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.0

6.1.383 The most likely impact, and realistic worst case, from the Round 4 Plan alone from Table 6.154 is considered to be less than one bird. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that razorbill densities from the MERP dataset potentially underestimate razorbill abundance.
- The apportioning value applied in the breeding season, it is unlikely that a significant proportion of razorbill from the Howth Head Coast SPA will utilize the Preferred Project areas and the assumption of 10% is likely an over-estimate but is applied on a precautionary basis.

6.1.384 A wider range of displacement rates are defined in JNCC *et al.* (2017) and these have been considered in the displacement analyses conducted. A precautionary approach has also been applied when considering the apportioning value to apply for all Preferred Projects with all three of the Preferred Projects beyond the mean-maximum foraging range of razorbill from Howth Head Coast SPA.

6.1.385 An impact of less than one bird represents 0.3% of the baseline mortality of the Howth Head Coast SPA razorbill population (557 breeding adults). When considering the impact associated with the most precautionary assumptions considered in Table 6.154, which is considered unrealistic due to an over-application of precaution, an annual displacement mortality of one bird is estimated. This represents an increase in baseline mortality of 1.0%. Under any of the scenarios presented, the actual displacement mortality is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.386 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Howth Head Coast SPA.

Inishtrahull SAC and SPA

Kittiwake

Alone

6.1.387 Collision risk modelling has been undertaken for kittiwake using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.155. In the breeding season, there is only connectivity between the Inishtrahull SPA and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.155: Collision risk estimates for kittiwake (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																
				Breeding season				Post-breeding							Pre-breeding						
				PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	98.9	3	2	3	8	29	21	5	2	1	2	59	21	15	3	1	0	1	41
			99.0	3	2	3	7	26	19	4	2	1	2	54	19	14	3	1	0	0	37
		8.71	98.9	2	2	2	6	22	16	3	1	1	1	45	16	12	2	0	0	0	31
			99.0	2	1	2	5	20	14	3	1	1	1	41	15	11	2	0	0	0	29
	3	13.1	98.9	4	2	3	9	37	26	6	2	1	2	75	28	20	4	1	0	1	53
			99.0	3	2	3	8	34	24	5	2	1	2	68	25	18	4	1	0	1	49
		8.71	98.9	3	2	2	7	28	20	4	2	1	2	58	21	15	3	1	0	1	41
			99.0	2	2	2	6	26	18	4	2	1	1	52	19	14	3	1	0	0	37
Option 3	2	13.1	98	1	1	1	3	14	10	1	1	0	1	27	10	7	1	0	0	0	19
		8.71	98	1	1	1	2	12	9	1	1	0	0	23	9	6	1	0	0	0	16
	3	13.1	98	1	1	1	3	18	13	2	1	1	1	34	13	9	1	0	0	0	24
		8.71	98	1	1	1	3	15	11	2	1	1	1	30	12	8	1	0	0	0	21

6.1.388 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.156, Table 6.157 and Table 6.158.

Table 6.156: Breeding season apportioning for kittiwake at Inishtrahull SPA for the impact from Preferred Project 4

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.3	0.6	0.9	1.2	1.6	1.9	2.2	2.5	2.8	3.1
			99.0	0.3	0.6	0.8	1.1	1.4	1.7	2.0	2.3	2.5	2.8
		8.71	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.3
			99.0	0.2	0.4	0.6	0.8	1.1	1.3	1.5	1.7	1.9	2.1
	3	13.1	98.9	0.4	0.7	1.1	1.4	1.8	2.1	2.5	2.8	3.2	3.5
			99.0	0.3	0.6	1.0	1.3	1.6	1.9	2.2	2.6	2.9	3.2
		8.71	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
			99.0	0.2	0.5	0.7	0.9	1.2	1.4	1.7	1.9	2.1	2.4
Option 3	2	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		8.71	98	0.1	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.8	0.9
	3	13.1	98	0.1	0.2	0.3	0.5	0.6	0.7	0.8	0.9	1.0	1.2
		8.71	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

Table 6.157: Breeding season apportioning for kittiwake at Inishtrahull SPA for the impact from Preferred Project 5

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.9
			99.0	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.4	1.5	1.7
		8.71	98.9	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.6
			99.0	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4
	3	13.1	98.9	0.2	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.9	2.1
			99.0	0.2	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9
		8.71	98.9	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.6	1.7
			99.0	0.2	0.3	0.5	0.6	0.8	1.0	1.1	1.3	1.4	1.6
Option 3	2	13.1	98	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
		8.71	98	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
	3	13.1	98	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8
		8.71	98	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8

Table 6.158: Breeding season apportioning for kittiwake at Inishtrahull SPA for the impact from Preferred Project 6

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.3	0.6	0.8	1.1	1.4	1.7	2.0	2.2	2.5	2.8
			99.0	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.0	2.3	2.6
		8.71	98.9	0.2	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.9	2.1
			99.0	0.2	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9
	3	13.1	98.9	0.3	0.6	0.9	1.3	1.6	1.9	2.2	2.5	2.8	3.2
			99.0	0.3	0.6	0.9	1.2	1.4	1.7	2.0	2.3	2.6	2.9
		8.71	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.4
			99.0	0.2	0.4	0.6	0.9	1.1	1.3	1.5	1.7	1.9	2.1
Option 3	2	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.8	0.9
		8.71	98	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.6	0.7	0.8
	3	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		8.71	98	0.1	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8	0.9

6.1.389 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.156, Table 6.157 and Table 6.158. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All of the Preferred Projects are beyond the mean-maximum foraging range of kittiwake from the Inishtrahull SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%.

6.1.390 All of the Preferred Projects are however, within the foraging range of kittiwake when using the mean-maximum foraging range plus one standard deviation (300.5 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al.* (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual kittiwakes from the Inishtrahull SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.391 There is no site-specific foraging range data available for kittiwake from the Inishtrahull SPA. However, the UK and Eire-wide utilisation distributions presented in Cleasby *et al.* (2018) suggest that the Preferred Projects lie beyond the 75% utilisation distribution band. This suggests limited connectivity between any kittiwake colony and the Preferred Projects and supports the use of a low apportioning value. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Inishtrahull SPA then this should only be a limited amount (e.g. 10%).

6.1.392 In the post-breeding and pre-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, and pre-breeding seasons for the Preferred Projects in the Irish Sea are 0.01% in both seasons and for the Preferred Projects in the North Sea are less than 0.01% in both seasons. The apportioned values from each of the Preferred Projects combined to the Inishtrahull SPA are presented in Table 6.159.

Table 6.159: Apportioning for kittiwake at Inishtrahull SPA in the post- and pre-breeding season for the impact from all Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
Option 2	2	13.1	98.9	0.0	0.0

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
			99.0	0.0	0.0
		8.71	98.9	0.0	0.0
			99.0	0.0	0.0
	3	13.1	98.9	0.0	0.0
			99.0	0.0	0.0
		8.71	98.9	0.0	0.0
			99.0	0.0	0.0
Option 3	2	13.1	98	0.0	0.0
		8.71	98	0.0	0.0
	3	13.1	98	0.0	0.0
		8.71	98	0.0	0.0

6.1.393 The annual apportioned impact for kittiwake at Inishtrahull SPA is provided in Table 6.160.

Table 6.160: Calculation of total impact attributable to kittiwake at Inishtrahull SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding			Post-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP4	PP5	PP6	All projects	All projects		
Option 2	2	13.1	98.9	0.3	0.2	0.3	0.0	0.0	0.8	6.20
			99.0	0.3	0.2	0.3	0.0	0.0	0.7	5.64
		8.71	98.9	0.2	0.2	0.2	0.0	0.0	0.6	4.75
			99.0	0.2	0.1	0.2	0.0	0.0	0.5	4.32
	3	13.1	98.9	0.4	0.2	0.3	0.0	0.0	0.9	6.98
			99.0	0.3	0.2	0.3	0.0	0.0	0.8	6.35
		8.71	98.9	0.3	0.2	0.2	0.0	0.0	0.7	5.35
			99.0	0.2	0.2	0.2	0.0	0.0	0.6	4.86
Option 3	2	13.1	98	0.1	0.1	0.1	0.0	0.0	0.3	2.12
		8.71	98	0.1	0.1	0.1	0.0	0.0	0.2	1.91
	3	13.1	98	0.1	0.1	0.1	0.0	0.0	0.3	2.39
		8.71	98	0.1	0.1	0.1	0.0	0.0	0.3	2.16

6.1.394 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.160 is considered to be 0.2-0.3 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that kittiwake densities from the MERP dataset potentially underestimate kittiwake abundance.
- The appropriate apportioning value to apply. It is considered highly unlikely that a significant proportion of kittiwake from the Inishtrahull SPA will forage in the sea areas in which the Preferred Projects will be located. A value of 10% has been applied however, this is considered to be highly precautionary with kittiwake unlikely to be found foraging at distances offshore commensurate with the distance between the Inishtrahull SPA and the Preferred Projects.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.
- The proportion of immatures present at each of the Preferred Projects.

6.1.395 Despite the predicted collision risk exceeding the 1% baseline mortality threshold of the Inishtrahull SPA population (1.91-2.16%), the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.396 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Inishtrahull SPA.

Ireland's Eye SAC and SPA

Gannet

Alone

Collision risk

6.1.397 Collision risk modelling has been undertaken for gannet using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.161. In the breeding season, there is only connectivity between the Ireland's Eye SPA and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.161: Collision risk estimates for gannet (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																
				Breeding season				Post-breeding							Pre-breeding						
				PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	1	14.9	98.9	5	3	6	14	1	1	0	0	0	0	2	2	1	0	0	0	0	4
			99.5	2	1	3	7	0	0	0	0	0	0	1	1	1	0	0	0	0	2
		13.33	98.9	5	3	5	13	1	0	0	0	0	0	2	2	1	0	0	0	0	4
			99.5	2	1	2	6	0	0	0	0	0	0	1	1	1	0	0	0	0	2
	2	14.9	98.9	6	4	7	17	1	1	0	0	0	0	2	3	2	0	0	0	0	6
			99.5	3	2	3	8	1	0	0	0	0	0	1	1	1	0	0	0	0	3
		13.33	98.9	6	4	6	16	1	1	0	0	0	0	2	3	2	0	0	0	0	5
			99.5	3	2	3	7	1	0	0	0	0	0	1	1	1	0	0	0	0	2

6.1.398 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.162, Table 6.163 and Table 6.164.

Table 6.162 Breeding season apportioning for gannet at Ireland's Eye SPA for the impact from Preferred Project 4

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	1	14.9	98.9	0.5	1.1	1.6	2.2	2.7	3.3	3.8	4.4	4.9	5.5
			99.5	0.2	0.5	0.7	1.0	1.2	1.5	1.7	2.0	2.2	2.5
		13.33	98.9	0.5	1.0	1.5	2.0	2.6	3.1	3.6	4.1	4.6	5.1
			99.5	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.3
	2	14.9	98.9	0.6	1.3	1.9	2.5	3.2	3.8	4.4	5.1	5.7	6.3
			99.5	0.3	0.6	0.9	1.2	1.4	1.7	2.0	2.3	2.6	2.9
		13.33	98.9	0.6	1.2	1.8	2.4	3.0	3.6	4.1	4.7	5.3	5.9
			99.5	0.3	0.5	0.8	1.1	1.3	1.6	1.9	2.2	2.4	2.7

Table 6.163 Breeding season apportioning for gannet at Ireland's Eye SPA for the impact from Preferred Project 5

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	1	14.9	98.9	0.3	0.7	1.0	1.3	1.6	2.0	2.3	2.6	2.9	3.3
			99.5	0.1	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.3	1.5
		13.33	98.9	0.3	0.6	0.9	1.2	1.5	1.9	2.2	2.5	2.8	3.1
			99.5	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4
	2	14.9	98.9	0.4	0.8	1.1	1.5	1.9	2.3	2.6	3.0	3.4	3.8
			99.5	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.5	1.7
		13.33	98.9	0.4	0.7	1.1	1.4	1.8	2.1	2.5	2.9	3.2	3.6
			99.5	0.2	0.3	0.5	0.7	0.8	1.0	1.1	1.3	1.5	1.6

Table 6.164 Breeding season apportioning for gannet at Ireland's Eye SPA for the impact from Preferred Project 6

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	1	14.9	98.9	0.6	1.1	1.7	2.3	2.8	3.4	3.9	4.5	5.1	5.6
			99.5	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.0	2.3	2.6
		13.33	98.9	0.5	1.1	1.6	2.1	2.6	3.2	3.7	4.2	4.7	5.3
			99.5	0.2	0.5	0.7	1.0	1.2	1.4	1.7	1.9	2.2	2.4
	2	14.9	98.9	0.7	1.3	2.0	2.6	3.3	3.9	4.6	5.2	5.9	6.5
			99.5	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0
		13.33	98.9	0.6	1.2	1.8	2.4	3.0	3.7	4.3	4.9	5.5	6.1
			99.5	0.3	0.6	0.8	1.1	1.4	1.7	1.9	2.2	2.5	2.8

6.1.399 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.162, Table 6.163 and Table 6.164. The three components of the population present at each of the Preferred Projects in the breeding season have been considered (see Annex H.3). The values associated with each of these population components is presented in Table 6.165 and multiplied together to provide an apportioning value for each of the Preferred Projects.

Table 6.165: Breeding season apportioning values for gannet at the Ireland's Eye SPA based on the approach applied in Annex H.3

Preferred Project	Proportion of breeding adult birds from SPA	Proportion of immature birds	Proportion of non-breeding birds	Overall breeding season apportioning value
4	0.01	0.426	0.1	<0.01
5	<0.01	0.426	0.1	<0.01
6	<0.01	0.426	0.1	<0.01

6.1.400 The results of the apportioning approach in Annex H.3 suggest that less than 1% of the predicted impact at each of the Preferred Projects is attributable to Ireland's Eye SPA. This is due to the small population present at the Ireland's Eye SPA when compared to other SPAs within the foraging range of gannet from the Preferred Projects including Ireland's Eye SPA.

6.1.401 The apportioning results in Annex H.3 have been reviewed against relevant site specific data. There is strong evidence showing space partitioning between gannet breeding colonies. The results shown in Wakefield *et al.* (2013) suggest that gannets from the Ireland's Eye SPA have a very restricted foraging range which does not interact with the sea areas in which the Preferred Projects are located. The sea areas in which the Preferred Projects are located is utilised by birds from the Ireland's Eye SPA and as gannets exhibit space partitioning these sea areas will not be utilised by birds from the Ireland's Eye SPA. The apportioning value for use in the breeding season is therefore set to 0%.

6.1.402 In the post-breeding and pre-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post- and pre-breeding seasons for the Preferred Projects in the Irish Sea are 0.01% and 0.01% and for the Preferred Projects in the North Sea is 0% in both seasons. The apportioned values from each of the Preferred Projects combined to the Ireland's Eye SPA are presented in Table 6.166. In all cases the apportioning impact is less than 0.1 collisions.

Table 6.166: Apportioning for gannet at the Ireland's Eye SPA in the post- and pre-breeding season for the impact from all Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
Option 2	1	14.9	98.9	0.0	0.0
			99.5	0.0	0.0
		13.33	98.9	0.0	0.0
			99.5	0.0	0.0
	2	14.9	98.9	0.0	0.0
			99.5	0.0	0.0
		13.33	98.9	0.0	0.0
			99.5	0.0	0.0

6.1.403 The annual apportioned impact for gannet at the Ireland's Eye SPA is provided in Table 6.167.

Table 6.167: Calculation of the annual impact attributable to gannet at the Ireland's Eye SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Post-breeding	Pre-breeding	Total	Increase in baseline mortality (%)
				All projects	All projects		
Option 2	1	14.9	98.9	0.0	0.0	0.0	0.00
			99.5	0.0	0.0	0.0	0.00
		13.33	98.9	0.0	0.0	0.0	0.00
			99.5	0.0	0.0	0.0	0.00
	2	14.9	98.9	0.0	0.0	0.0	0.00
			99.5	0.0	0.0	0.0	0.00
		13.33	98.9	0.0	0.0	0.0	0.00
			99.5	0.0	0.0	0.0	0.00

6.1.404 The values calculated in Table 6.167 take into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the gannet densities extracted from the MERP dataset are comparable with the exception of migratory periods where the use of the MERP dataset may underestimate gannet abundance.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.

6.1.405 In all cases the predicted impact is less than 0.1 collisions/annum representing less than a 0.1% increase in the baseline mortality of the gannet population at the Ireland's Eye SPA. Under any of the scenarios presented, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

Displacement

6.1.406 Displacement analysis has been undertaken for gannet using the approach advised in JNCC *et al*. (2017) (Annex H.1). To account for uncertainty in the analysis approach a range of displacement and mortality rates have been applied following the recommended approach to defining these in JNCC *et al*. (2017). Table 6.168 presents the unapportioned seasonal displacement mortality for gannet at each of the Preferred Projects using the appropriate range of displacement and mortality rates. The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.168: Displacement mortality for gannet at each of the Preferred Projects (unapportioned values) (no. of birds)

Preferred Project	Displacement rate (%)	Mortality rate (%)											
		Breeding				Post-breeding				Pre-breeding			
		1	2	5	10	1	2	5	10	1	2	5	10
1	60	N/A				1	2	4	9	1	1	4	7
	80	N/A				1	2	6	12	1	2	5	10
2	60	N/A				1	1	3	6	1	1	3	5
	80	N/A				1	2	4	8	1	1	3	7
3	60	N/A				1	2	4	8	1	1	4	7
	80	N/A				1	2	6	11	1	2	5	9
4	60	1	3	7	14	0	0	0	1	0	0	0	1
	80	2	4	9	18	0	0	1	1	0	0	0	1
5	60	0	1	2	4	0	0	0	0	0	0	0	0
	80	1	1	3	6	0	0	0	0	0	0	0	0
6	60	1	2	5	9	0	0	0	1	0	0	0	0
	80	1	2	6	12	0	0	0	1	0	0	0	1

6.1.407 In the breeding season, the population of birds present in an area of sea can be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.169.

Table 6.169: Breeding season apportioning for gannet at Ireland's Eye SPA for the impact from all Preferred Projects with connectivity in the breeding season

Preferred Project	Displacement / mortality rate (%)	Apportioning value (%)									
		10	20	30	40	50	60	70	80	90	100
1	60 / 1	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.2	1.4
	80 / 10	1.8	3.7	5.5	7.4	9.2	11.1	12.9	14.7	16.6	18.4
2	60 / 1	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.4	0.4
	80 / 10	0.6	1.1	1.7	2.3	2.9	3.4	4.0	4.6	5.2	5.7
3	60 / 1	0.1	0.2	0.3	0.4	0.5	0.6	0.6	0.7	0.8	0.9
	80 / 10	1.2	2.5	3.7	4.9	6.2	7.4	8.6	9.8	11.1	12.3

6.1.408 Discussion on the appropriate apportioning values to apply for gannet is provided in paragraphs 6.1.399 to 6.1.401 and those apportioning values to be applied in the breeding season at each of the Preferred Projects for gannet at Ireland's Eye SPA are summarised in Table 6.169.

6.1.409 In the post-breeding and pre-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post- and pre-breeding seasons for the Preferred Projects in the Irish Sea are 0.01% and 0.01% and for the Preferred Projects in the North Sea is 0% in both seasons. The apportioned values from each of the Preferred Projects combined to the Ireland's Eye SPA are presented in Table 6.170.

Table 6.170: Apportioning for gannet at Ireland's Eye SPA in the post- and pre-breeding season for the impact from all Preferred Projects

Preferred Project	Displacement rate (%)	Mortality rate (%)	Apportioned values	
			Post-breeding	Pre-breeding
1	60	1	0.0	0.0
	80	10	0.0	0.0
2	60	1	0.0	0.0
	80	10	0.0	0.0
3	60	1	0.0	0.0
	80	10	0.0	0.0
4	60	1	0.0	0.0
	80	10	0.0	0.0
5	60	1	0.0	0.0
	80	10	0.0	0.0
6	60	1	0.0	0.0
	80	10	0.0	0.0
Total	60	1	0.0	0.0
	80	10	0.0	0.0

6.1.410 The annual apportioned impact for gannet at the Ireland's Eye SPA is provided in Table 6.171.

Table 6.171: Calculation of the annual impact attributable to gannet at the Ireland's Eye SPA from the Round 4 Plan alone

Displacement / mortality assumptions	Post-breeding season						Pre-breeding season						Total	Increase in baseline mortality (%)
	PP1	PP2	PP3	PP4	PP5	PP6	PP1	PP2	PP3	PP4	PP5	PP6		
60 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
80 / 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00

6.1.411 The values calculated in Table 6.171 take into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the gannet densities extracted from the MERP dataset are comparable with the exception of migratory periods where the use of the MERP dataset may underestimate gannet abundance.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.

6.1.412 In all cases the predicted impact is less than 0.1 birds/annum representing less than a 0.1% increase in the baseline mortality of the gannet population at the Ireland's Eye SPA. Under any of the scenarios presented, the actual displacement mortality is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

Collision and displacement

6.1.413 The predicted impacts for both collision risk and displacement are less than 0.1 birds in all cases. This represents an increase of less than 0.1% in the baseline mortality of the gannet population at the Ireland's Eye SPA.

In-combination

Collision

6.1.414 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Ireland's Eye SPA.

Displacement

6.1.415 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Ireland's Eye SPA.

Collision and displacement

6.1.416 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Ireland's Eye SPA.

Kittiwake

Alone

6.1.417 Collision risk modelling has been undertaken for kittiwake using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.172. In the breeding season, there is only connectivity between the Ireland's Eye SPA and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in

Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.172: Collision risk estimates for kittiwake (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																
				Breeding season				Post-breeding							Pre-breeding						
				PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	98.9	3	2	3	8	29	21	5	2	1	2	59	21	15	3	1	0	1	41
			99.0	3	2	3	7	26	19	4	2	1	2	54	19	14	3	1	0	0	37
		8.71	98.9	2	2	2	6	22	16	3	1	1	1	45	16	12	2	0	0	0	31
			99.0	2	1	2	5	20	14	3	1	1	1	41	15	11	2	0	0	0	29
	3	13.1	98.9	4	2	3	9	37	26	6	2	1	2	75	28	20	4	1	0	1	53
			99.0	3	2	3	8	34	24	5	2	1	2	68	25	18	4	1	0	1	49
		8.71	98.9	3	2	2	7	28	20	4	2	1	2	58	21	15	3	1	0	1	41
			99.0	2	2	2	6	26	18	4	2	1	1	52	19	14	3	1	0	0	37
Option 3	2	13.1	98	1	1	1	3	14	10	1	1	0	1	27	10	7	1	0	0	0	19
		8.71	98	1	1	1	2	12	9	1	1	0	0	23	9	6	1	0	0	0	16
	3	13.1	98	1	1	1	3	18	13	2	1	1	1	34	13	9	1	0	0	0	24
		8.71	98	1	1	1	3	15	11	2	1	1	1	30	12	8	1	0	0	0	21

6.1.418 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.173, Table 6.174 and Table 6.175.

Table 6.173: Breeding season apportioning for kittiwake at Ireland's Eye SPA for the impact from Preferred Project 4

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.3	0.6	0.9	1.2	1.6	1.9	2.2	2.5	2.8	3.1
			99.0	0.3	0.6	0.8	1.1	1.4	1.7	2.0	2.3	2.5	2.8
		8.71	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.3
			99.0	0.2	0.4	0.6	0.8	1.1	1.3	1.5	1.7	1.9	2.1
	3	13.1	98.9	0.4	0.7	1.1	1.4	1.8	2.1	2.5	2.8	3.2	3.5
			99.0	0.3	0.6	1.0	1.3	1.6	1.9	2.2	2.6	2.9	3.2
		8.71	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
			99.0	0.2	0.5	0.7	0.9	1.2	1.4	1.7	1.9	2.1	2.4
Option 3	2	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		8.71	98	0.1	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.8	0.9
	3	13.1	98	0.1	0.2	0.3	0.5	0.6	0.7	0.8	0.9	1.0	1.2
		8.71	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

Table 6.174: Breeding season apportioning for kittiwake at Ireland's Eye SPA for the impact from Preferred Project 5

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.9
			99.0	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.4	1.5	1.7
		8.71	98.9	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.6
			99.0	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4
	3	13.1	98.9	0.2	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.9	2.1
			99.0	0.2	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9
		8.71	98.9	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.6	1.7
			99.0	0.2	0.3	0.5	0.6	0.8	1.0	1.1	1.3	1.4	1.6
Option 3	2	13.1	98	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
		8.71	98	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
	3	13.1	98	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8
		8.71	98	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8

Table 6.175: Breeding season apportioning for kittiwake at Ireland's Eye SPA for the impact from Preferred Project 6

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.3	0.6	0.8	1.1	1.4	1.7	2.0	2.2	2.5	2.8
			99.0	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.0	2.3	2.6
		8.71	98.9	0.2	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.9	2.1
			99.0	0.2	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9
	3	13.1	98.9	0.3	0.6	0.9	1.3	1.6	1.9	2.2	2.5	2.8	3.2
			99.0	0.3	0.6	0.9	1.2	1.4	1.7	2.0	2.3	2.6	2.9
		8.71	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.4
			99.0	0.2	0.4	0.6	0.9	1.1	1.3	1.5	1.7	1.9	2.1
Option 3	2	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.8	0.9
		8.71	98	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.6	0.7	0.8
	3	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		8.71	98	0.1	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8	0.9

6.1.419 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.173, Table 6.174 and Table 6.175. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). Preferred Project 5 is beyond the mean-maximum foraging range of kittiwake from the Ireland's Eye SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%.

6.1.420 Preferred Project 5 is however, within the foraging range of kittiwake when using the mean-maximum foraging range plus one standard deviation (300.5 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual kittiwakes from the Ireland's Eye SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.421 Preferred Projects 4 and 6 are within the mean-maximum foraging range of kittiwake and in order to identify the most realistic apportioning value to apply in the breeding season, the three components of the population present at each of the Preferred Projects have been considered (see Annex H.3). The values associated with each of these population components is presented in Table 6.176 and multiplied together to provide an apportioning value for both Preferred Projects.

Table 6.176: Breeding season apportioning values for kittiwake at the Ireland's Eye SPA based on the approach applied in Annex H.3

Preferred Project	Proportion of breeding adult birds from SPA	Proportion of immature birds	Proportion of non-breeding birds	Overall breeding season apportioning value
4	0.04	0.44	0.1	0.02
6	0.05	0.44	0.1	0.02

6.1.422 The results of the apportioning approach in Annex H.3 suggest that 2% and 2% of the predicted impact at Preferred Projects 4 and 6 respectively are attributable to the Ireland's Eye SPA. As mentioned in Section 5.2, the estimated proportion of immature birds in Table 6.176 does not take account of the distribution of

immature birds and may therefore over-estimate this component of the population present at each of the Preferred Projects.

6.1.423 There is no site-specific information in relation to the foraging behaviour of kittiwake from the Ireland's Eye SPA. However, the UK and Eire-wide utilisation distributions presented in Cleasby *et al.* (2018) suggest that the Preferred Projects lie beyond the 75% utilisation distribution band. This suggests limited connectivity between any kittiwake colony and the Preferred Projects and supports the use of a low apportioning value. Therefore if, due to the lack of site-specific data and on a precautionary basis, any impact from Preferred Project 5 is to be apportioned to the Ireland's Eye SPA then this should only be a limited amount and it is proposed that this be the same as that calculated for Preferred Project 6.

6.1.424 As there is no information on the proportion of immature birds present at Preferred Project 4 or 6 it is proposed that this component of the population be discounted accepting that this is will result in an over-estimation of the impact on the Ireland's Eye SPA. The apportioning value in the breeding season for Preferred Project 4, 5 and 6 would therefore be 0.04.

6.1.425 In the post-breeding and pre-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, and pre-breeding seasons for the Preferred Projects in the Irish Sea are 0.12% and 0.22% and for the Preferred Projects in the North Sea is less than 0.01% in both seasons. The apportioned values from each of the Preferred Projects combined to the Ireland's Eye SPA are presented in Table 6.177.

Table 6.177: Apportioning for kittiwake at the Ireland's Eye SPA in the post- and pre-breeding season for the impact from all Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
Option 2	2	13.1	98.9	0.0	0.0
			99.0	0.0	0.0
		8.71	98.9	0.0	0.0
			99.0	0.0	0.0
	3	13.1	98.9	0.0	0.0
			99.0	0.0	0.0
		8.71	98.9	0.0	0.0
			99.0	0.0	0.0
Option 3	2	13.1	98	0.0	0.0
		8.71	98	0.0	0.0
	3	13.1	98	0.0	0.0

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
		8.71	98	0.0	0.0

6.1.426 The annual apportioned impact for kittiwake at the Ireland's Eye SPA is provided in Table 6.178.

Table 6.178: Calculation of total impact attributable to kittiwake at the Ireland's Eye SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding			Post-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP4	PP5	PP6	All projects	All projects		
Option 2	2	13.1	98.9	0.1	0.1	0.1	0.0	0.0	0.3	0.12
			99.0	0.1	0.1	0.1	0.0	0.0	0.3	0.11
		8.71	98.9	0.1	0.1	0.1	0.0	0.0	0.2	0.09
			99.0	0.1	0.1	0.1	0.0	0.0	0.2	0.08
	3	13.1	98.9	0.1	0.1	0.1	0.0	0.0	0.4	0.13
			99.0	0.1	0.1	0.1	0.0	0.0	0.3	0.12
		8.71	98.9	0.1	0.1	0.1	0.0	0.0	0.3	0.10
			99.0	0.1	0.1	0.1	0.0	0.0	0.3	0.09
Option 3	2	13.1	98	0.0	0.0	0.0	0.0	0.0	0.1	0.04
		8.71	98	0.0	0.0	0.0	0.0	0.0	0.1	0.04
	3	13.1	98	0.0	0.0	0.0	0.0	0.0	0.1	0.05
		8.71	98	0.0	0.0	0.0	0.0	0.0	0.1	0.04

6.1.427 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.178 is considered to be 0.1 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that kittiwake densities from the MERP dataset potentially underestimate kittiwake abundance.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.
- The proportion of immatures present at each of the Preferred Projects.

6.1.428 An impact of 0.1 collisions/annum represents 0.04% of the baseline mortality of the Ireland's Eye SPA kittiwake population (1,882 breeding adults). When considering the highest impact estimated in Table 6.178, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 0.3-0.4 collisions/annum represents an increase in baseline mortality of 0.12-0.13%. Under any of the scenarios presented, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.429 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Ireland's Eye SPA.

Guillemot

Alone

6.1.430 Displacement analysis has been undertaken for guillemot using the approach advised in JNCC *et al.* (2017) (Annex H.1). To account for uncertainty in the analysis approach, a range of displacement and mortality rates have been applied following the recommended approach to defining these in JNCC *et al.* (2017). Table 6.179 presents the unapportioned seasonal displacement mortality for guillemot at each of the Preferred Projects using the appropriate range of displacement and mortality rates. In the breeding season, there is only connectivity between the Ireland's Eye SPA and Preferred Projects 4 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.179: Displacement mortality for guillemot at each of the Preferred Projects (unapportioned values) (no. of birds)

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
1	30	N/A				7	13	33	67
	50	N/A				11	22	56	112
	70	N/A				16	31	78	156
2	30	N/A				6	12	30	60
	50	N/A				10	20	50	100
	70	N/A				14	28	70	140
3	30	N/A				6	11	29	57
	50	N/A				10	19	48	95
	70	N/A				13	27	67	134
4	30	2	3	8	17	2	4	10	20
	50	3	6	14	28	3	7	17	34
	70	4	8	20	39	5	9	24	47
5	30					1	1	3	6
	50					1	2	5	10
	70					1	3	7	14
6	30	1	2	6	11	1	3	7	13

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
	50	2	4	9	18	2	4	11	22
	70	3	5	13	26	3	6	16	31

6.1.431 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.180.

Table 6.180: Breeding season apportioning for guillemot at Ireland's Eye SPA for the impact from all Preferred Projects with connectivity in the breeding season

Preferred Project	Displacement / mortality rate (%)	Apportioning value (%)									
		10	20	30	40	50	60	70	80	90	100
4	30 / 1	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.7
	50 / 5	1.4	2.8	4.2	5.6	7.0	8.4	9.8	11.2	12.6	14.1
	70 / 10	3.9	7.9	11.8	15.7	19.7	23.6	27.5	31.5	35.4	39.3
6	30 / 1	0.1	0.2	0.3	0.4	0.6	0.7	0.8	0.9	1.0	1.1
	50 / 5	0.9	1.8	2.8	3.7	4.6	5.5	6.4	7.3	8.3	9.2
	70 / 10	2.6	5.1	7.7	10.3	12.8	15.4	18.0	20.5	23.1	25.7

6.1.432 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.180. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All of the Preferred Projects are beyond the mean-maximum foraging range of guillemot from the Ireland's Eye SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. Preferred Projects 4 and 6 however, within the foraging range of guillemot when using the mean-maximum foraging range plus one standard deviation (153.7 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual guillemots from the Ireland's Eye SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of displacement mortality.

6.1.433 There is no site-specific foraging range data available for guillemot from the Ireland's Eye SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Ireland's Eye SPA then this should only be a limited amount (e.g. 10%).

6.1.434 In the non-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning value used for the Preferred Projects in the Irish Sea is 0.2% and for the Preferred Projects in the North Sea is 0%. The apportioned values from each of the Preferred Projects combined to the Ireland's Eye SPA are presented in Table 6.181.

Table 6.181: Apportioned displacement mortality for guillemot at the Ireland's Eye SPA in non-breeding season

Displacement / mortality rate (%)	Preferred Project						Total
	1	2	3	4	5	6	
30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50 / 5	0.0	0.0	0.0	0.0	0.0	0.0	0.1
70 / 10	0.0	0.0	0.0	0.1	0.0	0.1	0.2

6.1.435 The annual apportioned impact for guillemot at the Ireland's Eye SPA is provided in Table 6.182.

Table 6.182: Calculation of the annual impact attributable to guillemot at the Ireland's Eye SPA from the Round 4 Plan alone

Displacement / mortality assumptions	Breeding season		Non-breeding season						Total	Increase in baseline mortality (%)
	PP4	PP6	PP1	PP2	PP3	PP4	PP5	PP6		
30 / 1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.2
50 / 5	1.4	0.9	0.0	0.0	0.0	0.0	0.0	0.0	2.4	1.3
70 / 10	3.9	2.6	0.0	0.0	0.0	0.1	0.0	0.1	6.7	3.7

6.1.436 The most likely impact (and most realistic worst case) for the Round 4 Plan alone from Table 6.182 is considered to be 2.4 birds. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the densities for guillemot from the MERP dataset potentially underestimate guillemot abundance.
- The appropriate apportioning value to apply. It is considered highly unlikely that a significant proportion of guillemot from Ireland's Eye SPA will forage in the sea areas in which the Preferred Projects will be located. A value of 10% has been applied however, this is considered to be highly precautionary with auks unlikely to be found foraging at distances offshore commensurate with the distance between Ireland's Eye SPA and the Preferred Projects.

6.1.437 Despite the predicted displacement risk exceeding the 1% baseline mortality threshold of the Ireland's Eye SPA population (1.3%), the actual number of birds displaced is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.438 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Ireland's Eye SPA.

Razorbill

Alone

6.1.439 Displacement analysis has been undertaken for razorbill using the approach advised in JNCC *et al.* (2017) (Annex H.1). To account for uncertainty in the analysis approach a range of displacement and mortality rates have been applied following the recommended approach to defining these in JNCC *et al.* (2017). Table 6.183 presents the unapportioned seasonal displacement mortality for razorbill at each of the Preferred Projects using the appropriate range of displacement and mortality rates. In the breeding season, there is only connectivity between the Ireland's Eye SPA and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.183: Displacement mortality for razorbill at each of the Preferred Projects (unapportioned values) (no. of birds)

Preferred Project	Displacement rate (%)	Mortality rate (%)															
		Breeding				Post-breeding				Non-breeding				Pre-breeding			
		1	2	5	10	1	2	5	10	1	2	5	10	1	2	5	10
1	30	N/A				1	1	4	7	1	2	5	9	1	2	5	11
	40	N/A				1	2	5	10	1	3	6	13	1	3	7	14
	70	N/A				2	3	9	17	2	4	11	22	2	5	12	25
2	30	N/A				1	1	3	6	1	2	4	8	1	2	5	9
	40	N/A				1	2	4	8	1	2	5	10	1	2	6	12
	70	N/A				1	3	7	13	2	4	9	18	2	4	11	21
3	30	N/A				1	1	3	6	1	1	4	7	1	2	4	8
	40	N/A				1	1	4	7	1	2	5	10	1	2	6	11
	70	N/A				1	3	7	13	2	3	9	17	2	4	10	20
4	30	0	0	1	1	0	1	1	3	0	1	2	4	0	1	2	4
	40	0	0	1	2	0	1	2	4	0	1	2	5	1	1	3	5
	70	0	1	2	3	1	1	3	7	1	2	4	8	1	2	5	10
5	30	0	0	0	0	0	0	0	1	0	0	1	1	0	0	1	1
	40	0	0	0	1	0	0	1	1	0	0	1	2	0	0	1	2
	70	0	0	0	1	0	0	1	2	0	1	1	3	0	1	2	3
6	30	0	0	0	1	0	0	1	2	0	0	1	2	0	0	1	2

Preferred Project	Displacement rate (%)	Mortality rate (%)															
		Breeding				Post-breeding				Non-breeding				Pre-breeding			
		1	2	5	10	1	2	5	10	1	2	5	10	1	2	5	10
	40	0	0	1	1	0	0	1	2	0	1	1	3	0	1	2	3
	70	0	0	1	2	0	1	2	4	1	1	3	5	1	1	3	6

6.1.440 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.184.

Table 6.184: Breeding season apportioning for razorbill at Ireland's Eye SPA for the impact from all Preferred Projects with connectivity in the breeding season

Preferred Project	Displacement / mortality rate (%)	Apportioning value (%)									
		10	20	30	40	50	60	70	80	90	100
4	30 / 1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	40 / 5	0.1	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8	0.9
	70 / 10	0.3	0.6	1.0	1.3	1.6	1.9	2.2	2.6	2.9	3.2
5	30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	40 / 5	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3
	70 / 10	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
6	30 / 1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
	40 / 5	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.6
	70 / 10	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0

6.1.441 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.184. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All of the Preferred Projects are beyond the mean-maximum foraging range of razorbill from the Ireland's Eye SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. All of the Preferred Projects are however, within the foraging range of razorbill when using the mean-maximum foraging range plus one standard deviation (164.6 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al.* (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual razorbill from the Ireland's Eye SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of displacement mortality.

6.1.442 There is no site-specific foraging range data available for razorbill from the Ireland's Eye SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Ireland's Eye SPA then this should only be a limited amount (e.g. 10%).

6.1.443 In the post-, non- and pre-breeding seasons, the apportioning values presented in Annex H.3 have been applied. In the Irish Sea the apportioning values used in the post-, non- and pre-breeding seasons 0.11%, 0.08% and 0.11%, respectively and for the Preferred Projects in the North Sea the values are less than 0.01% in the post- and pre-breeding seasons and 0.02% in the non-breeding season. The apportioned values from each of the Preferred Projects combined to the Ireland's Eye SPA are presented in Table 6.185.

Table 6.185: Apportioned displacement mortality for razorbill at the Ireland's Eye SPA in non-breeding seasons

Preferred Project	Displacement rate (%)	Mortality rate (%)	Apportioned values		
			Post-breeding	Non-breeding	Pre-breeding
1	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0

Preferred Project	Displacement rate (%)	Mortality rate (%)	Apportioned values		
			Post-breeding	Non-breeding	Pre-breeding
2	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0
3	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0
4	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0
5	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0
6	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0
Total	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0

6.1.444 The annual apportioned impact for razorbill at the Ireland's Eye SPA is provided in Table 6.186.

Table 6.186: Calculation of the annual impact attributable to razorbill at the Ireland's Eye SPA from the Round 4 Plan alone

Displacement / mortality assumptions	Breeding season			Non-breeding seasons (post-, non- and pre-seasons combined)						Total	Increase in baseline mortality (%)
	PP4	PP5	PP6	PP1	PP2	PP3	PP4	PP5	PP6		
30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40 / 5	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.3
70 / 10	0.3	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.9

6.1.445 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.186 is considered to be less than one bird. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that razorbill densities from the MERP dataset potentially underestimate razorbill abundance.
- The apportioning value applied in the breeding season, it is unlikely that a significant proportion of razorbill from the Ireland's Eye SPA will utilize the Preferred Project areas and the assumption of 10% is likely an over-estimate but is applied on a precautionary basis.

6.1.446 A wider range of displacement rates are defined in JNCC *et al.* (2017) and these have been considered in the displacement analyses conducted. A precautionary approach has also been applied when considering the apportioning value to apply for all Preferred Projects with all three of the Preferred Projects beyond the mean-maximum foraging range of razorbill from Ireland's Eye SPA.

6.1.447 An impact of less than one bird represents 0.3% of the baseline mortality of the Ireland's Eye SPA razorbill population (699 breeding adults). When considering the highest impact in Table 6.186, which is considered unrealistic due to an over-application of precaution, an annual displacement mortality of one bird is estimated. This represents an increase in baseline mortality of 0.9%. Under any of the scenarios presented, the actual displacement mortality is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.448 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Ireland's Eye SPA.

Puffin

Alone

6.1.449 Displacement analysis has been undertaken for puffin using the approach advised in JNCC *et al.* (2017) (Annex H.1). To account for uncertainty in the analysis approach a range of displacement and mortality rates have been applied following the recommended approach to defining these in JNCC *et al.* (2017). Table 6.187 presents the unapportioned seasonal displacement mortality for puffin at each of the Preferred Projects using the appropriate range of displacement and mortality rates. In the breeding season, there is only connectivity between the Ireland's Eye SPA and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.187: Displacement mortality for puffin at each of the Preferred Projects (unapportioned values) (no. of birds)

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
1	30	N/A				1	2	4	8
	50	N/A				1	3	6	13
	70	N/A				2	4	9	18
2	30	N/A				1	1	3	5
	50	N/A				1	2	5	9
	70	N/A				1	3	6	13
3	30	N/A				1	1	3	6
	50	N/A				1	2	5	9
	70	N/A				1	3	6	13
4	30	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0
	70	0	0	0	0	0	0	0	0
5	30	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0
	70	0	0	0	0	0	0	0	0
6	30	0	0	0	0	0	0	0	0

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
	50	0	0	0	0	0	0	0	0
	70	0	0	0	0	0	0	0	0

6.1.450 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.188.

Table 6.188: Breeding season apportioning for puffin at Ireland's Eye SPA for the impact from all Preferred Projects with connectivity in the breeding season

Preferred Project	Displacement / mortality rate (%)	Apportioning value (%)									
		10	20	30	40	50	60	70	80	90	100
4	30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	50 / 5	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	70 / 10	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.4
5	30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	50 / 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	70 / 10	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
6	30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	50 / 5	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
	70 / 10	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2

6.1.451 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.188. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). Preferred Projects 5 and 6 are beyond the mean-maximum foraging range of puffin from the Ireland's Eye SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. Both of the Preferred Projects are however, within the foraging range of puffin when using the mean-maximum foraging range plus one standard deviation (265.4 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual puffin from the Ireland's Eye SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of displacement mortality.

6.1.452 Preferred Project 4 is on the edge of the mean-maximum foraging range, with the centre of the wind farm, used in the apportioning approach in Annex H.3 lying outside of the mean-maximum foraging range. As a result the apportioning value calculated for Preferred Project 4 is 0%.

6.1.453 There is no site-specific foraging range data available for puffin from the Ireland's Eye SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Ireland's Eye SPA then this should only be a limited amount (e.g. 10%).

6.1.454 In the non-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning value used for the Preferred Projects in the Irish Sea is less than 0.01% and for the Preferred Projects in the North Sea is also less than 0.01%. The apportioned values from each of the Preferred Projects combined to the Ireland's Eye SPA are presented in Table 6.189.

Table 6.189: Apportioned displacement mortality for puffin at the Ireland's Eye SPA in the non-breeding season

Displacement / mortality rate (%)	Preferred Project						Total
	1	2	3	4	5	6	
30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Displacement / mortality rate (%)	Preferred Project						Total
	1	2	3	4	5	6	
50 / 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70 / 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0

6.1.455 The annual apportioned impact for puffin at the Ireland's Eye SPA is provided in Table 6.190.

Table 6.190: Calculation of the annual impact attributable puffin at the Ireland's Eye SPA from the Round 4 Plan alone

Displacement / mortality assumptions	Breeding season			Non-breeding season						Total	Increase in baseline mortality (%)
	PP4	PP5	PP6	PP1	PP2	PP3	PP4	PP5	PP6		
30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.15
50 / 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.26
70 / 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	3.53

6.1.456 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.190 is considered to be less than one bird. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that puffin densities from the MERP dataset potentially over-estimate puffin abundance.
- The apportioning value applied in the breeding season, it is unlikely that a significant proportion of puffin from the Ireland's Eye SPA will utilize the Preferred Project areas and the assumption of 10% is likely an over-estimate but is applied on a precautionary basis.

6.1.457 An impact of less than one bird represents 1.26% of the baseline mortality of the Ireland's Eye SPA puffin population (20 breeding adults). When considering the highest impact in Table 6.190, which is considered unrealistic due to an over-application of precaution, an annual displacement mortality of 0.1 birds is estimated. This represents an increase in baseline mortality of 3.53%. However, the actual displacement mortality predicted is considerably less than one bird and there are considered to be significant assumptions which lead to over-estimation associated with the predicted displacement mortality.

In-combination

6.1.458 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Ireland's Eye SPA.

Lambay Island SAC and SPA

Lesser black-backed gull

Alone

6.1.459 Collision risk modelling for the Round 4 Plan has been undertaken for lesser black-backed gull using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated a range of values for a number of input parameters. The results of collision risk modelling for each Preferred Project are presented on an unapportioned seasonal basis in Table 6.191. In the breeding season, there is only connectivity between the designated site and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.191: Collision risk estimates for lesser black-backed gull (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																								
				Breeding season				Post-breeding							Non-breeding							Pre-breeding						
				PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	99.5	4	5	4	13	1	1	0	1	1	0	5	2	2	1	1	1	1	7	1	1	0	0	0	0	3
		9.8	99.5	3	5	3	11	1	1	0	0	1	0	4	1	2	0	1	1	0	6	1	1	0	0	0	0	3
	3	13.1	99.5	5	6	4	15	1	2	0	1	1	1	6	2	3	1	1	1	1	9	1	1	0	0	1	0	4
		9.8	99.5	4	5	3	12	1	1	0	1	1	0	5	2	3	1	1	1	1	7	1	1	0	0	0	0	3
Option 3	2	13.1	98.9	3	4	2	9	1	1	0	0	0	0	4	1	2	0	0	1	0	5	1	1	0	0	0	0	3
			99.3	2	2	2	6	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
		9.8	98.9	2	4	2	8	1	1	0	0	0	0	3	1	2	0	0	1	0	5	1	1	0	0	0	0	2
			99.3	1	2	1	5	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
	3	13.1	98.9	3	4	3	10	1	1	0	0	1	0	4	2	3	0	1	1	0	7	1	1	0	0	0	0	3
			99.3	2	3	2	6	1	1	0	0	0	0	3	1	2	0	0	0	0	4	1	1	0	0	0	0	2
		9.8	98.9	3	4	2	9	1	1	0	0	1	0	4	2	2	0	0	1	0	6	1	1	0	0	0	0	3
			99.3	2	3	2	6	1	1	0	0	0	0	2	1	2	0	0	0	0	4	1	1	0	0	0	0	2

6.1.460 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.192, Table 6.193 and Table 6.194.

Table 6.192: Breeding season apportioning for lesser black-backed gull at the Lambay Island SPA for the impact from Preferred Project 4

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.4	0.8	1.2	1.6	2.0	2.4	2.9	3.3	3.7	4.1
		9.8	99.5	0.3	0.7	1.0	1.3	1.7	2.0	2.4	2.7	3.0	3.4
	3	13.1	99.5	0.5	0.9	1.4	1.8	2.3	2.7	3.2	3.6	4.1	4.5
		9.8	99.5	0.4	0.8	1.1	1.5	1.9	2.3	2.6	3.0	3.4	3.8
Option 3	2	13.1	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
			99.3	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.6
		9.8	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.4
			99.3	0.1	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.3	1.5
	3	13.1	98.9	0.3	0.6	0.9	1.2	1.4	1.7	2.0	2.3	2.6	2.9
			99.3	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.8
		9.8	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.4	2.6
			99.3	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.7

Table 6.193: Breeding season apportioning for lesser black-backed gull at the Lambay Island SPA for the impact from Preferred Project 5

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.5	1.1	1.6	2.1	2.6	3.2	3.7	4.2	4.8	5.3
		9.8	99.5	0.5	0.9	1.4	1.9	2.3	2.8	3.3	3.7	4.2	4.7
	3	13.1	99.5	0.6	1.2	1.8	2.4	2.9	3.5	4.1	4.7	5.3	5.9
		9.8	99.5	0.5	1.0	1.6	2.1	2.6	3.1	3.6	4.2	4.7	5.2
Option 3	2	13.1	98.9	0.4	0.7	1.1	1.5	1.8	2.2	2.6	2.9	3.3	3.7
			99.3	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.3
		9.8	98.9	0.4	0.7	1.1	1.4	1.8	2.2	2.5	2.9	3.3	3.6
			99.3	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.8	2.1	2.3
	3	13.1	98.9	0.4	0.8	1.2	1.6	2.0	2.4	2.9	3.3	3.7	4.1
			99.3	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
		9.8	98.9	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0
			99.3	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.1	2.3	2.6

Table 6.194: Breeding season apportioning for lesser black-backed gull at the Lambay Island SPA for the impact from Preferred Project 6

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.4	0.8	1.1	1.5	1.9	2.3	2.7	3.0	3.4	3.8
		9.8	99.5	0.3	0.6	0.9	1.3	1.6	1.9	2.2	2.5	2.8	3.1
	3	13.1	99.5	0.4	0.8	1.3	1.7	2.1	2.5	3.0	3.4	3.8	4.2
		9.8	99.5	0.3	0.7	1.0	1.4	1.7	2.1	2.4	2.8	3.1	3.5
Option 3	2	13.1	98.9	0.2	0.5	0.7	1.0	1.2	1.4	1.7	1.9	2.2	2.4
			99.3	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5
		9.8	98.9	0.2	0.4	0.7	0.9	1.1	1.3	1.5	1.7	2.0	2.2
			99.3	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4
	3	13.1	98.9	0.3	0.5	0.8	1.1	1.3	1.6	1.9	2.1	2.4	2.7
			99.3	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.5	1.7
		9.8	98.9	0.2	0.5	0.7	1.0	1.2	1.5	1.7	1.9	2.2	2.4
			99.3	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5

6.1.461 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.192, Table 6.193 and Table 6.194. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al*. (2019). All of the Preferred Projects are beyond the mean-maximum foraging range of lesser black-backed gull from the Lambay Island SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. All three projects are however, within the foraging range of lesser black-backed gull when using the mean-maximum foraging range plus one standard deviation for lesser black-backed gull (236 km) presented in Woodward *et al*. (2019). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual lesser black-backed gulls from the Lambay Island SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.462 There is no site-specific foraging range data available for lesser black-backed gull from the Lambay Island SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Lambay Island SPA then this should only be a limited amount (e.g. 10%).

6.1.463 In the post-, non- and pre-breeding seasons, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, non- and pre-breeding seasons for the Preferred Projects in the Irish Sea are 0.19%, 0.3% and 0.19%, respectively. For the Preferred Projects in the North Sea the values are 0.15%, 0.16% and 0.16%, respectively. The apportioned values from each of the Preferred Projects combined to the Lambay Island SPA are presented in Table 6.195. In all cases the impact is less than 0.1 collisions.

Table 6.195: Apportioned collision risk estimates for lesser black-backed gull at the Lambay Island SPA in non-breeding seasons

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values		
				Post-breeding	Non-breeding	Pre-breeding
Option 2	2	13.1	99.5	0.0	0.0	0.0
		9.8	99.5	0.0	0.0	0.0

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values		
				Post-breeding	Non-breeding	Pre-breeding
	3	13.1	99.5	0.0	0.0	0.0
		9.8	99.5	0.0	0.0	0.0
Option 3	2	13.1	98.9	0.0	0.0	0.0
			99.3	0.0	0.0	0.0
		9.8	98.9	0.0	0.0	0.0
			99.3	0.0	0.0	0.0
	3	13.1	98.9	0.0	0.0	0.0
			99.3	0.0	0.0	0.0
		9.8	98.9	0.0	0.0	0.0
			99.3	0.0	0.0	0.0

6.1.464 The annual apportioned impact for lesser black-backed gull at the Lambay Island SPA is provided in Table 6.196.

Table 6.196: Calculation of the annual impact attributable to lesser black-backed gull at the Lambay Island SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding			Post-breeding	Non-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP4	PP5	PP6	All projects	All projects	All projects		
Option 2	2	13.1	99.5	0.4	0.5	0.4	0.0	0.0	0.0	1.3	1.89
		9.8	99.5	0.3	0.5	0.3	0.0	0.0	0.0	1.1	1.60
	3	13.1	99.5	0.5	0.6	0.4	0.0	0.0	0.0	1.5	2.11
		9.8	99.5	0.4	0.5	0.3	0.0	0.0	0.0	1.3	1.79
Option 3	2	13.1	98.9	0.3	0.4	0.2	0.0	0.0	0.0	0.9	1.25
			99.3	0.2	0.2	0.2	0.0	0.0	0.0	0.6	0.79
		9.8	98.9	0.2	0.4	0.2	0.0	0.0	0.0	0.8	1.17
			99.3	0.1	0.2	0.1	0.0	0.0	0.0	0.5	0.75
	3	13.1	98.9	0.3	0.4	0.3	0.0	0.0	0.0	1.0	1.39
			99.3	0.2	0.3	0.2	0.0	0.0	0.0	0.6	0.89
		9.8	98.9	0.3	0.4	0.2	0.0	0.0	0.0	0.9	1.31
			99.3	0.2	0.3	0.2	0.0	0.0	0.0	0.6	0.83

6.1.465 The most likely impact (and most realistic worst case) for the Round 4 Plan alone from Table 6.196 is considered to be 0.5-0.6 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the densities for lesser black-backed gull from the MERP dataset potentially overestimate lesser black-backed gull abundance.
- The appropriate apportioning value to apply. It is considered highly unlikely that a significant proportion of lesser black-backed gulls from Lambay Island SPA will forage in the sea areas in which the Preferred Projects will be located. A value of 10% has been applied however, this is considered to be highly precautionary with large gulls unlikely to be found foraging at distances offshore commensurate with the distance between Lambay Island SPA and the Preferred Projects.

6.1.466 An impact of 0.5-0.6 collisions/annum represents 0.75-0.83% of the baseline mortality of the Lambay Island SPA lesser black-backed gull population (618 breeding adults). When considering the highest impact estimated in Table 6.196, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 1.3-1.5 collisions/annum represents an increase in baseline mortality of 1.89-2.11%.

6.1.467 Despite the predicted collision risk exceeding the 1% baseline mortality threshold of the Lambay Island SPA population, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.468 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Lambay Island SPA.

Kittiwake

Alone

6.1.469 Collision risk modelling has been undertaken for kittiwake using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.197. In the breeding season, there is only connectivity between the Lambay Island SPA and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.197: Collision risk estimates for kittiwake (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																
				Breeding season				Post-breeding							Pre-breeding						
				PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	98.9	3	2	3	8	29	21	5	2	1	2	59	21	15	3	1	0	1	41
			99.0	3	2	3	7	26	19	4	2	1	2	54	19	14	3	1	0	0	37
		8.71	98.9	2	2	2	6	22	16	3	1	1	1	45	16	12	2	0	0	0	31
			99.0	2	1	2	5	20	14	3	1	1	1	41	15	11	2	0	0	0	29
	3	13.1	98.9	4	2	3	9	37	26	6	2	1	2	75	28	20	4	1	0	1	53
			99.0	3	2	3	8	34	24	5	2	1	2	68	25	18	4	1	0	1	49
		8.71	98.9	3	2	2	7	28	20	4	2	1	2	58	21	15	3	1	0	1	41
			99.0	2	2	2	6	26	18	4	2	1	1	52	19	14	3	1	0	0	37
Option 3	2	13.1	98	1	1	1	3	14	10	1	1	0	1	27	10	7	1	0	0	0	19
		8.71	98	1	1	1	2	12	9	1	1	0	0	23	9	6	1	0	0	0	16
	3	13.1	98	1	1	1	3	18	13	2	1	1	1	34	13	9	1	0	0	0	24
		8.71	98	1	1	1	3	15	11	2	1	1	1	30	12	8	1	0	0	0	21

6.1.470 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.198, Table 6.199 and Table 6.200.

Table 6.198: Breeding season apportioning for kittiwake at Lambay Island SPA for the impact from Preferred Project 4

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.3	0.6	0.9	1.2	1.6	1.9	2.2	2.5	2.8	3.1
			99.0	0.3	0.6	0.8	1.1	1.4	1.7	2.0	2.3	2.5	2.8
		8.71	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.3
			99.0	0.2	0.4	0.6	0.8	1.1	1.3	1.5	1.7	1.9	2.1
	3	13.1	98.9	0.4	0.7	1.1	1.4	1.8	2.1	2.5	2.8	3.2	3.5
			99.0	0.3	0.6	1.0	1.3	1.6	1.9	2.2	2.6	2.9	3.2
		8.71	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
			99.0	0.2	0.5	0.7	0.9	1.2	1.4	1.7	1.9	2.1	2.4
Option 3	2	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		8.71	98	0.1	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.8	0.9
	3	13.1	98	0.1	0.2	0.3	0.5	0.6	0.7	0.8	0.9	1.0	1.2
		8.71	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

Table 6.199: Breeding season apportioning for kittiwake at Lambay Island SPA for the impact from Preferred Project 5

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.9
			99.0	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.4	1.5	1.7
		8.71	98.9	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.6
			99.0	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4
	3	13.1	98.9	0.2	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.9	2.1
			99.0	0.2	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9
		8.71	98.9	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.6	1.7
			99.0	0.2	0.3	0.5	0.6	0.8	1.0	1.1	1.3	1.4	1.6
Option 3	2	13.1	98	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
		8.71	98	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
	3	13.1	98	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8
		8.71	98	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8

Table 6.200: Breeding season apportioning for kittiwake at Lambay Island SPA for the impact from Preferred Project 6

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.3	0.6	0.8	1.1	1.4	1.7	2.0	2.2	2.5	2.8
			99.0	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.0	2.3	2.6
		8.71	98.9	0.2	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.9	2.1
			99.0	0.2	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9
	3	13.1	98.9	0.3	0.6	0.9	1.3	1.6	1.9	2.2	2.5	2.8	3.2
			99.0	0.3	0.6	0.9	1.2	1.4	1.7	2.0	2.3	2.6	2.9
		8.71	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.4
			99.0	0.2	0.4	0.6	0.9	1.1	1.3	1.5	1.7	1.9	2.1
Option 3	2	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.8	0.9
		8.71	98	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.6	0.7	0.8
	3	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		8.71	98	0.1	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8	0.9

6.1.471 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.198, Table 6.199 and Table 6.200. All three of the Preferred Projects are within the mean-maximum foraging range of kittiwake from Lambay Island SPA. Preferred Project 5 is on the edge of the mean-maximum foraging range, with the centre of the wind farm, used in the apportioning approach in Annex H.3 lying outside of the mean-maximum foraging range. As a result the apportioning value calculated for Preferred Project 5 is 0%. For the remaining two Preferred Projects, the three components of the population present at each project have been considered (see Annex H.3). The values associated with each of these population components are presented in Table 6.201 and multiplied together to provide an apportioning value for each of the Preferred Projects.

Table 6.201: Breeding season apportioning values for kittiwake at Lambay Island SPA based on the approach applied in Annex H.3

Preferred Project	Proportion of breeding adult birds from SPA	Proportion of immature birds	Proportion of non-breeding birds	Overall breeding season apportioning value
4	0.1	0.44	0.1	0.05
6	0.11	0.44	0.1	0.06

6.1.472 The results of the apportioning approach in Annex H.3 suggest that between 5-6% of the predicted impact at Preferred Projects 4 and 6 is attributable to Lambay Island SPA. As mentioned in Section 5.2, the estimated proportion of immature birds in Table 6.201 does not take account of the distribution of immature birds and may therefore over-estimate this component of the population present at each of the Preferred Projects.

6.1.473 A total of 19 kittiwakes were tagged at Lambay Island in 2009 (12) and 2010 (7) with four of these considered to represent foraging trips (2 in both years). The maximum distance travelled by birds whilst foraging was 29.9 km in 2009 and 25.6 km in 2010 both considerably shorter than the distance between the colony and the Preferred Projects (Chivers *et al.,* 2012). These foraging distances are however, only representative of a small number of birds and may therefore not reflect the foraging behaviour of birds at the colony.

6.1.474 The UK and Eire-wide utilisation distributions presented in Cleasby *et al.* (2018) suggest that the Preferred Projects lie beyond the 75% utilisation distribution band of kittiwake. This suggests that the sea areas in which the Preferred Projects are located do not represent an important area for kittiwakes and any usage of these areas is likely by birds from more local colonies. Despite this, and on a precautionary basis, it is considered appropriate to apportion some of breeding season impact from the Preferred Projects to the Lambay Island SPA kittiwake population.

6.1.475 As there is no information on the proportion of immature birds present at Preferred Projects it is proposed that this component of the population be discounted accepting that this is will result in an over-estimation of the impact on the Lambay Island SPA. The apportioning value in the breeding season would therefore be 9% for Preferred Project 4 and 10% for Preferred Project 6. On a precautionary basis the highest of these two values is also applied to Preferred Project 5 in the breeding season.

6.1.476 In the post-breeding and pre-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, and pre-breeding seasons for the Preferred Projects in the Irish Sea are 0.54% and 0.95% and for the Preferred Projects in the North Sea are 0.01% and 0.01%. The apportioned values from each of the Preferred Projects combined to the Lambay Island SPA are presented in Table 6.202.

Table 6.202: Apportioning for kittiwake at Lambay Island SPA in the post- and pre-breeding season for the impact from all Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
Option 2	2	13.1	98.9	0.0	0.0
			99.0	0.0	0.0
		8.71	98.9	0.0	0.0
			99.0	0.0	0.0
	3	13.1	98.9	0.0	0.0
			99.0	0.0	0.0
		8.71	98.9	0.0	0.0
			99.0	0.0	0.0
Option 3	2	13.1	98	0.0	0.0
		8.71	98	0.0	0.0
	3	13.1	98	0.0	0.0
		8.71	98	0.0	0.0

6.1.477 The annual apportioned impact for kittiwake at Lambay Island SPA is provided in Table 6.203.

Table 6.203: Calculation of total impact attributable to kittiwake at Lambay Island from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding			Post-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP4	PP5	PP6	All projects	All projects		
Option 2	2	13.1	98.9	0.3	0.2	0.3	0.0	0.0	0.8	0.07
			99.0	0.2	0.2	0.3	0.0	0.0	0.7	0.06
		8.71	98.9	0.2	0.2	0.2	0.0	0.0	0.6	0.05
			99.0	0.2	0.1	0.2	0.0	0.0	0.5	0.05
	3	13.1	98.9	0.3	0.2	0.3	0.0	0.0	0.9	0.07
			99.0	0.3	0.2	0.3	0.0	0.0	0.8	0.07
		8.71	98.9	0.2	0.2	0.2	0.0	0.0	0.7	0.06
			99.0	0.2	0.2	0.2	0.0	0.0	0.6	0.05
Option 3	2	13.1	98	0.1	0.1	0.1	0.0	0.0	0.3	0.02
		8.71	98	0.1	0.1	0.1	0.0	0.0	0.2	0.02
	3	13.1	98	0.1	0.1	0.1	0.0	0.0	0.3	0.03
		8.71	98	0.1	0.1	0.1	0.0	0.0	0.3	0.02

6.1.478 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.203 is considered to be 0.2-0.3 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that kittiwake densities from the MERP dataset potentially underestimate kittiwake abundance.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.
- The proportion of immatures present at each of the Preferred Projects.

6.1.479 An impact of 0.2-0.3 collisions/annum represents 0.02% of the baseline mortality of the Lambay Island SPA kittiwake population (8,182 breeding adults). When considering the highest impact estimated in Table 6.203, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 0.8-0.9 collisions/annum represents an increase in baseline mortality of 0.07%. Under any of the scenarios presented, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.480 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Lambay Island SPA.

Guillemot

Alone

6.1.481 Displacement analysis has been undertaken for guillemot using the approach advised in JNCC *et al.* (2017) (Annex H.1). To account for uncertainty in the analysis approach, a range of displacement and mortality rates have been applied following the recommended approach to defining these in JNCC *et al.* (2017). Table 6.204 presents the unapportioned seasonal displacement mortality for guillemot at each of the Preferred Projects using the appropriate range of displacement and mortality rates. In the breeding season, there is only connectivity between the Lambay Island SPA and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.204: Displacement mortality for guillemot at each of the Preferred Projects (unapportioned values) (no. of birds)

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
1	30	N/A				7	13	33	67
	50	N/A				11	22	56	112
	70	N/A				16	31	78	156
2	30	N/A				6	12	30	60
	50	N/A				10	20	50	100
	70	N/A				14	28	70	140
3	30	N/A				6	11	29	57
	50	N/A				10	19	48	95
	70	N/A				13	27	67	134
4	30	2	3	8	17	2	4	10	20
	50	3	6	14	28	3	7	17	34
	70	4	8	20	39	5	9	24	47
5	30	1	1	3	5	1	1	3	6
	50	1	2	4	8	1	2	5	10
	70	1	2	6	12	1	3	7	14
6	30	1	2	6	11	1	3	7	13

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
	50	2	4	9	18	2	4	11	22
	70	3	5	13	26	3	6	16	31

6.1.482 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.205.

Table 6.205: Breeding season apportioning for guillemot at Lambay Island SPA for the impact from all Preferred Projects with connectivity in the breeding season

Preferred Project	Displacement / mortality rate (%)	Apportioning value (%)									
		10	20	30	40	50	60	70	80	90	100
4	30 / 1	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.7
	50 / 5	1.4	2.8	4.2	5.6	7.0	8.4	9.8	11.2	12.6	14.1
	70 / 10	3.9	7.9	11.8	15.7	19.7	23.6	27.5	31.5	35.4	39.3
5	30 / 1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5
	50 / 5	0.4	0.8	1.3	1.7	2.1	2.5	3.0	3.4	3.8	4.2
	70 / 10	1.2	2.4	3.6	4.7	5.9	7.1	8.3	9.5	10.7	11.8
6	30 / 1	0.1	0.2	0.3	0.4	0.6	0.7	0.8	0.9	1.0	1.1
	50 / 5	0.9	1.8	2.8	3.7	4.6	5.5	6.4	7.3	8.3	9.2
	70 / 10	2.6	5.1	7.7	10.3	12.8	15.4	18.0	20.5	23.1	25.7

6.1.483 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.205. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All of the Preferred Projects are beyond the mean-maximum foraging range of guillemot from the Lambay Island SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. Preferred Projects 4 and 6 however, within the foraging range of guillemot when using the mean-maximum foraging range plus one standard deviation (153.7 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual guillemots from the Lambay Island SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of displacement mortality.

6.1.484 There is no site-specific foraging range data available for guillemot from the Lambay Island SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Lambay Island SPA then this should only be a limited amount (e.g. 10%).

6.1.485 In the non-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning value used for the Preferred Projects in the Irish Sea is 6.3% and for the Preferred Projects in the North Sea is 0%. The apportioned values from each of the Preferred Projects combined to the Lambay Island SPA are presented in Table 6.206.

Table 6.206: Apportioned displacement mortality for guillemot at the Lambay Island SPA in non-breeding season

Displacement / mortality rate (%)	Preferred Project						Total
	1	2	3	4	5	6	
30 / 1	0.0	0.0	0.0	0.1	0.0	0.1	0.2
50 / 5	0.0	0.0	0.0	1.1	0.3	0.7	2.1
70 / 10	0.0	0.0	0.0	3.0	0.9	1.9	5.8

6.1.486 The annual apportioned impact for guillemot at the Lambay Island SPA is provided in Table 6.207.

Table 6.207: Calculation of the annual impact attributable to guillemot at the Lambay Island SPA from the Round 4 Plan alone

Displacement / mortality assumptions	Breeding season			Non-breeding season						Total	Increase in baseline mortality (%)
	PP4	PP5	PP6	PP1	PP2	PP3	PP4	PP5	PP6		
30 / 1	0.2	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.1	0.6	0.0
50 / 5	1.4	0.4	0.9	0.0	0.0	0.0	1.1	0.3	0.7	4.8	0.1
70 / 10	3.9	1.2	2.6	0.0	0.0	0.0	3.0	0.9	1.9	13.5	0.3

6.1.487 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.207 is considered to be 4.8 birds. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that guillemot densities from the MERP dataset potentially underestimate guillemot abundance.
- The apportioning value applied in the breeding season, it is unlikely that a significant proportion of guillemot from the Lambay Island SPA will utilize the Preferred Project areas and the assumption of 10% is likely an over-estimate but is applied on a precautionary basis.

6.1.488 A wider range of displacement rates are defined in JNCC *et al.* (2017) and these have been considered in the displacement analyses conducted. A precautionary approach has also been applied when considering the apportioning value to apply for all Preferred Projects.

6.1.489 An impact of 4.8 birds represents 0.1% of the baseline mortality of the Lambay Island SPA guillemot population (80,164 breeding adults). When considering the highest impact in Table 6.207, which is considered unrealistic due to an over-application of precaution, an annual displacement mortality of 13.5 birds is estimated. This represents an increase in baseline mortality of 0.3%. In the context of baseline mortality the predicted displacement mortality is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.490 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Lambay Island SPA.

Razorbill

Alone

6.1.491 Displacement analysis has been undertaken for razorbill using the approach advised in JNCC *et al.* (2017) (Annex H.1). To account for uncertainty in the analysis approach a range of displacement and mortality rates have been applied following the recommended approach to defining these in JNCC *et al.* (2017). Table 6.208 presents the unapportioned seasonal displacement mortality for razorbill at each of the Preferred Projects using the appropriate range of displacement and mortality rates. In the breeding season, there is only connectivity between the Lambay Island SPA and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.208: Displacement mortality for razorbill at each of the Preferred Projects (unapportioned values) (no. of birds)

Preferred Project	Displacement rate (%)	Mortality rate (%)															
		Breeding				Post-breeding				Non-breeding				Pre-breeding			
		1	2	5	10	1	2	5	10	1	2	5	10	1	2	5	10
1	30	N/A				1	1	4	7	1	2	5	9	1	2	5	11
	40	N/A				1	2	5	10	1	3	6	13	1	3	7	14
	70	N/A				2	3	9	17	2	4	11	22	2	5	12	25
2	30	N/A				1	1	3	6	1	2	4	8	1	2	5	9
	40	N/A				1	2	4	8	1	2	5	10	1	2	6	12
	70	N/A				1	3	7	13	2	4	9	18	2	4	11	21
3	30	N/A				1	1	3	6	1	1	4	7	1	2	4	8
	40	N/A				1	1	4	7	1	2	5	10	1	2	6	11
	70	N/A				1	3	7	13	2	3	9	17	2	4	10	20
4	30	0	0	1	1	0	1	1	3	0	1	2	4	0	1	2	4
	40	0	0	1	2	0	1	2	4	0	1	2	5	1	1	3	5
	70	0	1	2	3	1	1	3	7	1	2	4	8	1	2	5	10
5	30	0	0	0	0	0	0	0	1	0	0	1	1	0	0	1	1
	40	0	0	0	1	0	0	1	1	0	0	1	2	0	0	1	2
	70	0	0	0	1	0	0	1	2	0	1	1	3	0	1	2	3
6	30	0	0	0	1	0	0	1	2	0	0	1	2	0	0	1	2

Preferred Project	Displacement rate (%)	Mortality rate (%)															
		Breeding				Post-breeding				Non-breeding				Pre-breeding			
		1	2	5	10	1	2	5	10	1	2	5	10	1	2	5	10
	40	0	0	1	1	0	0	1	2	0	1	1	3	0	1	2	3
	70	0	0	1	2	0	1	2	4	1	1	3	5	1	1	3	6

6.1.492 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.209.

Table 6.209: Breeding season apportioning for razorbill at Lambay Island SPA for the impact from all Preferred Projects with connectivity in the breeding season

Preferred Project	Displacement / mortality rate (%)	Apportioning value (%)									
		10	20	30	40	50	60	70	80	90	100
4	30 / 1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	40 / 5	0.1	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8	0.9
	70 / 10	0.3	0.6	1.0	1.3	1.6	1.9	2.2	2.6	2.9	3.2
5	30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	40 / 5	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3
	70 / 10	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
6	30 / 1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
	40 / 5	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.6
	70 / 10	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0

6.1.493 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.209. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All of the Preferred Projects are beyond the mean-maximum foraging range of razorbill from the Lambay Island SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. All of the Preferred Projects are however, within the foraging range of razorbill when using the mean-maximum foraging range plus one standard deviation (164.6 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al.* (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual razorbills from the Lambay Island SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of displacement mortality.

6.1.494 There is no site-specific foraging range data available for razorbill from the Lambay Island SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Lambay Island SPA then this should only be a limited amount (e.g. 10%).

6.1.495 In the post-, non- and pre-breeding seasons, the apportioning values presented in Annex H.3 have been applied. In the Irish Sea the apportioning values used in the post-, non- and pre-breeding seasons 0.94%, 0.68% and 0.94%, respectively and for the Preferred Projects in the North Sea the values are 0.02%, 0.13% and 0.02%, respectively. The apportioned values from each of the Preferred Projects combined to the Lambay Island SPA are presented in Table 6.210.

Table 6.210: Apportioned displacement mortality for razorbill at the Lambay Island SPA in non-breeding seasons

Preferred Project	Displacement rate (%)	Mortality rate (%)	Apportioned values		
			Post-breeding	Non-breeding	Pre-breeding
1	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0

Preferred Project	Displacement rate (%)	Mortality rate (%)	Apportioned values		
			Post-breeding	Non-breeding	Pre-breeding
2	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0
3	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0
4	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0
5	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0
6	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0
Total	30	1	0.0	0.0	0.0
	40	5	0.0	0.1	0.1
	70	10	0.1	0.1	0.1

6.1.496 The annual apportioned impact for razorbill at the Lambay Island SPA is provided in Table 6.211.

Table 6.211: Calculation of the annual impact attributable to razorbill at the Lambay Island SPA from the Round 4 Plan alone

Displacement / mortality assumptions	Breeding season			Non-breeding seasons (post-, non- and pre-seasons combined)						Total	Increase in baseline mortality (%)
	PP4	PP5	PP6	PP1	PP2	PP3	PP4	PP5	PP6		
30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40 / 5	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.3	0.1
70 / 10	0.3	0.1	0.2	0.0	0.0	0.0	0.1	0.0	0.1	0.9	0.2

6.1.497 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.211 is considered to be 0.3 birds. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that razorbill densities from the MERP dataset potentially underestimate razorbill abundance.
- The apportioning value applied in the breeding season, it is unlikely that a significant proportion of razorbill from the Lambay Island SPA will utilize the Preferred Project areas and the assumption of 10% is likely an over-estimate but is applied on a precautionary basis.

6.1.498 A wider range of displacement rates are defined in JNCC *et al.* (2017) and these have been considered in the displacement analyses conducted. A precautionary approach has also been applied when considering the apportioning value to apply for all Preferred Projects with all three of the Preferred Projects beyond the mean-maximum foraging range of razorbill from Lambay Island SPA.

6.1.499 An impact of 0.3 birds represents 0.1% of the baseline mortality of the Lambay Island SPA razorbill population (5,811 breeding adults). When considering the highest impact in Table 6.211, which is considered unrealistic due to an over-application of precaution, an annual displacement mortality of 0.9 birds is estimated. This represents an increase in baseline mortality of 0.2%. Under any of the scenarios presented, the actual displacement mortality is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.500 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Lambay Island SPA.

Puffin

Alone

6.1.501 Displacement analysis has been undertaken for puffin using the approach advised in JNCC *et al.* (2017) (Annex H.1). To account for uncertainty in the analysis approach a range of displacement and mortality rates have been applied following the recommended approach to defining these in JNCC *et al.* (2017). Table 6.212 presents the unapportioned seasonal displacement mortality for puffin at each of the Preferred Projects using the appropriate range of displacement and mortality rates. In the breeding season, there is only connectivity between the Lambay Island SPA and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.212: Displacement mortality for puffin at each of the Preferred Projects (unapportioned values) (no. of birds)

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
1	30	N/A				1	2	4	8
	50	N/A				1	3	6	13
	70	N/A				2	4	9	18
2	30	N/A				1	1	3	5
	50	N/A				1	2	5	9
	70	N/A				1	3	6	13
3	30	N/A				1	1	3	6
	50	N/A				1	2	5	9
	70	N/A				1	3	6	13
4	30	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0
	70	0	0	0	0	0	0	0	0
5	30	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0
	70	0	0	0	0	0	0	0	0
6	30	0	0	0	0	0	0	0	0

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
	50	0	0	0	0	0	0	0	0
	70	0	0	0	0	0	0	0	0

6.1.502 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.213.

Table 6.213: Breeding season apportioning for puffin at Lambay Island SPA for the impact from all Preferred Projects with connectivity in the breeding season

Preferred Project	Displacement / mortality rate (%)	Apportioning value (%)									
		10	20	30	40	50	60	70	80	90	100
4	30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	50 / 5	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	70 / 10	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.4
5	30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	50 / 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	70 / 10	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
6	30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	50 / 5	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
	70 / 10	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2

6.1.503 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.213. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). Preferred Project 5 is beyond the mean-maximum foraging range of puffin from the Lambay Island SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. Preferred Project 5 is however, within the foraging range of puffin when using the mean-maximum foraging range plus one standard deviation (265.4 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual puffins from the Lambay Island SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of displacement mortality.

6.1.504 Preferred Projects 4 and 6 are on the edge of the mean-maximum foraging range, with the centre of both wind farms, used in the apportioning approach in Annex H.3 lying outside of the mean-maximum foraging range. As a result the apportioning value calculated for Preferred Projects 4 and 6 is 0%.

6.1.505 There is no site-specific foraging range data available for puffin from the Lambay Island SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Lambay Island SPA then this should only be a limited amount (e.g. 10%).

6.1.506 In the non-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning value used for the Preferred Projects in the Irish Sea is 0.02% and for the Preferred Projects in the North Sea is less than 0.01%. The apportioned values from each of the Preferred Projects combined to the Lambay Island SPA are presented in Table 6.214. In all cases the apportioned impact is less than 0.1 birds.

Table 6.214: Apportioned displacement mortality for puffin at the Lambay Island SPA in the non-breeding season

Displacement / mortality rate (%)	Preferred Project						Total
	1	2	3	4	5	6	
30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Displacement / mortality rate (%)	Preferred Project						Total
	1	2	3	4	5	6	
50 / 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70 / 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0

6.1.507 The annual apportioned impact for puffin at the Lambay Island SPA is provided in Table 6.215.

Table 6.215: Calculation of the annual impact attributable puffin at the Lambay Island SPA from the Round 4 Plan alone

Displacement / mortality assumptions	Breeding season			Non-breeding season						Total	Increase in baseline mortality (%)
	PP4	PP5	PP6	PP1	PP2	PP3	PP4	PP5	PP6		
30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01
50 / 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.10
70 / 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.27

6.1.508 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.215 is considered to be less than one bird. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that puffin densities from the MERP dataset potentially over-estimate puffin abundance.
- The apportioning value applied in the breeding season, it is unlikely that a significant proportion of puffin from the Lambay Island SPA will utilize the Preferred Project areas and the assumption of 10% is likely an over-estimate but is applied on a precautionary basis.

6.1.509 An impact of less than one bird represents less than 0.01% of the baseline mortality of the Lambay Island SPA puffin population (265 breeding adults). When considering the highest impact in Table 6.215, which is considered unrealistic due to an over-application of precaution, an annual displacement mortality of 0.1 birds is estimated. This represents an increase in baseline mortality of 0.27%. Under any of the scenarios presented, the actual displacement mortality is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.510 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Lambay Island SPA.

Liverpool Bay SPA

Red-throated diver

Alone

6.1.511 Red-throated diver are abundant throughout Liverpool Bay SPA, with the majority of the original SPA boundary delineated based on the distribution of this species. The highest densities of the species occur off the Lancashire coast at Formby, off the coast of the Wirral, offshore of Llandulas on the North Wales coast and off the coast of Penmaenmawr, North Wales (Figure 6.3).

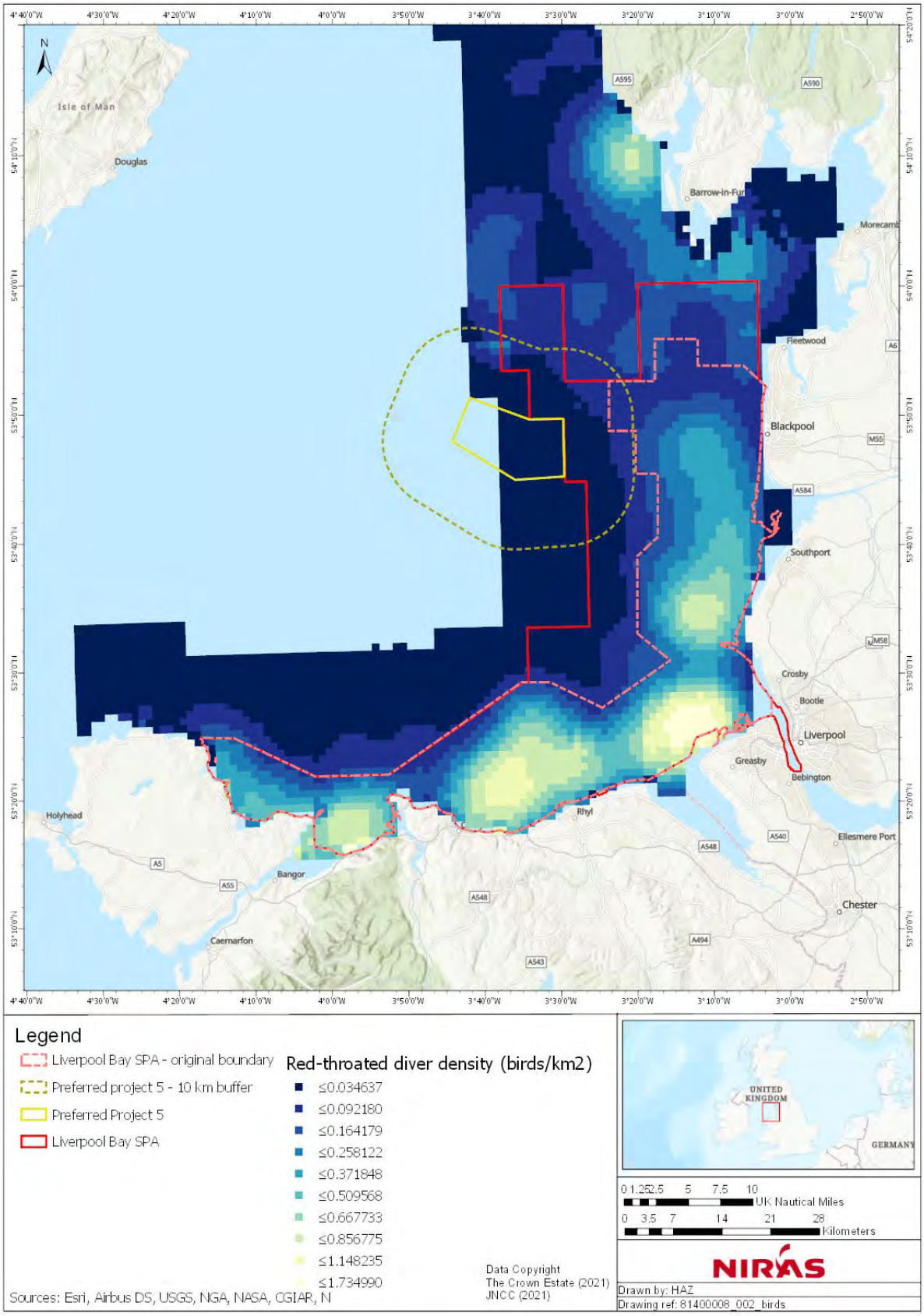


Figure 6.3: Red-throated diver densities in Liverpool Bay (data provided by JNCC)

6.1.512 When applying a 10 km buffer around the Preferred Projects, as advised by Natural England, there is connectivity between Preferred Project 5 and Liverpool Bay SPA. Connectivity only exists between the 10 km buffer associated with Preferred Project 5 and the SPA, with the area of overlap representing 9.96% of the total area of the SPA. The area of overlap does include part of the original SPA boundary which was incorporated into the original SPA due to the densities of common scoter present. The densities of red-throated diver in the area of overlap (both the original and updated SPA boundaries) are below the threshold used to identify the SPA boundary based on diver density alone (Webb *et al.,* 2006). This indicates that the area of overlap (both the original and updated SPA boundaries) is also not important for red-throated diver in the context of the SPA designation.

6.1.513 Liverpool Bay SPA was originally designated in 2010 to protect wintering populations of common scoter and red-throated diver. In 2017, the SPA was extended to include areas to the north and west of the existing SPA which were identified as supporting non-breeding little gull and to include the marine foraging ranges of little tern and common tern that were breeding features at existing SPAs. No boundary changes incorporated as part of the extended SPA were due to the distribution of existing features of the SPA, although the populations of these features were updated to account for new survey data which were considered more robust (Natural England *et al.,* 2016).

6.1.514 Preferred Project 5 lies on the boundary to the extended SPA and is approximately six kilometres from the original SPA boundary. This means that only part of the 10 km buffer extends into the original SPA the designation for which included red-throated diver. The overlap between the 10 km buffer associated with Preferred Project 5 and the original SPA boundary represents 1.27% of the total area of the original SPA. The areas of the extended SPA were not considered to support populations of red-throated diver significant enough to warrant inclusion as part of the SPA and the new SPA boundary has not been updated due to the distribution of the existing features (Natural England *et al.,* 2016) meaning the area of the extended SPA covered by the 10 km buffer of Preferred Project 5 is not considered important for red-throated divers.

6.1.515 Population estimates have been calculated for one kilometre bands out to 10 km. These values are presented in Table 6.216. In order to calculate the number of birds subject to displacement the displacement rates presented in APEM (2021) have been applied. The displacement rates estimated in APEM (2021) are presented in 0.5 km bands. One kilometre bands are being used for the purposes of the analysis presented in this report and therefore the displacement rates in the two 0.5 km bands from APEM (2021) relevant to the 1 km bands used in the analysis presented in Table 6.216 have been averaged to provide displacement rates. The average displacement rates have been applied to the relevant populations in Table 6.216 to provide displaced populations in each 1 km band. These displaced populations have then been multiplied by varying mortality rates to calculate the potential mortality of red-throated divers in Liverpool Bay SPA as a result of displacement from Preferred Project 5.

6.1.516 The highest total displacement mortality calculated in Table 6.216 is associated with a 10% mortality rate and is 0.4 birds. This represents 0.03% of the SPA population and a 0.21% increase in the baseline mortality of the SPA population.

Table 6.216: Calculation of displacement mortality for red-throated diver at Liverpool Bay SPA

Wind farm/buffer area	Population estimate (no. of birds)	Displacement rate (%)	Displaced population (no. of birds)	Mortality rate (%)			
				1	2	5	10
Array area	No overlap	100	-	-	-	-	-
0-1	0.00	46.4	0.04	0.00	0.00	0.00	0.00
1-2	0.07	40.0	0.10	0.00	0.00	0.00	0.00
2-3	0.17	40.8	0.19	0.00	0.00	0.01	0.01
3-4	0.30	37.8	0.32	0.00	0.00	0.01	0.02
4-5	0.47	32.3	0.43	0.00	0.01	0.02	0.03
5-6	0.65	34.0	0.49	0.00	0.01	0.02	0.04
6-7	0.86	43.0	0.65	0.00	0.01	0.02	0.05
7-8	1.10	40.7	0.89	0.01	0.01	0.03	0.07
8-9	1.36	34.3	0.90	0.01	0.02	0.04	0.09
9-10	1.55	41.9	0.04	0.01	0.02	0.04	0.09
Total	6.53	-	4.01	0.04	0.08	0.20	0.40

In-combination

6.1.517 It is acknowledged that Natural England have previously advised that the current level of in-combination mortality estimated for red-throated diver at Liverpool Bay SPA represents an adverse effect on the integrity. However, Preferred Project 5 only interacts with a small area of the SPA considered important for red-throated diver (i.e. the original SPA) and displacement from Preferred Project 5 only results in a very small impact which would not be expected to make an appreciable difference to any in-combination impact.

Common scoter

Alone

6.1.518 There are two main concentrations of common scoter in Liverpool Bay SPA, these occur off the Lancashire coast between Fleetwood and Lytham Saint Anne's and off the North Welsh coast between Colwyn Bay and the Point of Ayr (Figure 6.4). These 'hotspots' extend offshore but not to the boundary of the SPA. There are additional areas of common scoter, albeit not as concentrated, adjacent to the Lancashire coast at Formby, the North Wales coast between the Great Orme and Puffin Island and adjacent to the Anglesey coast associated with Red Wharf Bay.

6.1.519 Liverpool Bay SPA was originally designated in 2010 to protect wintering populations of common scoter and red-throated diver. In 2017, the SPA was extended to include areas to the north and west of the existing SPA which were identified as supporting non-breeding little gull and to include the marine foraging ranges of little tern and common tern that were breeding features at existing SPAs. No boundary changes incorporated as part of the extended SPA were proposed for the existing features of the SPA, although the populations of these features were updated to account for new survey data which were considered more robust (Natural England *et al.,* 2016).

6.1.520 Displacement analysis for common scoter has used a 4 km buffer following the guidance presented in JNCC *et al.* (2017). Preferred Project 5 lies on the boundary to the extended SPA and is approximately six kilometres from the original SPA boundary. This means that the 4 km buffer used to assess displacement impacts on common scoter does not extend into the original SPA, the designation for which included common scoter. The areas of the extended SPA were not considered to support populations significant enough to warrant inclusion as part of the SPA and the new SPA boundary has not been updated due to the distribution of the existing features (Natural England *et al.,* 2016) meaning the area of the extended SPA covered by the 4 km buffer of Preferred Project 5 is not considered important for common scoters.

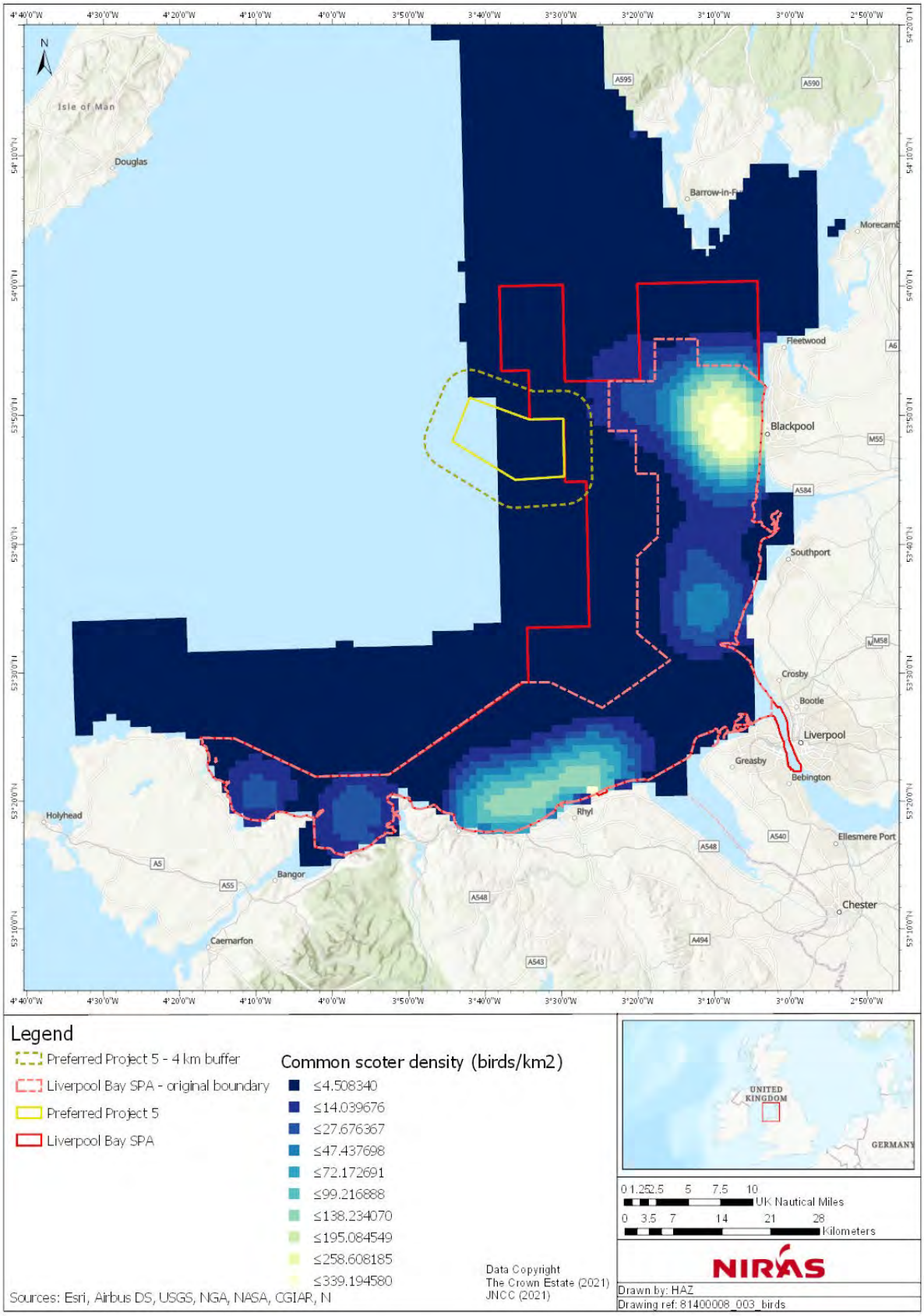


Figure 6.4: Common scoter densities in Liverpool Bay (data provided by JNCC)

6.1.521 Density data associated with the designation of the SPA has been provided by JNCC. These data have been interrogated to calculate a population estimate for common scoter within the 4 km buffer associated with Preferred Project 5. This has provided a population of common scoter of 41.9 birds. Using this population, displacement analysis following the guidance in JNCC *et al.* (2017) has been conducted (Table 6.217).

6.1.522 Following the guidance in JNCC *et al.* (2017), a displacement rate range of 90-100% is considered appropriate for common scoter based on the vulnerability scores in Wade *et al.* (2016). If a worst case scenario of 10% mortality is assumed then the displacement mortality for common scoter at Liverpool Bay SPA is four birds. This represents 0.01% of the SPA population and a 0.03% increase in the baseline mortality of the SPA population. Even if a 100% mortality rate was to be assumed, which is a highly unlikely scenario, the resulting increase in the baseline mortality of the SPA population would only be 0.3%. Although these birds are likely to be displaced they are not those that form the aggregations for which the SPA was originally designated.

Table 6.217: Displacement mortality for common scoter at the Liverpool Bay SPA from Preferred Project 5

		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	0	1	1	2	2	3	3	3	4	4
	20	0	0	0	1	2	3	3	4	5	6	7	8	8
	30	0	0	1	1	3	4	5	6	8	9	10	11	13
	40	0	0	1	2	3	5	7	8	10	12	13	15	17
	50	0	0	1	2	4	6	8	10	13	15	17	19	21
	60	0	1	1	3	5	8	10	13	15	18	20	23	25
	70	0	1	1	3	6	9	12	15	18	21	23	26	29
	80	0	1	2	3	7	10	13	17	20	23	27	30	34
	90	0	1	2	4	8	11	15	19	23	26	30	34	38
	100	0	1	2	4	8	13	17	21	25	29	34	38	42

In-combination

6.1.523 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Liverpool Bay SPA.

Red-breasted merganser

6.1.524 Connectivity between the red-breasted merganser feature of the Liverpool Bay SPA and the Round 4 Plan has been identified using a precautionary 15 km buffer. However, for the purposes of displacement analysis a 2 km buffer is considered appropriate based on the guidance in JNCC *et al.* (2017). The use of a 2 km buffer means that there is only connectivity between the Liverpool Bay SPA and Preferred Project 5.

6.1.525 Red-breasted merganser is a coastally distributed species with the winter distribution of the species concentrated in the outer waters of estuaries. The Preferred Projects, at the nearest point are located approximately 28 km offshore with this unlikely to be a distance at which significant numbers of red-breasted mergansers will be found. In Liverpool Bay very few birds were recorded during surveys undertaken by Bradbury *et al.* (2011) with those that were located within a few kilometres of the coast.

6.1.526 There is unlikely to be significant numbers of red-breasted merganser occurring in the areas that may be impacted by the Round 4 Plan. It is therefore considered that any impact on the red-breasted merganser feature of the Liverpool Bay SPA will be negligible.

In-combination

6.1.527 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Liverpool Bay SPA.

Little gull

6.1.528 There is connectivity between the little gull feature of Liverpool Bay SPA and Preferred Project 5 only. Preferred Project 5 is located adjacent to the western boundary of the northern part of Liverpool Bay SPA.

6.1.529 The Liverpool Bay SPA was extended in 2017 with the new designation including areas supporting a non-breeding population of little gull. The areas within the wider Liverpool Bay were identified using a technique called Maximum curvature which identifies the point of greatest change in a curve in the relationship between two values. The techniques identifies a threshold density for determining the important parts of aggregated species' distributions and those grid cells hosting densities above the threshold density may be deemed important, and in this use, included within the boundary of the SPA.

6.1.530 For the little gull feature of the Liverpool Bay SPA, the maximum curvature threshold density was 0.0648 birds/km^2. Preferred Project 5 is located on the edge of the Liverpool Bay SPA in an area that, based on the application of maximum curvature, supports densities of lower than 0.0648 birds/km^2. As Preferred Project 5 lies outside of the SPA boundary, it therefore lies in an area considered not important for little gull.

6.1.531 The densities of little gull present at Preferred Project 5 are lower than the threshold density of 0.0648 birds/km^2. Figure A1.1 in Lawson *et al.* (2016)

suggests that the actual densities present at Preferred Project 5 are between 0-0.04 birds/km^2. If the highest density from this range (0.04 birds/km^2) is used in collision risk modelling the resulting collision risk estimate is 0.78 collisions/annum.

6.1.532 The predicted impact on little gull from Preferred Project 5, if it were to be attributed to the Liverpool Bay SPA population, is considered to be negligible and likely indiscernible from background mortality.

In-combination

6.1.533 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Liverpool Bay SPA.

Lough Neagh and Lough Beg Ramsar

Lesser black-backed gull

Alone

6.1.534 Collision risk modelling for the Round 4 Plan has been undertaken for lesser black-backed gull using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated a range of values for a number of input parameters. The results of collision risk modelling for each Preferred Project are presented on an unapportioned seasonal basis in Table 6.218. In the breeding season, there is only connectivity between the designated site and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.218: Collision risk estimates for lesser black-backed gull (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																								
				Breeding season				Post-breeding							Non-breeding							Pre-breeding						
				PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	99.5	4	5	4	13	1	1	0	1	1	0	5	2	2	1	1	1	1	7	1	1	0	0	0	0	3
		9.8	99.5	3	5	3	11	1	1	0	0	1	0	4	1	2	0	1	1	0	6	1	1	0	0	0	0	3
	3	13.1	99.5	5	6	4	15	1	2	0	1	1	1	6	2	3	1	1	1	1	9	1	1	0	0	1	0	4
		9.8	99.5	4	5	3	12	1	1	0	1	1	0	5	2	3	1	1	1	1	7	1	1	0	0	0	0	3
Option 3	2	13.1	98.9	3	4	2	9	1	1	0	0	0	0	4	1	2	0	0	1	0	5	1	1	0	0	0	0	3
			99.3	2	2	2	6	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
		9.8	98.9	2	4	2	8	1	1	0	0	0	0	3	1	2	0	0	1	0	5	1	1	0	0	0	0	2
			99.3	1	2	1	5	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
	3	13.1	98.9	3	4	3	10	1	1	0	0	1	0	4	2	3	0	1	1	0	7	1	1	0	0	0	0	3
			99.3	2	3	2	6	1	1	0	0	0	0	3	1	2	0	0	0	0	4	1	1	0	0	0	0	2
		9.8	98.9	3	4	2	9	1	1	0	0	1	0	4	2	2	0	0	1	0	6	1	1	0	0	0	0	3
			99.3	2	3	2	6	1	1	0	0	0	0	2	1	2	0	0	0	0	4	1	1	0	0	0	0	2

6.1.535 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.219, Table 6.220 and Table 6.221.

Table 6.219: Breeding season apportioning for lesser black-backed gull at the Lough Neagh and Lough Beg Ramsar for the impact from Preferred Project 4

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.4	0.8	1.2	1.6	2.0	2.4	2.9	3.3	3.7	4.1
		9.8	99.5	0.3	0.7	1.0	1.3	1.7	2.0	2.4	2.7	3.0	3.4
	3	13.1	99.5	0.5	0.9	1.4	1.8	2.3	2.7	3.2	3.6	4.1	4.5
		9.8	99.5	0.4	0.8	1.1	1.5	1.9	2.3	2.6	3.0	3.4	3.8
Option 3	2	13.1	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
			99.3	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.6
		9.8	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.4
			99.3	0.1	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.3	1.5
	3	13.1	98.9	0.3	0.6	0.9	1.2	1.4	1.7	2.0	2.3	2.6	2.9
			99.3	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.8
		9.8	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.4	2.6
			99.3	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.7

Table 6.220: Breeding season apportioning for lesser black-backed gull at the Lough Neagh and Lough Beg Ramsar for the impact from Preferred Project 5

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.5	1.1	1.6	2.1	2.6	3.2	3.7	4.2	4.8	5.3
		9.8	99.5	0.5	0.9	1.4	1.9	2.3	2.8	3.3	3.7	4.2	4.7
	3	13.1	99.5	0.6	1.2	1.8	2.4	2.9	3.5	4.1	4.7	5.3	5.9
		9.8	99.5	0.5	1.0	1.6	2.1	2.6	3.1	3.6	4.2	4.7	5.2
Option 3	2	13.1	98.9	0.4	0.7	1.1	1.5	1.8	2.2	2.6	2.9	3.3	3.7
			99.3	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.3
		9.8	98.9	0.4	0.7	1.1	1.4	1.8	2.2	2.5	2.9	3.3	3.6
			99.3	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.8	2.1	2.3
	3	13.1	98.9	0.4	0.8	1.2	1.6	2.0	2.4	2.9	3.3	3.7	4.1
			99.3	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
		9.8	98.9	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0
			99.3	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.1	2.3	2.6

Table 6.221: Breeding season apportioning for lesser black-backed gull at the Lough Neagh and Lough Beg Ramsar for the impact from Preferred Project 6

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.4	0.8	1.1	1.5	1.9	2.3	2.7	3.0	3.4	3.8
		9.8	99.5	0.3	0.6	0.9	1.3	1.6	1.9	2.2	2.5	2.8	3.1
	3	13.1	99.5	0.4	0.8	1.3	1.7	2.1	2.5	3.0	3.4	3.8	4.2
		9.8	99.5	0.3	0.7	1.0	1.4	1.7	2.1	2.4	2.8	3.1	3.5
Option 3	2	13.1	98.9	0.2	0.5	0.7	1.0	1.2	1.4	1.7	1.9	2.2	2.4
			99.3	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5
		9.8	98.9	0.2	0.4	0.7	0.9	1.1	1.3	1.5	1.7	2.0	2.2
			99.3	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4
	3	13.1	98.9	0.3	0.5	0.8	1.1	1.3	1.6	1.9	2.1	2.4	2.7
			99.3	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.5	1.7
		9.8	98.9	0.2	0.5	0.7	1.0	1.2	1.5	1.7	1.9	2.2	2.4
			99.3	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5

6.1.536 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.219, Table 6.220 and Table 6.221. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al*. (2019). All of the Preferred Projects are beyond the mean-maximum foraging range of lesser black-backed gull from the Lough Neagh and Lough Beg SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. All three projects are however, within the foraging range of lesser black-backed gull when using the mean-maximum foraging range plus one standard deviation for lesser black-backed gull (236 km) presented in Woodward *et al*. (2019). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual lesser black-backed gulls from the Lough Neagh and Lough Beg SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.537 There is no site-specific foraging range data available for lesser black-backed gull from the Lough Neagh and Lough Beg SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Lough Neagh and Lough Beg SPA then this should only be a limited amount (e.g. 10%).

6.1.538 In the post-, non- and pre-breeding seasons, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, non- and pre-breeding seasons for the Preferred Projects in the Irish Sea are 0.28%, 0.44% and 0.28%, respectively. For the Preferred Projects in the North Sea the values used are 0.22%, 0.23% and 0.23%, respectively. The apportioned values from each of the Preferred Projects combined to the Lough Neagh and Lough Beg SPA are presented in Table 6.222. In all cases the impact is less than 0.1 collisions.

Table 6.222: Apportioned collision risk estimates for lesser black-backed gull at the Lough Neagh and Lough Beg SPA in non-breeding seasons

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values		
				Post-breeding	Non-breeding	Pre-breeding
Option 2	2	13.1	99.5	0.0	0.0	0.0
		9.8	99.5	0.0	0.0	0.0
	3	13.1	99.5	0.0	0.0	0.0
		9.8	99.5	0.0	0.0	0.0
Option 3	2	13.1	98.9	0.0	0.0	0.0
			99.3	0.0	0.0	0.0
		9.8	98.9	0.0	0.0	0.0
			99.3	0.0	0.0	0.0
	3	13.1	98.9	0.0	0.0	0.0
			99.3	0.0	0.0	0.0
		9.8	98.9	0.0	0.0	0.0
			99.3	0.0	0.0	0.0

6.1.539 The annual apportioned impact for lesser black-backed gull at the Lough Neagh and Lough Beg SPA is provided in Table 6.223.

Table 6.223: Calculation of the annual impact attributable to lesser black-backed gull at the Lough Neagh and Lough Beg SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding season			Post-breeding	Non-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP4	PP5	PP6	All projects	All projects	All projects		
Option 2	2	13.1	99.5	0.4	0.5	0.4	0.0	0.0	0.0	1.4	1.31
		9.8	99.5	0.3	0.5	0.3	0.0	0.0	0.0	1.2	1.11
	3	13.1	99.5	0.5	0.6	0.4	0.0	0.0	0.0	1.5	1.46
		9.8	99.5	0.4	0.5	0.3	0.0	0.0	0.0	1.3	1.24
Option 3	2	13.1	98.9	0.3	0.4	0.2	0.0	0.0	0.0	0.9	0.86
			99.3	0.2	0.2	0.2	0.0	0.0	0.0	0.6	0.55
		9.8	98.9	0.2	0.4	0.2	0.0	0.0	0.0	0.8	0.81
			99.3	0.1	0.2	0.1	0.0	0.0	0.0	0.5	0.52
	3	13.1	98.9	0.3	0.4	0.3	0.0	0.0	0.0	1.0	0.97
			99.3	0.2	0.3	0.2	0.0	0.0	0.0	0.6	0.61
		9.8	98.9	0.3	0.4	0.2	0.0	0.0	0.0	0.9	0.91
			99.3	0.2	0.3	0.2	0.0	0.0	0.0	0.6	0.58

6.1.540 The most likely impact (and most realistic worst case) for the Round 4 Plan alone from Table 6.223 is considered to be 0.5-0.6 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the densities for lesser black-backed gull from the MERP dataset potentially overestimate lesser black-backed gull abundance.
- The appropriate apportioning value to apply. It is considered highly unlikely that a significant proportion of lesser black-backed gulls from Lough Neagh and Lough Beg Ramsar will forage in the sea areas in which the Preferred Projects will be located. A value of 10% has been applied however, this is considered to be highly precautionary with large gulls unlikely to be found foraging at distances offshore commensurate with the distance between Lough Neagh and Lough Beg Ramsar and the Preferred Projects.

6.1.541 An impact of 0.5-0.6 collisions/annum represents 0.52-0.58% of the baseline mortality of the Lough Neagh and Lough Beg SPA lesser black-backed gull population (902 breeding adults). When considering the highest impact estimated in Table 6.223, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 1.4-1.5 collisions/annum represents an increase in baseline mortality of 1.31-1.46%.

6.1.542 Despite the predicted collision risk exceeding the 1% baseline mortality threshold of the Lough Neagh and Lough Beg SPA population, when considering the highest impact in Table 6.223, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.543 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Lough Neagh and Lough Beg SPA.

Morecambe Bay Ramsar and Morecambe Bay and Duddon Estuary SPA

Lesser black-backed gull

Alone

6.1.544 Collision risk modelling for the Round 4 Plan has been undertaken for lesser black-backed gull using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated a range of values for a number of input parameters. The results of collision risk modelling for each Preferred Project are presented on an unapportioned seasonal basis in Table 6.224. In the breeding season, there is only connectivity between the designated site and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.224: Collision risk estimates for lesser black-backed gull (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																								
				Breeding season				Post-breeding							Non-breeding							Pre-breeding						
				PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	99.5	4	5	4	13	1	1	0	1	1	0	5	2	2	1	1	1	1	7	1	1	0	0	0	0	3
		9.8	99.5	3	5	3	11	1	1	0	0	1	0	4	1	2	0	1	1	0	6	1	1	0	0	0	0	3
	3	13.1	99.5	5	6	4	15	1	2	0	1	1	1	6	2	3	1	1	1	1	9	1	1	0	0	1	0	4
		9.8	99.5	4	5	3	12	1	1	0	1	1	0	5	2	3	1	1	1	1	7	1	1	0	0	0	0	3
Option 3	2	13.1	98.9	3	4	2	9	1	1	0	0	0	0	4	1	2	0	0	1	0	5	1	1	0	0	0	0	3
			99.3	2	2	2	6	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
		9.8	98.9	2	4	2	8	1	1	0	0	0	0	3	1	2	0	0	1	0	5	1	1	0	0	0	0	2
			99.3	1	2	1	5	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
	3	13.1	98.9	3	4	3	10	1	1	0	0	1	0	4	2	3	0	1	1	0	7	1	1	0	0	0	0	3
			99.3	2	3	2	6	1	1	0	0	0	0	3	1	2	0	0	0	0	4	1	1	0	0	0	0	2
		9.8	98.9	3	4	2	9	1	1	0	0	1	0	4	2	2	0	0	1	0	6	1	1	0	0	0	0	3
			99.3	2	3	2	6	1	1	0	0	0	0	2	1	2	0	0	0	0	4	1	1	0	0	0	0	2

6.1.545 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.225, Table 6.226 and Table 6.227.

Table 6.225: Breeding season apportioning for lesser black-backed gull at the Morecambe Bay and Duddon Estuary SPA for the impact from Preferred Project 4

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.4	0.8	1.2	1.6	2.0	2.4	2.9	3.3	3.7	4.1
		9.8	99.5	0.3	0.7	1.0	1.3	1.7	2.0	2.4	2.7	3.0	3.4
	3	13.1	99.5	0.5	0.9	1.4	1.8	2.3	2.7	3.2	3.6	4.1	4.5
		9.8	99.5	0.4	0.8	1.1	1.5	1.9	2.3	2.6	3.0	3.4	3.8
Option 3	2	13.1	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
			99.3	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.6
		9.8	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.4
			99.3	0.1	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.3	1.5
	3	13.1	98.9	0.3	0.6	0.9	1.2	1.4	1.7	2.0	2.3	2.6	2.9
			99.3	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.8
		9.8	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.4	2.6
			99.3	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.7

Table 6.226: Breeding season apportioning for lesser black-backed gull at the Morecambe Bay and Duddon Estuary SPA for the impact from Preferred Project 5

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.5	1.1	1.6	2.1	2.6	3.2	3.7	4.2	4.8	5.3
		9.8	99.5	0.5	0.9	1.4	1.9	2.3	2.8	3.3	3.7	4.2	4.7
	3	13.1	99.5	0.6	1.2	1.8	2.4	2.9	3.5	4.1	4.7	5.3	5.9
		9.8	99.5	0.5	1.0	1.6	2.1	2.6	3.1	3.6	4.2	4.7	5.2
Option 3	2	13.1	98.9	0.4	0.7	1.1	1.5	1.8	2.2	2.6	2.9	3.3	3.7
			99.3	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.3
		9.8	98.9	0.4	0.7	1.1	1.4	1.8	2.2	2.5	2.9	3.3	3.6
			99.3	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.8	2.1	2.3
	3	13.1	98.9	0.4	0.8	1.2	1.6	2.0	2.4	2.9	3.3	3.7	4.1
			99.3	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
		9.8	98.9	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0
			99.3	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.1	2.3	2.6

Table 6.227: Breeding season apportioning for lesser black-backed gull at the Morecambe Bay and Duddon Estuary SPA for the impact from Preferred Project 6

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.4	0.8	1.1	1.5	1.9	2.3	2.7	3.0	3.4	3.8
		9.8	99.5	0.3	0.6	0.9	1.3	1.6	1.9	2.2	2.5	2.8	3.1
	3	13.1	99.5	0.4	0.8	1.3	1.7	2.1	2.5	3.0	3.4	3.8	4.2
		9.8	99.5	0.3	0.7	1.0	1.4	1.7	2.1	2.4	2.8	3.1	3.5
Option 3	2	13.1	98.9	0.2	0.5	0.7	1.0	1.2	1.4	1.7	1.9	2.2	2.4
			99.3	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5
		9.8	98.9	0.2	0.4	0.7	0.9	1.1	1.3	1.5	1.7	2.0	2.2
			99.3	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4
	3	13.1	98.9	0.3	0.5	0.8	1.1	1.3	1.6	1.9	2.1	2.4	2.7
			99.3	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.5	1.7
		9.8	98.9	0.2	0.5	0.7	1.0	1.2	1.5	1.7	1.9	2.2	2.4
			99.3	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5

6.1.546 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.225, Table 6.226 and Table 6.227. The three components of the population present at each of the Preferred Projects in the breeding season have been considered (see Annex H.3). The values associated with each of these population components are presented in Table 6.228 and multiplied together to provide an apportioning value for each of the Preferred Projects.

Table 6.228: Breeding season apportioning values for lesser black-backed gull at Morecambe Bay and Duddon Estuary SPA based on the approach applied in Annex H.3

Preferred Project	Proportion of breeding adult birds from SPA	Proportion of immature birds	Proportion of non-breeding birds	Overall breeding season apportioning value
4	0.02	0.38	0.34	0.01
5	0.03	0.38	0.34	0.01
6	0.03	0.38	0.34	0.01

6.1.547 The results of the apportioning approach in Annex H.3 suggest that 1% of the predicted impact at each of the Preferred Projects is attributable to the Morecambe Bay and Duddon Estuary SPA. As mentioned in Section 5.2, the estimated proportion of immature birds in Table 6.228 does not take account of the distribution of immature birds and may therefore over-estimate this component of the population present at each of the Preferred Projects.

6.1.548 The tracking data presented in Thaxter *et al.* (2018) shows that birds from the SPA show significant interaction with the marine environment. The apportioning values calculated for the Preferred Projects in Table 6.228 are a function of the distance of the constituent colonies at Morecambe Bay and Duddon Estuary SPA to the Preferred Projects, in relation to other breeding colonies, and more significantly the size of the breeding colony. In recent years the number of birds at the constituent breeding colonies at the SPA have decreased when compared to the designated population.

6.1.549 Birds from Morecambe Bay and Duddon Estuary SPA are the only birds from colonies with connectivity to the Preferred Projects that show significant utilisation of the offshore environment (Scragg *et al.,* 2016; Clewley *et al.,* 2017). The apportioning values presented in Table 6.228 are therefore considered to be under-estimates. To account for this the proportion of breeding adult birds in Table 6.228 (column 2) has been set to 1 (i.e. 100%) making the assumption that all breeding adult birds present at the Preferred Projects originate from the Morecambe Bay and Duddon Estuary SPA. The resulting apportioning values are presented in Table 6.229.

Table 6.229: Breeding season apportioning values for lesser black-backed gull at Morecambe Bay and Duddon Estuary SPA

Preferred Project	Proportion of breeding adult birds from SPA	Proportion of immature birds	Proportion of non-breeding birds	Overall breeding season apportioning value
4	1	0.38	0.34	0.41
5	1	0.38	0.34	0.41
6	1	0.38	0.34	0.41

6.1.550 In the post-, non- and pre-breeding seasons, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, non- and pre-breeding seasons for the Preferred Projects in the Irish Sea are 3.1%, 4.8% and 3.1%, respectively. For the Preferred Projects in the North Sea the values applied are 2.4%, 2.5% and 2.5%, respectively. The apportioned values from each of the Preferred Projects combined to the Morecambe Bay and Duddon Estuary SPA are presented in Table 6.230.

Table 6.230: Apportioned collision risk estimates for lesser black-backed gull at the Morecambe Bay and Duddon Estuary SPA in non-breeding seasons

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values		
				Post-breeding	Non-breeding	Pre-breeding
Option 2	2	13.1	99.5	0.1	0.2	0.1
		9.8	99.5	0.1	0.2	0.1
	3	13.1	99.5	0.1	0.3	0.1
		9.8	99.5	0.1	0.2	0.1
Option 3	2	13.1	98.9	0.1	0.2	0.1
			99.3	0.1	0.1	0.0
		9.8	98.9	0.1	0.2	0.1
			99.3	0.1	0.1	0.0
	3	13.1	98.9	0.1	0.2	0.1
			99.3	0.1	0.1	0.1
		9.8	98.9	0.1	0.2	0.1

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values		
				Post-breeding	Non-breeding	Pre-breeding
			99.3	0.1	0.1	0.0

6.1.551 The annual apportioned impact for lesser black-backed gull at the Morecambe Bay and Duddon Estuary SPA is provided in Table 6.231.

Table 6.231: Calculation of the annual impact attributable to lesser black-backed gull at the Morecambe Bay and Duddon Estuary SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding			Post-breeding	Non-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP4	PP5	PP6	All projects	All projects	All projects		
Option 2	2	13.1	99.5	1.7	2.2	1.5	0.1	0.2	0.1	5.8	0.52
		9.8	99.5	1.4	1.9	1.3	0.1	0.2	0.1	4.9	0.44
	3	13.1	99.5	1.9	2.4	1.7	0.1	0.3	0.1	6.5	0.58
		9.8	99.5	1.5	2.1	1.4	0.1	0.2	0.1	5.5	0.49
Option 3	2	13.1	98.9	1.1	1.5	1.0	0.1	0.2	0.1	3.8	0.34
			99.3	0.7	0.9	0.6	0.1	0.1	0.0	2.4	0.22
		9.8	98.9	1.0	1.5	0.9	0.1	0.2	0.1	3.6	0.32
			99.3	0.6	0.9	0.6	0.1	0.1	0.0	2.3	0.21
	3	13.1	98.9	1.2	1.7	1.1	0.1	0.2	0.1	4.3	0.39
			99.3	0.7	1.1	0.7	0.1	0.1	0.1	2.8	0.25
		9.8	98.9	1.1	1.6	1.0	0.1	0.2	0.1	4.1	0.36
			99.3	0.7	1.0	0.6	0.1	0.1	0.0	2.6	0.23

6.1.552 The most likely impact (and most realistic worst case) for the Round 4 Plan alone from Table 6.231 is considered to be 2.3-2.6 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. The lesser black-backed gull population at Morecambe Bay and Duddon Estuary SPA has significantly declined in recent years. The lesser black-backed gull colony at South Walney (where the majority of the SPA colony is located) in 2005 was 11,710 AON. The most recent count at South Walney was 381 AON, a 96.7% reduction. This has implications for the data used to calculate collision risk estimates as the underlying data supporting the MERP dataset will have been collected when the population at the colony was larger and therefore more birds are likely to have been present offshore, inflating the densities present and therefore potentially resulting in an over-estimation of the predicted collision risk for the Round 4 Plan.

6.1.553 An impact of 2.3-2.6 collisions/annum represents 0.21-0.23% of the baseline mortality of the Morecambe Bay and Duddon Estuary SPA lesser black-backed gull population (9,720 breeding adults). When considering the highest impact estimated in Table 6.231, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 5.8-6.5 collisions/annum represents an increase in baseline mortality of 0.52-0.58%.

6.1.554 It has not been possible to parameterise a PVA model that either follows the guidance provided by Natural England or provides an accurate reflection of the observed trends at the colony.

6.1.555 A previous assessment, which considered higher impact values for the Morecambe Bay and Duddon Estuary SPA, concluded no AEOI (DECC, 2014). Taking into account the considerable uncertainty associated with the impact predicted for the Round 4 Plan alone it is therefore considered that the impact from the Round 4 Plan will not represent an adverse effect on the lesser black-backed gull population of the Morecambe Bay and Duddon Estuary SPA.

In-combination

6.1.556 Seasonal collision risk estimates for all projects considered in-combination, where available, are presented in Annex H.4. The projects considered in the breeding season are those within the mean-maximum foraging range plus one standard deviation of lesser black-backed gull from the Morecambe Bay and Duddon Estuary SPA. Where available project-specific apportioning values have been used in the breeding season. Such values are available for both Burbo Bank Extension and Walney Extension. Project-specific values are unavailable for other projects within mean-maximum foraging range plus one standard deviation however, the proximity of Walney Extension to Barrow, Ormonde, Walney 1&2 and West of Duddon Sands also means it is appropriate to apply the breeding season apportioning value for Walney Extension to these projects. This is also applied for Burbo Bank, Gwynt-y-Môr, Rhyl Flats and North Hoyle where the apportioning value used at Burbo Bank Extension is applied. For all other projects an apportioning value of 100% has been applied in the breeding season, on a precautionary basis. The total in-combination values are presented in Table 6.232 for each of the cumulative tiers considered in the HRA (see Appendix A and B).

Table 6.232: Calculation of the in-combination impact attributable to the lesser black-backed gull feature at the Morecambe Bay and Duddon Estuary SPA

Tier	Breeding	Post-breeding	Non-breeding	Pre-breeding	Total
Round 4 Plan	2.1-2.4	0.1	0.1	0	2.3-2.6
1	58	6	0	0	64
2	0	3	0	0	3
3	0	0	0	0	0
4	0	0	0	0	0
Total	60	10	0	0	70

6.1.557 The predicted in-combination collision risk estimate represents 6.25-6.27% of the baseline mortality of the lesser black-backed gull population of the Morecambe Bay and Duddon Estuary SPA. However, over 97% of this impact comes from projects other than the Round 4 Plan. The population of birds at Morecambe Bay, specifically at the South Walney colony, where the majority of birds that make up the SPA designation breed has decreased significantly in recent years. This influences the collision risk estimates for the older projects incorporated into the in-combination assessment as the density of birds will have decreased at these projects due to the decrease in birds at the colony. This means that the in-combination estimate for Tier 1 projects is likely to represent a significant over-estimate. The apportioning rates used for projects considered in-combination do not account for immature and non-breeding birds and as such the impacts associated with them are likely to be over-estimates. In addition there are a number of other considerable uncertainties associated with the values for projects considered in-combination that are incorporated into the totals presented in Table 6.232. These include:

- Compounding high levels of precaution. Many of the in-combination values presented are those advocated by Natural England, which incorporated high levels of precaution throughout the assessment which has the potential to compound precaution and lead to highly inflated impact magnitudes. If high levels of precaution are applied across the assessments for all projects considered in-combination this can lead to highly inflated in-combination impacts.
- The apportioning values associated with many projects are considered to be highly precautionary, not accounting for immature birds, non-breeding birds and adult breeding birds from other colonies. The first of these two components will be present throughout the Irish Sea and should therefore be accounted for in apportioning values derived for the breeding season.
- The changes to turbine scenarios that occur between consent decisions and eventual as-built designs. This can lead to significant reductions in the collision risk estimates associated with a Project. For example, for lesser black-backed gull Ørsted (2018b) estimated that changes to turbine scenarios at those projects considered in-combination could lead to a reduction in the in-combination total of 35% for projects that were

already built at that time or 33% when including projects that were yet to be built. This is especially relevant for projects in the Irish Sea where the turbine scenarios that informed collision risk modelling are significantly different to those ultimately built. For example at Walney 1 & 2 and West of Duddon Sands, the number of turbines modelled was 152 and 139 respectively with the as-built scenario comprised of 102 and 108 turbines respectively. At Walney Extension modelling was undertaken using a 207 x 3.6 MW turbine scenario whereas the as-built turbine scenario is comprised of 40 x 8.25 MW and 47 x 7 MW turbines.

- Collision risk modelling undertaken to support the applications of previous offshore wind farm projects have had to use information that, based on evidence that has subsequently been collected, leads to an over-estimation of the project's effect on certain species. This is especially relevant to flight speed and nocturnal activity factors.
- The lesser black-backed gull population at the SPA has significantly declined in recent years. As there are fewer birds present at the colony, this will lead to fewer birds from the SPA being present in offshore areas, including those areas occupied by those projects considered in-combination. Collision risk modelling for those projects considered in-combination with connectivity in the breeding season was undertaken when the population of lesser black-backed gulls at the SPA was higher. Due to the reduction in birds at the SPA and therefore the reduction in abundance in areas away from the colony (e.g. foraging areas), the collision risk estimate attributable to the SPA from projects considered in-combination will also have reduced. For example, the survey data used to inform the collision risk modelling for both Walney 1 & 2 and West of Duddon Sands, two of the biggest contributors to the in-combination impact, were conducted in 2005. The lesser black-backed gull colony at South Walney (where the majority of the SPA colony is located) in 2005 was 11,710 AON. The most recent count at South Walney was 381 AON, a 96.7% reduction. This has previously been considered in DONG Energy (2014) with the analyses presented showing that a reduction in population size at the SPA exhibited an exponential relationship with the density of birds offshore.
- Future impacts associated with plans and projects in Tiers 5 and 6 are not included in the in-combination assessment due to the development stage of the plan or project (and therefore the uncertainty as to whether the plan or project will come to fruition and therefore contribute to the in-combination impact) and/or high levels of uncertainty associated with the available impacts.

6.1.558 The predicted in-combination impact is therefore a function of overly precautionary assumptions and predictions that are based upon conditions that no longer apply (e.g. elevated bird abundance considered in previous assessments that are no longer present in relevant sea areas) which lead to significant over-estimates and it is therefore not considered realistic. Despite the uncertainty associated with the in-combination estimate, the impact from the Round 4 Plan does not contribute a significant proportion to the in-combination impact.

6.1.559 The lesser black-backed gull population at Morecambe Bay and Duddon Estuary SPA has undergone significant declines in recent years. If reductions in the population translated to reductions in the densities present at sea then the impacts at Walney 1&2 and West of Duddon Sands would be reduced by 96.7% leading to impacts of less than one collision/annum at both projects and reducing the in-combination impact by over 50%.

6.1.560 It has not been possible to parameterise a PVA model that either follows the guidance provided by Natural England or provides an accurate reflection of the observed trends at the colony.

6.1.561 Previous assessments, which have considered higher impact values for the Morecambe Bay and Duddon Estuary SPA have concluded no adverse effect (DECC, 2014). Taking into account the considerable uncertainty associated with the impact predicted for the Round 4 Plan alone and for projects considered in-combination it is therefore considered that the actual in-combination impact will not represent an adverse effect on the lesser black-backed gull population of the Morecambe Bay and Duddon Estuary SPA.

6.1.562 The existing in-combination has not previously been considered to represent an adverse effect and the impact from the Round 4 Plan alone is not considered to represent an appreciable increase on the current in-combination impact.

Herring gull

Alone

6.1.563 Collision risk modelling for the Round 4 Plan has been undertaken for herring gull using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated a range of values for a number of input parameters. The results of collision risk modelling for each Preferred Project are presented on an unapportioned seasonal basis in Table 6.233. In the breeding season, there is only connectivity between the designated site and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.233: Collision risk estimates for herring gull (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)										
				Breeding season				Non-breeding						
				PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	12.8	99.5	3	2	3	8	16	18	6	3	2	3	48
		9.8	99.5	2	2	3	6	13	16	5	2	2	3	41
	3	12.8	99.5	3	2	3	9	20	24	7	4	2	4	62
		9.8	99.5	3	2	3	7	18	21	6	3	2	3	53
Option 3	2	12.8	99.0	2	1	2	5	14	16	3	2	1	2	39
			99.3	1	1	1	3	10	11	2	1	1	1	27
		9.8	99.0	2	1	2	5	13	15	3	2	1	2	35
			99.3	1	1	1	3	9	10	2	1	1	1	25
	3	12.8	99.0	2	1	2	6	18	21	4	2	2	3	50
			99.3	1	1	2	4	13	15	3	2	1	2	35
		9.8	99.0	2	1	2	5	16	19	4	2	2	2	46
			99.3	1	1	1	4	11	13	3	2	1	2	32

6.1.564 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.234, Table 6.235 and Table 6.236.

Table 6.234: Breeding season apportioning for herring gull at the Morecambe Bay Ramsar for the impact from Preferred Project 4

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	12.8	99.5	0.3	0.5	0.8	1.1	1.4	1.6	1.9	2.2	2.5	2.7
		9.8	99.5	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.3
	3	12.8	99.5	0.3	0.6	0.9	1.3	1.6	1.9	2.2	2.5	2.8	3.1
		9.8	99.5	0.3	0.5	0.8	1.1	1.3	1.6	1.8	2.1	2.4	2.6
Option 3	2	12.8	99.0	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.6	1.7
			99.3	0.1	0.2	0.4	0.5	0.6	0.7	0.9	1.0	1.1	1.2
		9.8	99.0	0.2	0.3	0.5	0.6	0.8	1.0	1.1	1.3	1.4	1.6
			99.3	0.1	0.2	0.3	0.4	0.6	0.7	0.8	0.9	1.0	1.1
	3	12.8	99.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
			99.3	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4
		9.8	99.0	0.2	0.4	0.5	0.7	0.9	1.1	1.3	1.5	1.6	1.8
			99.3	0.1	0.3	0.4	0.5	0.6	0.8	0.9	1.0	1.1	1.3

Table 6.235: Breeding season apportioning for herring gull at the Morecambe Bay Ramsar for the impact from Preferred Project 5

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	12.8	99.5	0.2	0.4	0.5	0.7	0.9	1.1	1.3	1.4	1.6	1.8
		9.8	99.5	0.2	0.3	0.5	0.6	0.8	1.0	1.1	1.3	1.5	1.6
	3	12.8	99.5	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.1
		9.8	99.5	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.8
Option 3	2	12.8	99.0	0.1	0.2	0.4	0.5	0.6	0.7	0.9	1.0	1.1	1.2
			99.3	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8	0.9
		9.8	99.0	0.1	0.2	0.4	0.5	0.6	0.7	0.9	1.0	1.1	1.2
			99.3	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	3	12.8	99.0	0.1	0.3	0.4	0.6	0.7	0.9	1.0	1.1	1.3	1.4
			99.3	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		9.8	99.0	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4
			99.3	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

Table 6.236: Breeding season apportioning for herring gull at the Morecambe Bay Ramsar for the impact from Preferred Project 6

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	12.8	99.5	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0
		9.8	99.5	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.0	2.3	2.5
	3	12.8	99.5	0.3	0.7	1.0	1.4	1.7	2.0	2.4	2.7	3.0	3.4
		9.8	99.5	0.3	0.6	0.9	1.1	1.4	1.7	2.0	2.3	2.6	2.8
Option 3	2	12.8	99.0	0.2	0.4	0.6	0.8	0.9	1.1	1.3	1.5	1.7	1.9
			99.3	0.1	0.3	0.4	0.5	0.7	0.8	0.9	1.1	1.2	1.3
		9.8	99.0	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.6	1.7
			99.3	0.1	0.2	0.4	0.5	0.6	0.7	0.8	1.0	1.1	1.2
	3	12.8	99.0	0.2	0.4	0.6	0.9	1.1	1.3	1.5	1.7	1.9	2.1
			99.3	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5
		9.8	99.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
			99.3	0.1	0.3	0.4	0.5	0.7	0.8	1.0	1.1	1.2	1.4

6.1.565 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.234, Table 6.235 and Table 6.236. Preferred Project 4 is on the edge of the mean-maximum foraging range, with the centre of the wind farm, used in the apportioning approach in Annex H.3 lying outside of the mean-maximum foraging range from the breeding colonies of herring gull within the SPA. As a result the apportioning value calculated for Preferred Project 5 is 0%. For the remaining two Preferred Projects, the three components of the population present at each project have been considered (see Annex H.3). The values associated with each of these population components are presented in Table 6.237 and multiplied together to provide an apportioning value for each of the Preferred Projects.

Table 6.237: Breeding season apportioning values for herring gull at Morecambe Bay and Duddon Estuary SPA based on the approach applied in Annex H.3

Preferred Project	Proportion of breeding adult birds from SPA	Proportion of immature birds	Proportion of non-breeding birds	Overall breeding season apportioning value
5	0.22	0.49	0.35	0.07
6	0.18	0.49	0.35	0.06

6.1.566 The results of the apportioning approach in Annex H.3 suggest that between 6-7% of the predicted impact at each of the Preferred Projects is attributable to Morecambe Bay and Duddon Estuary SPA. As mentioned in Section 5.2, the estimated proportion of immature birds in Table 6.237 does not take account of the distribution of immature birds and may therefore over-estimate this component of the population present at each of the Preferred Projects.

6.1.567 A total of 24 tags were deployed at the Morecambe Bay and Duddon Estuary SPA in 2014 (Thaxter *et al.,* 2017). The data collected showed very little interaction with the offshore environment with birds primarily using terrestrial and intertidal habitats with clear hotspots over local mussel beds and the coast east of Barrow-in-Furness. These data suggest that the apportioning values calculated in Table 6.237 are likely to be appropriate however, on a precautionary basis, the proportions of immatures present has been set to zero. This provides apportioning values of 10.9% for Preferred Project 5 and 9.1% for Preferred Project 6. On a precautionary basis the highest of these values has also been applied to Preferred Project 4.

6.1.568 In the non-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning value used for the Preferred Projects in the Irish Sea is 1.6% and for the Preferred Projects in the North Sea is 0.04%. The apportioned values from each of the Preferred Projects combined to the Morecambe Bay and Duddon Estuary SPA are presented in Table 6.238.

Table 6.238: Apportioned collision risk estimates for herring gull at the Morecambe Bay and Duddon Estuary SPA in non-breeding seasons

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values
				Non-breeding
Option 2	2	12.8	99.5	0.1
		9.8	99.5	0.1
	3	12.8	99.5	0.2
		9.8	99.5	0.2
Option 3	2	12.8	99.0	0.1
			99.3	0.1
		9.8	99.0	0.1
			99.3	0.1
	3	12.8	99.0	0.1
			99.3	0.1
		9.8	99.0	0.1
			99.3	0.1

6.1.569 The annual apportioned impact for herring gull at the Morecambe Bay and Duddon Estuary SPA is provided in Table 6.239.

Table 6.239: Calculation of the annual impact attributable to herring gull at the Morecambe Bay and Duddon Estuary SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding season			Non-breeding	Total	Baseline mortality (%)
				PP4	PP5	PP6	All projects		
Option 2	2	12.8	99.5	0.3	0.2	0.3	0.1	0.9	0.04
		9.8	99.5	0.3	0.2	0.2	0.1	0.8	0.03
	3	12.8	99.5	0.3	0.2	0.3	0.2	1.1	0.05
		9.8	99.5	0.3	0.2	0.3	0.2	0.9	0.04
Option 3	2	12.8	99.0	0.2	0.1	0.2	0.1	0.6	0.03
			99.3	0.1	0.1	0.1	0.1	0.4	0.02
		9.8	99.0	0.2	0.1	0.2	0.1	0.6	0.02
			99.3	0.1	0.1	0.1	0.1	0.4	0.02
	3	12.8	99.0	0.2	0.2	0.2	0.1	0.7	0.03
			99.3	0.2	0.1	0.1	0.1	0.5	0.02
		9.8	99.0	0.2	0.2	0.2	0.1	0.6	0.03
			99.3	0.1	0.1	0.1	0.1	0.4	0.02

6.1.570 The most likely impact (and most realistic worst case) for the Round 4 Plan alone from Table 6.239 is considered to be 0.4 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the densities for herring gull from the MERP dataset potentially overestimate herring gull abundance.

6.1.571 An impact of 0.4 collisions/annum represents 0.02% of the baseline mortality of the Morecambe Bay and Duddon Estuary SPA herring gull population (20,000 breeding adults). When considering the highest impact estimated in Table 6.239, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 0.9-1.1 collisions/annum represents an increase in baseline mortality of 0.04-0.05%. Under any of the scenarios presented, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.572 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Morecambe Bay and Duddon Estuary SPA.

Sandwich tern

Alone

6.1.573 The Morecambe Bay and Duddon Estuary SPA is designated to protect breeding species of terns and their associated marine foraging area. The SPA was a re-classification and extension of the original independent Morecambe Bay SPA and Duddon Estuary SPA which were designated to protect only the breeding colonies of a number of tern species.

6.1.574 The generic mean-maximum foraging range of Sandwich tern is 34.3 ± 23.2 km Woodward *et al.* (2019), with the SPA boundary located approximately 25.9 km from the nearest Preferred Project. However, the SPA boundary includes a proportion of the generic foraging range. Within the SPA Sandwich terns breed at South Walney, Foulney Island and Hodbarrow RSPB with the distance to the neasrest Preferred Project from each of these colonies 32.2 km, 34.8 km and 40.5 km, respectively. This distance falls within the foraging range of Sandwich tern when including one standard deviation. The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not

reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual Sandwich terns from the Morecambe Bay and Duddon Estuary SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.575 Wilson *et al.* (2014) presents the foraging utilisation of Sandwich tern from the Duddon Estuary. The data collected show a limited foraging range with the areas of highest usage not extending far (approximately less than 5 km) from the estuary with no connectivity with the preferred Projects.

6.1.576 The boundary of the SPA was defined using a 'Maximum curvature' approach to identify a threshold representing the optimum trade-off between the number of birds included and the area included as part of the SPA boundary. This analysis approach utilised information on habitat conditions alongside the tern distribution data described above. Natural England (2016) shows the results of this process with the foraging areas of Sandwich tern responsible for part of the marine limit of the SPA on the western sides of the SPA boundary. This boundary is, at its nearest point nearly 26 km from the nearest Preferred Project and it is therefore considered that very few birds (if any) would utilise the Preferred Project areas.

6.1.577 It is therefore considered highly unlikely that the abundance of Sandwich terns at Preferred Project 6 would be sufficient to result in an impact of a magnitude high enough to result in an adverse effect.

In-combination

6.1.578 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Morecambe Bay and Duddon Estuary SPA.

North Inishowen Coast SAC

Kittiwake

Alone

6.1.579 Collision risk modelling has been undertaken for kittiwake using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.240. In the breeding season, there is only connectivity between the North Inishowen Coast SPA and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.240: Collision risk estimates for kittiwake (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																
				Breeding season				Post-breeding							Pre-breeding						
				PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	98.9	3	2	3	8	29	21	5	2	1	2	59	21	15	3	1	0	1	41
			99.0	3	2	3	7	26	19	4	2	1	2	54	19	14	3	1	0	0	37
		8.71	98.9	2	2	2	6	22	16	3	1	1	1	45	16	12	2	0	0	0	31
			99.0	2	1	2	5	20	14	3	1	1	1	41	15	11	2	0	0	0	29
	3	13.1	98.9	4	2	3	9	37	26	6	2	1	2	75	28	20	4	1	0	1	53
			99.0	3	2	3	8	34	24	5	2	1	2	68	25	18	4	1	0	1	49
		8.71	98.9	3	2	2	7	28	20	4	2	1	2	58	21	15	3	1	0	1	41
			99.0	2	2	2	6	26	18	4	2	1	1	52	19	14	3	1	0	0	37
Option 3	2	13.1	98	1	1	1	3	14	10	1	1	0	1	27	10	7	1	0	0	0	19
		8.71	98	1	1	1	2	12	9	1	1	0	0	23	9	6	1	0	0	0	16
	3	13.1	98	1	1	1	3	18	13	2	1	1	1	34	13	9	1	0	0	0	24
		8.71	98	1	1	1	3	15	11	2	1	1	1	30	12	8	1	0	0	0	21

6.1.580 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.241, Table 6.242 and Table 6.243.

Table 6.241: Breeding season apportioning for kittiwake at North Inishowen Coast SPA for the impact from Preferred Project 4

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.3	0.6	0.9	1.2	1.6	1.9	2.2	2.5	2.8	3.1
			99.0	0.3	0.6	0.8	1.1	1.4	1.7	2.0	2.3	2.5	2.8
		8.71	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.3
			99.0	0.2	0.4	0.6	0.8	1.1	1.3	1.5	1.7	1.9	2.1
	3	13.1	98.9	0.4	0.7	1.1	1.4	1.8	2.1	2.5	2.8	3.2	3.5
			99.0	0.3	0.6	1.0	1.3	1.6	1.9	2.2	2.6	2.9	3.2
		8.71	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
			99.0	0.2	0.5	0.7	0.9	1.2	1.4	1.7	1.9	2.1	2.4
Option 3	2	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		8.71	98	0.1	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.8	0.9
	3	13.1	98	0.1	0.2	0.3	0.5	0.6	0.7	0.8	0.9	1.0	1.2
		8.71	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

Table 6.242: Breeding season apportioning for kittiwake at North Inishowen Coast SPA for the impact from Preferred Project 5

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.9
			99.0	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.4	1.5	1.7
		8.71	98.9	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.6
			99.0	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4
	3	13.1	98.9	0.2	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.9	2.1
			99.0	0.2	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9
		8.71	98.9	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.6	1.7
			99.0	0.2	0.3	0.5	0.6	0.8	1.0	1.1	1.3	1.4	1.6
Option 3	2	13.1	98	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
		8.71	98	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
	3	13.1	98	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8
		8.71	98	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8

Table 6.243: Breeding season apportioning for kittiwake at North Inishowen Coast SPA for the impact from Preferred Project 6

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.3	0.6	0.8	1.1	1.4	1.7	2.0	2.2	2.5	2.8
			99.0	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.0	2.3	2.6
		8.71	98.9	0.2	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.9	2.1
			99.0	0.2	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9
	3	13.1	98.9	0.3	0.6	0.9	1.3	1.6	1.9	2.2	2.5	2.8	3.2
			99.0	0.3	0.6	0.9	1.2	1.4	1.7	2.0	2.3	2.6	2.9
		8.71	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.4
			99.0	0.2	0.4	0.6	0.9	1.1	1.3	1.5	1.7	1.9	2.1
Option 3	2	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.8	0.9
		8.71	98	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.6	0.7	0.8
	3	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		8.71	98	0.1	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8	0.9

6.1.581 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.241, Table 6.242 and Table 6.243. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All of the Preferred Projects are beyond the mean-maximum foraging range of kittiwake from the North Inishowen Coast SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%.

6.1.582 All of the Preferred Projects are however, within the foraging range of kittiwake when using the mean-maximum foraging range plus one standard deviation (300.5 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al.* (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual kittiwakes from the North Inishowen Coast SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.583 There is no site-specific foraging range data available for kittiwake from the North Inishowen Coast SPA. However, the UK and Eire-wide utilisation distributions presented in Cleasby *et al.* (2018) suggest that the Preferred Projects lie beyond the 75% utilisation distribution band. This suggests limited connectivity between any kittiwake colony and the Preferred Projects and supports the use of a low apportioning value. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the North Inishowen Coast SPA then this should only be a limited amount (e.g. 10%).

6.1.584 In the post-breeding and pre-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, and pre-breeding seasons for the Preferred Projects in the Irish Sea are 0.07% and 0.12% and for the Preferred Projects in the North Sea are less than 0.01% in both seasons. The apportioned values from each of the Preferred Projects combined to the North Inishowen Coast SPA are presented in Table 6.244.

Table 6.244: Apportioning for kittiwake at the North Inishowen Coast SPA in the post- and pre-breeding season for the impact from all Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
Option 2	2	13.1	98.9	0.0	0.0

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
			99.0	0.0	0.0
		8.71	98.9	0.0	0.0
			99.0	0.0	0.0
	3	13.1	98.9	0.0	0.0
			99.0	0.0	0.0
		8.71	98.9	0.0	0.0
			99.0	0.0	0.0
Option 3	2	13.1	98	0.0	0.0
		8.71	98	0.0	0.0
	3	13.1	98	0.0	0.0
		8.71	98	0.0	0.0

6.1.585 The annual apportioned impact for kittiwake at the North Inishowen Coast SPA is provided in Table 6.245.

Table 6.245: Calculation of total impact attributable to kittiwake at the North Inishowen Coast SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding			Post-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP4	PP5	PP6	All projects	All projects		
Option 2	2	13.1	98.9	0.3	0.2	0.3	0.0	0.0	0.8	0.54
			99.0	0.3	0.2	0.3	0.0	0.0	0.7	0.49
		8.71	98.9	0.2	0.2	0.2	0.0	0.0	0.6	0.41
			99.0	0.2	0.1	0.2	0.0	0.0	0.5	0.37
	3	13.1	98.9	0.4	0.2	0.3	0.0	0.0	0.9	0.61
			99.0	0.3	0.2	0.3	0.0	0.0	0.8	0.55
		8.71	98.9	0.3	0.2	0.2	0.0	0.0	0.7	0.46
			99.0	0.2	0.2	0.2	0.0	0.0	0.6	0.42
Option 3	2	13.1	98	0.1	0.1	0.1	0.0	0.0	0.3	0.18
		8.71	98	0.1	0.1	0.1	0.0	0.0	0.2	0.17
	3	13.1	98	0.1	0.1	0.1	0.0	0.0	0.3	0.21
		8.71	98	0.1	0.1	0.1	0.0	0.0	0.3	0.19

6.1.586 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.245 is considered to be 0.2-0.3 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that kittiwake densities from the MERP dataset potentially underestimate kittiwake abundance.
- The appropriate apportioning value to apply. It is considered highly unlikely that a significant proportion of kittiwake from the North Inishowen Coast SPA will forage in the sea areas in which the Preferred Projects will be located. A value of 10% has been applied however, this is considered to be highly precautionary with kittiwake unlikely to be found foraging at distances offshore commensurate with the distance between the North Inishowen Coast SPA and the Preferred Projects.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.
- The proportion of immatures present at each of the Preferred Projects.

6.1.587 An impact of 0.2-0.3 collisions/annum represents 0.17-0.19% of the baseline mortality of the North Inishowen Coast SPA kittiwake population (1,000 breeding adults). When considering the highest impact estimated in Table 6.245, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 0.8-0.9 collisions/annum represents an increase in baseline mortality of 0.54-0.61%. Under any of the scenarios presented the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.588 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the North Inishowen Coast SPA.

North Norfolk Coast SPA and Ramsar

Sandwich tern

Alone

6.1.589 In the breeding season, there is only connectivity between the North Norfolk Coast SPA and Preferred Project 3 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019).

6.1.590 Due to the lack of suitable data, it has not been possible to quantify the impact from Preferred Project 3 on the Sandwich tern feature of the North Norfolk Coast SPA and Ramsar. However, information is available that allows for a qualitative assessment to be conducted.

6.1.591 The foraging range used in the Round 4 screening approach was the mean-maximum foraging range plus one standard deviation presented in Woodward *et al.* (2019) (57.5 km). Preferred Project 3 is located on the edge of this foraging range with the nearest point approximately 56 km from North Norfolk Coast SPA.

The use of the mean-maximum foraging range plus one standard deviation is highly precautionary and is applied on this basis at the screening stage to ensure a thorough appraisal of potential connectivity and therefore, in the breeding season, identification of LSE.

6.1.592 There are two main Sandwich tern colonies within the north Norfolk Coast SPA, at Scolt Head and Blakeney Point. If measuring from the actual colony locations, Blakeney Point is 57.4 km from Preferred Project 3, at its nearest point meaning the majority of Preferred Project 3 is outside of generic foraging range with Scolt Head approximately 60 km from Preferred Project 3 which is therefore beyond the generic foraging range of Sandwich tern.

6.1.593 Tracking of Sandwich terns from the breeding colonies at Blakeney Point and Scolt Head has been conducted and based on the predicted relative usage maps presented in Wilson *et al.* (2014) suggests little, if any, usage of the Preferred Project 3 area by terns from either colony (Figure 6.5). The Greater Wash SPA was designated to protect important sea areas for Sandwich tern from the North Norfolk Coast SPA based upon the information presented in Wilson *et al.* (2014). There is no overlap between the Greater Wash SPA and Preferred Project 3 indicating that Preferred Project 3 does not represent an important sea area for Sandwich tern from the North Norfolk Coast SPA.

6.1.594 Based on the distance between the North Norfolk Coast SPA and Preferred Project 3 and the tracking data presented in Wilson *et al.* (2014) it is considered highly unlikely that Preferred Project 3 will have any impact on the Sandwich tern feature of the North Norfolk Coast SPA.

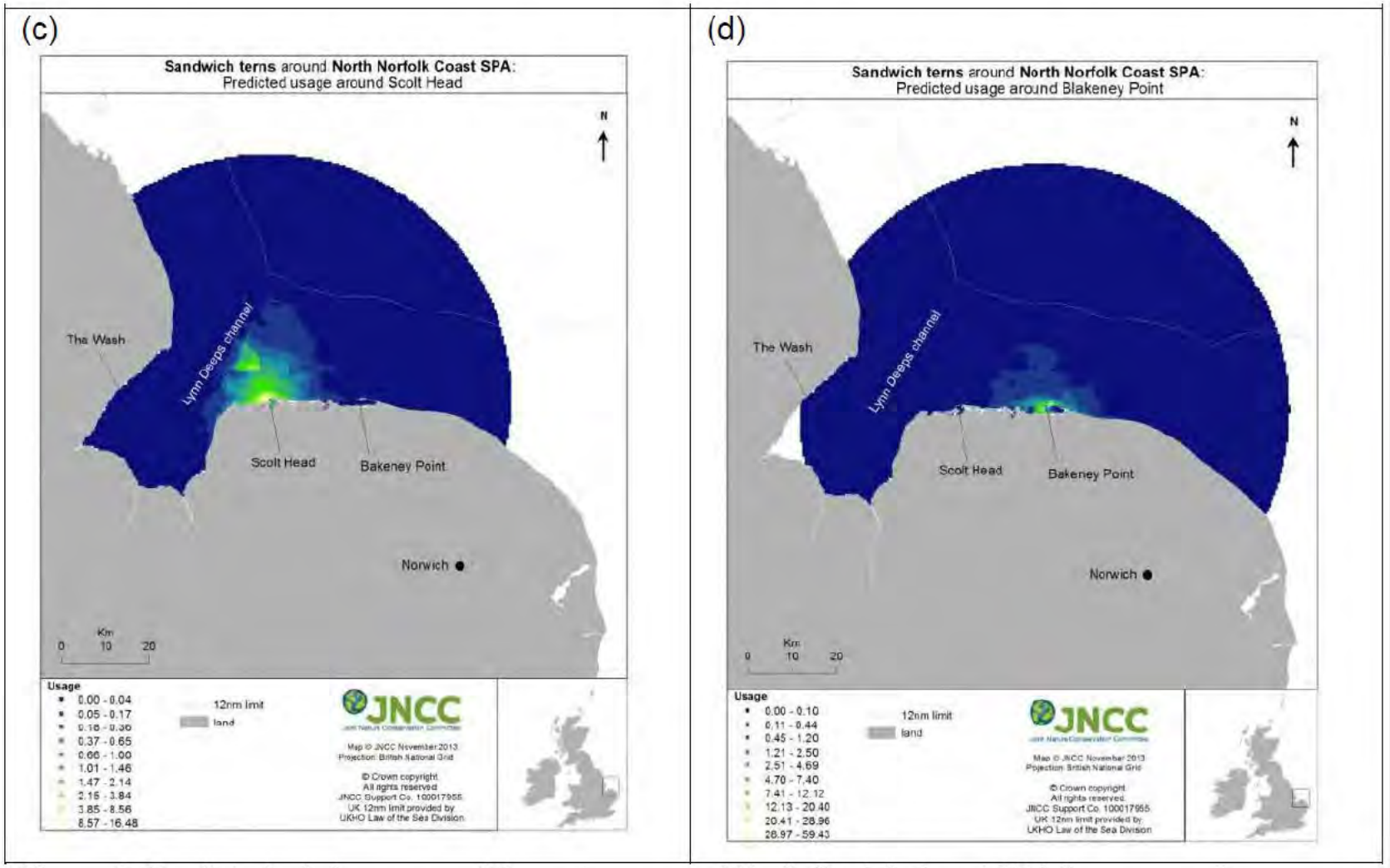


Figure 6.5: Predicted relative usage of the waters around North Norfolk Coast SPA for Sandwich terns around Scolt Head (c) and Blakeney Point (d). Usage values are relative and binned using natural groupings inherent in the data (natural jenks, which reduce the variance within classes and maximize the variance between classes, determined within ArcMap v10.1). (taken from Wilson *et al.*, 2014).

In-combination

6.1.595 The Round 4 Plan is considered highly unlikely to contribute any impact to the in-combination impact on the Sandwich tern feature of the North Norfolk Coast SPA.

Northumberland Marine SPA

Lesser black-backed gull

Alone

6.1.596 The Northumberland Marine SPA is designated to protect the sea areas used by the populations of birds designated as part of Coquet Island SPA, Farne Islands SPA, Lindisfarne SPA and Northumbria Coast SPA. As a result the predicted impacts and the assessment conclusions drawn for the constituent SPAs are considered equally applicable to the Northumberland Marine SPA.

6.1.597 Lesser black-backed gull is a feature of the Coquet Island SPA and has been considered in the assessment for the Coquet Island SPA presented above. That assessment concluded that although the predicted collision risk exceeds the 1% baseline mortality threshold of the Coquet Island SPA population, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account. This conclusion is considered applicable to the Northumberland Marine SPA.

In-combination

6.1.598 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Northumberland Marine SPA.

Kittiwake

Alone

6.1.599 The Northumberland Marine SPA is designated to protect the sea areas used by the populations of birds designated as part of Coquet Island SPA, Farne Islands SPA, Lindisfarne SPA and Northumbria Coast SPA. As a result the predicted impacts and the assessment conclusions drawn for the constituent SPAs are considered equally applicable to the Northumberland Marine SPA.

6.1.600 Kittiwake is a feature of the Coquet Island SPA and Farne Islands SPA and has been considered in the assessment for the both of these SPAs above. The combined impact on these two SPAs is presented in Table 6.246 below and considered against the designated population of the Northumberland Marine SPA.

Table 6.246: Calculation of the annual impact attributable to kittiwake at the Northumberland Marine SPA (Coquet Island SPA plus Farne Islands SPA impacts) from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Post-breeding	Pre-breeding	Total	Baseline mortality (%)
				All projects	All projects		
Option 2	2	13.1	98.9	0.3	0.3	0.6	0.05
			99.0	0.3	0.3	0.5	0.04
		8.71	98.9	0.2	0.2	0.5	0.04
			99.0	0.2	0.2	0.4	0.03
	3	13.1	98.9	0.4	0.4	0.8	0.06
			99.0	0.4	0.3	0.7	0.06
		8.71	98.9	0.3	0.3	0.6	0.05
			99.0	0.3	0.3	0.5	0.04
Option 3	2	13.1	98	0.1	0.1	0.3	0.02
		8.71	98	0.1	0.1	0.2	0.02
	3	13.1	98	0.2	0.2	0.4	0.03
		8.71	98	0.2	0.1	0.3	0.02

6.1.601 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.246 is considered to be 0.2 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that kittiwake densities from the MERP dataset potentially underestimate kittiwake abundance.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.
- The apportioning value applied in the breeding season, it is unlikely that a significant proportion of kittiwake from Northumberland Marine SPA will utilize the Preferred Project areas and the assumption of 10% is likely an over-estimate but is applied on a precautionary basis.

6.1.602 An impact of 0.2 collisions/annum represents 0.02% of the baseline mortality of the Northumberland Marine SPA kittiwake population (8,667 breeding adults). When considering the highest impact estimated in Table 6.246, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 0.6-0.8 collisions/annum represents an increase in baseline mortality of 0.05-0.06%. Under any of the scenarios presented, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.603 The predicted in-combination impacts on the constituent SPAs are considered to be a function of overly precautionary assumptions which lead to significant over-estimates and it is therefore are not considered realistic. Despite the uncertainty associated with the in-combination estimate, the impact from the Round 4 Plan does not contribute a significant proportion to the in-combination impact.

Puffin

Alone

6.1.604 The Northumberland Marine SPA is designated to protect the sea areas used by the populations of birds designated as part of Coquet Island SPA, Farne Islands SPA, Lindisfarne SPA and Northumbria Coast SPA. As a result the predicted impacts and the assessment conclusions drawn for the constituent SPAs are considered equally applicable to the Northumberland Marine SPA.

6.1.605 Puffin is a feature of the Coquet Island SPA and Farne Islands SPA and has been considered in the assessment for the both of these SPAs above. The combined impact on these two SPAs is presented in Table 6.247 below and considered against the designated population of the Northumberland Marine SPA.

Table 6.247: Calculation of the annual impact attributable to puffin at the Northumberland Marine SPA from the Round 4 Plan alone

Displacement / mortality assumptions	Breeding season			Non-breeding season						Total	Increase in baseline mortality (%)
	PP1	PP2	PP3	PP1	PP2	PP3	PP4	PP5	PP6		
30 / 1	0	0	0	0	0	0	0	0	0	1	0.01
50 / 5	1	1	0	2	1	1	0	0	0	6	0.06
70 / 10	2	1	1	5	4	4	0	0	0	16	0.16

6.1.606 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.247 is considered to be six birds. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that puffin densities from the MERP dataset potentially over-estimate puffin abundance.
- The apportioning value applied in the breeding season, it is unlikely that a significant proportion of puffin from the constituent SPAs will utilize the Preferred Project areas and the assumption of 10% is likely an over-estimate but is applied on a precautionary basis.

6.1.607 A wider range of displacement rates are defined in JNCC *et al.* (2017) and these have been considered in the displacement analyses conducted. A precautionary approach has also been applied when considering the apportioning value to apply for all Preferred Projects with all three of the Preferred Projects beyond the mean-maximum foraging range of puffin from the constituent SPAs.

6.1.608 An impact of six birds represents 0.06% of the baseline mortality of the Northumberland Marine SPA puffin population (108,484 breeding adults). When considering the highest impact in Table 6.247, which is considered unrealistic due to an over-application of precaution, an annual displacement mortality of 16 birds is estimated. This represents an increase in baseline mortality of 0.16%. However, the actual displacement mortality predicted is low and there are considered to be significant assumptions which lead to over-estimation associated with the predicted displacement mortality.

In-combination

6.1.609 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Northumberland Marine SPA.

Northumbria Coast Ramsar

Kittiwake

Alone

6.1.610 Collision risk modelling has been undertaken for kittiwake using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.248. In the breeding season, there is only connectivity between the Northumbria Coast Ramsar and Preferred Projects 1, 2 and 3 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.248: Collision risk estimates for kittiwake (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																
				Breeding season				Post-breeding							Pre-breeding					
				PP1	PP2	PP3	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	98.9	73	52	11	136	29	21	5	2	1	2	59	21	15	3	1	0	1	41
			99.0	66	47	10	123	26	19	4	2	1	2	54	19	14	3	1	0	0	37
		8.71	98.9	56	40	8	104	22	16	3	1	1	1	45	16	12	2	0	0	0	31
			99.0	51	36	8	94	20	14	3	1	1	1	41	15	11	2	0	0	0	29
	3	13.1	98.9	82	59	13	154	37	26	6	2	1	2	75	28	20	4	1	0	1	53
			99.0	75	54	12	140	34	24	5	2	1	2	68	25	18	4	1	0	1	49
		8.71	98.9	63	45	9	118	28	20	4	2	1	2	58	21	15	3	1	0	1	41
			99.0	57	41	9	107	26	18	4	2	1	1	52	19	14	3	1	0	0	37
Option 3	2	13.1	98	34	25	4	63	14	10	1	1	0	1	27	10	7	1	0	0	0	19
		8.71	98	30	22	3	55	12	9	1	1	0	0	23	9	6	1	0	0	0	16
	3	13.1	98	39	28	4	71	18	13	2	1	1	1	34	13	9	1	0	0	0	24
		8.71	98	34	24	3	62	15	11	2	1	1	1	30	12	8	1	0	0	0	21

6.1.611 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.249, Table 6.250 and Table 6.251.

Table 6.249: Breeding season apportioning for kittiwake at Northumbria Coast Ramsar for the impact from Preferred Project 1

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	7.3	14.5	21.8	29.0	36.3	43.5	50.8	58.0	65.3	72.6
			99.0	6.6	13.2	19.8	26.4	33.0	39.6	46.2	52.8	59.4	66.0
		8.71	98.9	5.6	11.1	16.7	22.3	27.8	33.4	39.0	44.5	50.1	55.7
			99.0	5.1	10.1	15.2	20.2	25.3	30.4	35.4	40.5	45.6	50.6
	3	13.1	98.9	8.2	16.5	24.7	32.9	41.2	49.4	57.6	65.9	74.1	82.3
			99.0	7.5	15.0	22.5	29.9	37.4	44.9	52.4	59.9	67.4	74.9
		8.71	98.9	6.3	12.6	19.0	25.3	31.6	37.9	44.2	50.6	56.9	63.2
			99.0	5.7	11.5	17.2	23.0	28.7	34.5	40.2	46.0	51.7	57.4
Option 3	2	13.1	98	3.4	6.9	10.3	13.8	17.2	20.7	24.1	27.6	31.0	34.5
		8.71	98	3.0	6.0	9.0	12.1	15.1	18.1	21.1	24.1	27.1	30.1
	3	13.1	98	3.9	7.8	11.7	15.6	19.6	23.5	27.4	31.3	35.2	39.1
		8.71	98	3.4	6.8	10.3	13.7	17.1	20.5	23.9	27.4	30.8	34.2

Table 6.250: Breeding season apportioning for kittiwake at Northumbria Coast Ramsar for the impact from Preferred Project 2

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	5.2	10.4	15.6	20.8	25.9	31.1	36.3	41.5	46.7	51.9
			99.0	4.7	9.4	14.2	18.9	23.6	28.3	33.0	37.7	42.5	47.2
		8.71	98.9	4.0	8.0	11.9	15.9	19.9	23.9	27.9	31.9	35.8	39.8
			99.0	3.6	7.2	10.9	14.5	18.1	21.7	25.3	29.0	32.6	36.2
	3	13.1	98.9	5.9	11.8	17.7	23.6	29.5	35.3	41.2	47.1	53.0	58.9
			99.0	5.4	10.7	16.1	21.4	26.8	32.1	37.5	42.8	48.2	53.6
		8.71	98.9	4.5	9.0	13.6	18.1	22.6	27.1	31.6	36.2	40.7	45.2
			99.0	4.1	8.2	12.3	16.4	20.5	24.7	28.8	32.9	37.0	41.1
Option 3	2	13.1	98	2.5	4.9	7.4	9.9	12.3	14.8	17.2	19.7	22.2	24.6
		8.71	98	2.2	4.3	6.5	8.6	10.8	12.9	15.1	17.2	19.4	21.6
	3	13.1	98	2.8	5.6	8.4	11.2	14.0	16.8	19.6	22.4	25.2	28.0
		8.71	98	2.4	4.9	7.3	9.8	12.2	14.7	17.1	19.6	22.0	24.5

Table 6.251: Breeding season apportioning for kittiwake at Northumbria Coast Ramsar for the impact from Preferred Project 3

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	1.1	2.2	3.4	4.5	5.6	6.7	7.9	9.0	10.1	11.2
			99.0	1.0	2.0	3.1	4.1	5.1	6.1	7.2	8.2	9.2	10.2
		8.71	98.9	0.8	1.7	2.5	3.3	4.2	5.0	5.8	6.7	7.5	8.3
			99.0	0.8	1.5	2.3	3.0	3.8	4.5	5.3	6.0	6.8	7.6
	3	13.1	98.9	1.3	2.6	3.8	5.1	6.4	7.7	8.9	10.2	11.5	12.8
			99.0	1.2	2.3	3.5	4.6	5.8	7.0	8.1	9.3	10.5	11.6
		8.71	98.9	0.9	1.9	2.8	3.8	4.7	5.7	6.6	7.6	8.5	9.5
			99.0	0.9	1.7	2.6	3.4	4.3	5.2	6.0	6.9	7.7	8.6
Option 3	2	13.1	98	0.4	0.7	1.1	1.4	1.8	2.1	2.5	2.9	3.2	3.6
		8.71	98	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.8	3.1
	3	13.1	98	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.1
		8.71	98	0.3	0.7	1.0	1.4	1.7	2.1	2.4	2.8	3.1	3.5

6.1.612 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.249, Table 6.250 and Table 6.251. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All three of the Preferred Projects are beyond the mean-maximum foraging range of kittiwake from the Northumbria Coast Ramsar and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. All of the Preferred Projects are however, within the foraging range of kittiwake when using the mean-maximum foraging range plus one standard deviation from Woodward *et al.* (2019) (300.6 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual kittiwakes from the Northumbria Coast Ramsar could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.613 There is no site-specific foraging range data available for kittiwake from the Northumbria Coast Ramsar. However, Cleasby *et al.* (2018) has modelled the utilisation of kittiwakes in UK waters. Although utilisations specific to kittiwake from Northumbria Coast Ramsar are not presented the overall utilisation of kittiwake in UK waters suggests that Preferred Project 1 is within the 1-5% utilisation bands with Preferred Project 2 in the 1% utilisation band but primarily outside of the utilisation of kittiwake from UK colonies. Preferred Project 3 lies in an area of much higher utilisation, however this is driven by birds from the much larger breeding colony at the Flamborough and Filey Coast SPA. It is considered unlikely that Preferred Project 3 would represent an area of significant utilisation by birds from Northumbria Coast Ramsar due to the distance between the Ramsar and Preferred Project 3, which when compared to the distance to Preferred Projects 1 and 2 would suggest limited utilisation. In addition, limited utilisation of these areas by birds from the Ramsar would also be caused by significant levels of competition with birds from the much larger Flamborough and Filey Coast SPA. It is therefore proposed that the breeding season apportioning values for use at Preferred Projects 1, 2 and 3 are 5%, 1% and 0% respectively.

6.1.614 In the post-breeding and pre-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post- and pre-breeding seasons for the Preferred Projects in the North Sea are 0.6% and 0.8%, respectively and for the Preferred Projects in the Irish Sea are 0.2% and 0.4%, respectively. The apportioned values from each of the Preferred Projects combined to the Northumbria Coast Ramsar are presented in Table 6.252.

Table 6.252: Apportioned collision mortality for kittiwake at the Northumbria Coast Ramsar in non-breeding seasons

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
Option 2	2	13.1	98.9	0.3	0.3
			99.0	0.2	0.2
		8.71	98.9	0.2	0.2
			99.0	0.2	0.2
	3	13.1	98.9	0.4	0.3
			99.0	0.3	0.3
		8.71	98.9	0.3	0.3
			99.0	0.2	0.2
Option 3	2	13.1	98	0.1	0.1
		8.71	98	0.1	0.1
	3	13.1	98	0.2	0.2
		8.71	98	0.1	0.1

6.1.615 The annual apportioned impact for kittiwake at Northumbria Coast Ramsar is provided in Table 6.253.

Table 6.253: Calculation of the annual impact attributable to kittiwake at the Northumbria Coast Ramsar from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding		Post-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP1	PP2	All projects	All projects		
Option 2	2	13.1	98.9	3.6	0.5	0.3	0.3	4.7	0.39
			99.0	3.3	0.5	0.2	0.2	4.3	0.36
		8.71	98.9	2.8	0.4	0.2	0.2	3.6	0.30
			99.0	2.5	0.4	0.2	0.2	3.3	0.27
	3	13.1	98.9	4.1	0.6	0.4	0.3	5.4	0.45
			99.0	3.7	0.5	0.3	0.3	4.9	0.41
		8.71	98.9	3.2	0.5	0.3	0.3	4.1	0.35
			99.0	2.9	0.4	0.2	0.2	3.8	0.32
Option 3	2	13.1	98	1.7	0.2	0.1	0.1	2.2	0.19
		8.71	98	1.5	0.2	0.1	0.1	1.9	0.16
	3	13.1	98	2.0	0.3	0.2	0.2	2.6	0.21
		8.71	98	1.7	0.2	0.1	0.1	2.2	0.19

6.1.616 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.253 is considered to be 1.9-2.2 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that kittiwake densities from the MERP dataset potentially underestimate kittiwake abundance.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.
- The apportioning value applied in the breeding season, it is unlikely that a significant proportion of kittiwake from the Northumbria Coast Ramsar SPA will utilize the Preferred Project areas and the assumption of 10% is likely an over-estimate but is applied on a precautionary basis.

6.1.617 An impact of 1.9-2.2 collisions/annum represents 0.16-0.29% of the baseline mortality of the Northumbria Coast Ramsar kittiwake population (4,070 pairs). When considering the highest impact estimated in Table 6.253, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 4.7-5.4 collisions/annum represents an increase in baseline mortality of 0.39-0.45%. In the context of baseline mortality the predicted mortality is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.618 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Northumbria Coast SPA.

Outer Firth of Forth and St Andrews Bay Complex SPA

Gannet

Alone

6.1.619 The Outer Firth of Forth and St Andrews Bay Complex SPA is designated to protect the sea areas utilised by birds included on the designation of a number of SPAs adjacent to or within the Outer Firth of Forth and St Andrews Bay Complex SPA. For gannet, this relates the Forth Islands SPA. As the population of birds designated as part of the Outer Firth of Forth and St Andrews Bay Complex SPA is the same as that designated as part of the Forth Islands SPA, any impact and associated assessment conclusions reached for the Forth Islands is considered equally applicable to the Outer Firth of Forth and St Andrews Bay Complex SPA.

6.1.620 The most likely impact (and most realistic worst case) from collision risk modelling for gannet at the Forth Islands SPA of 3.6-4.4 collisions/annum represents 0.10-0.13% of the baseline mortality of the Forth Islands SPA gannet population (21,600 pairs). When considering the highest impact estimated in Table 6.135, an annual collision risk estimate of 8.4-10.3 collisions/annum represents an increase in baseline mortality of 0.24-0.29%.

6.1.621 The most likely impact (and most realistic worst case) from displacement for gannet at the Forth Islands SPA of.6-22.8 birds represents 0.05-0.65% of the baseline mortality of the Forth Islands SPA gannet population.

6.1.622 When combined this provides a total impact from collision and displacement of 5.2 -27.2 birds/annum representing 0.16-0.78% of the baseline mortality of the gannet population at the Forth Islands SPA.

6.1.623 However, Marine Scotland Science and NatureScot have previously advised that, consideration of displacement impacts for gannet is not required as such impacts are not considered likely to result in an adverse effect on the site integrity of an SPA based on the findings of Searle *et al* (2014).

In-combination

6.1.624 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Outer Firth of Forth and St Andrews Bay Complex SPA.

Kittiwake

6.1.625 The Outer Firth of Forth and St Andrews Bay Complex SPA is designated to protect the sea areas utilised by birds included on the designation of a number of SPAs adjacent to or within the Outer Firth of Forth and St Andrews Bay Complex SPA. For kittiwake, in the context of the RIAA this relates to the populations of kittiwake at the Forth Islands SPA and St Abb's to Fast Castle SPA.

6.1.626 The most likely impact (and most realistic worst case predicted for kittiwake at the Forth Islands SPA is 3.2-3.7 collisions/annum which represents 0.13-0.15% of the baseline mortality of the Forth Islands SPA kittiwake population (8,400 pairs). Even if the highest impact presented in Table 6.139 is applied, which is considered unrealistic due to an over-application of precaution, the associated impact represents 0.32-0.36% of baseline mortality. However, there are considered to be significant assumptions which lead to over-estimation associated with the collision risk estimates. In the context of baseline mortality the predicted mortality is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.627 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Outer Firth of Forth and St Andrews Bay Complex SPA.

Rathlin Island SPA

Lesser black-backed gull

Alone

6.1.628 Collision risk modelling for the Round 4 Plan has been undertaken for lesser black-backed gull using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated a range of values for a number of input parameters. The results of collision risk modelling for each Preferred Project are presented on an unapportioned seasonal basis in Table 6.254. In the breeding season, there is only connectivity between the designated site and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging

range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.254: Collision risk estimates for lesser black-backed gull (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																								
				Breeding season				Post-breeding							Non-breeding							Pre-breeding						
				PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	99.5	4	5	4	13	1	1	0	1	1	0	5	2	2	1	1	1	1	7	1	1	0	0	0	0	3
		9.8	99.5	3	5	3	11	1	1	0	0	1	0	4	1	2	0	1	1	0	6	1	1	0	0	0	0	3
	3	13.1	99.5	5	6	4	15	1	2	0	1	1	1	6	2	3	1	1	1	1	9	1	1	0	0	1	0	4
		9.8	99.5	4	5	3	12	1	1	0	1	1	0	5	2	3	1	1	1	1	7	1	1	0	0	0	0	3
Option 3	2	13.1	98.9	3	4	2	9	1	1	0	0	0	0	4	1	2	0	0	1	0	5	1	1	0	0	0	0	3
			99.3	2	2	2	6	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
		9.8	98.9	2	4	2	8	1	1	0	0	0	0	3	1	2	0	0	1	0	5	1	1	0	0	0	0	2
			99.3	1	2	1	5	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
	3	13.1	98.9	3	4	3	10	1	1	0	0	1	0	4	2	3	0	1	1	0	7	1	1	0	0	0	0	3
			99.3	2	3	2	6	1	1	0	0	0	0	3	1	2	0	0	0	0	4	1	1	0	0	0	0	2
		9.8	98.9	3	4	2	9	1	1	0	0	1	0	4	2	2	0	0	1	0	6	1	1	0	0	0	0	3
			99.3	2	3	2	6	1	1	0	0	0	0	2	1	2	0	0	0	0	4	1	1	0	0	0	0	2

6.1.629 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.255, Table 6.256 and Table 6.257.

Table 6.255: Breeding season apportioning for lesser black-backed gull at the Rathlin Island SPA for the impact from Preferred Project 4

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.4	0.8	1.2	1.6	2.0	2.4	2.9	3.3	3.7	4.1
		9.8	99.5	0.3	0.7	1.0	1.3	1.7	2.0	2.4	2.7	3.0	3.4
	3	13.1	99.5	0.5	0.9	1.4	1.8	2.3	2.7	3.2	3.6	4.1	4.5
		9.8	99.5	0.4	0.8	1.1	1.5	1.9	2.3	2.6	3.0	3.4	3.8
Option 3	2	13.1	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
			99.3	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.6
		9.8	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.4
			99.3	0.1	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.3	1.5
	3	13.1	98.9	0.3	0.6	0.9	1.2	1.4	1.7	2.0	2.3	2.6	2.9
			99.3	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.8
		9.8	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.4	2.6
			99.3	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.7

Table 6.256: Breeding season apportioning for lesser black-backed gull at the Rathlin Island SPA for the impact from Preferred Project 5

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.5	1.1	1.6	2.1	2.6	3.2	3.7	4.2	4.8	5.3
		9.8	99.5	0.5	0.9	1.4	1.9	2.3	2.8	3.3	3.7	4.2	4.7
	3	13.1	99.5	0.6	1.2	1.8	2.4	2.9	3.5	4.1	4.7	5.3	5.9
		9.8	99.5	0.5	1.0	1.6	2.1	2.6	3.1	3.6	4.2	4.7	5.2
Option 3	2	13.1	98.9	0.4	0.7	1.1	1.5	1.8	2.2	2.6	2.9	3.3	3.7
			99.3	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.3
		9.8	98.9	0.4	0.7	1.1	1.4	1.8	2.2	2.5	2.9	3.3	3.6
			99.3	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.8	2.1	2.3
	3	13.1	98.9	0.4	0.8	1.2	1.6	2.0	2.4	2.9	3.3	3.7	4.1
			99.3	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
		9.8	98.9	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0
			99.3	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.1	2.3	2.6

Table 6.257: Breeding season apportioning for lesser black-backed gull at the Rathlin Island SPA for the impact from Preferred Project 6

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.4	0.8	1.1	1.5	1.9	2.3	2.7	3.0	3.4	3.8
		9.8	99.5	0.3	0.6	0.9	1.3	1.6	1.9	2.2	2.5	2.8	3.1
	3	13.1	99.5	0.4	0.8	1.3	1.7	2.1	2.5	3.0	3.4	3.8	4.2
		9.8	99.5	0.3	0.7	1.0	1.4	1.7	2.1	2.4	2.8	3.1	3.5
Option 3	2	13.1	98.9	0.2	0.5	0.7	1.0	1.2	1.4	1.7	1.9	2.2	2.4
			99.3	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5
		9.8	98.9	0.2	0.4	0.7	0.9	1.1	1.3	1.5	1.7	2.0	2.2
			99.3	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4
	3	13.1	98.9	0.3	0.5	0.8	1.1	1.3	1.6	1.9	2.1	2.4	2.7
			99.3	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.5	1.7
		9.8	98.9	0.2	0.5	0.7	1.0	1.2	1.5	1.7	1.9	2.2	2.4
			99.3	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5

6.1.630 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.255, Table 6.256 and Table 6.257. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al*. (2019). All of the Preferred Projects are beyond the mean-maximum foraging range of lesser black-backed gull from the Rathlin Island SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. All three projects are however, within the foraging range of lesser black-backed gull when using the mean-maximum foraging range plus one standard deviation for lesser black-backed gull (236 km) presented in Woodward *et al*. (2019). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual lesser black-backed gulls from the Rathlin Island SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.631 There is no site-specific foraging range data available for lesser black-backed gull from the Rathlin Island SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Rathlin Island SPA then this should only be a limited amount (e.g. 10%).

6.1.632 In the post-, non- and pre-breeding seasons, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, non- and pre-breeding seasons for the Preferred Projects in the Irish Sea are 0.07%, 0.1% and 0.07%, respectively. For the Preferred Projects in the North Sea the values used are 0.05% in all seasons. The apportioned values from each of the Preferred Projects combined to the Rathlin Island SPA are presented in Table 6.258. In all cases the impact is less than 0.1 collisions.

Table 6.258: Apportioned collision risk estimates for lesser black-backed gull at the Rathlin Island SPA in non-breeding seasons

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values		
				Post-breeding	Non-breeding	Pre-breeding
Option 2	2	13.1	99.5	0.0	0.0	0.0
		9.8	99.5	0.0	0.0	0.0

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values		
				Post-breeding	Non-breeding	Pre-breeding
	3	13.1	99.5	0.0	0.0	0.0
		9.8	99.5	0.0	0.0	0.0
Option 3	2	13.1	98.9	0.0	0.0	0.0
			99.3	0.0	0.0	0.0
		9.8	98.9	0.0	0.0	0.0
			99.3	0.0	0.0	0.0
	3	13.1	98.9	0.0	0.0	0.0
			99.3	0.0	0.0	0.0
		9.8	98.9	0.0	0.0	0.0
			99.3	0.0	0.0	0.0

6.1.633 The annual apportioned impact for lesser black-backed gull at the Rathlin Island SPA is provided in Table 6.259.

Table 6.259: Calculation of the annual impact attributable to lesser black-backed gull at the Rathlin Island SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding			Post-breeding	Non-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP4	PP5	PP6	All projects	All projects	All projects		
Option 2	2	13.1	99.5	0.4	0.5	0.4	0.0	0.0	0.0	1.3	3.71
		9.8	99.5	0.3	0.5	0.3	0.0	0.0	0.0	1.1	3.16
	3	13.1	99.5	0.5	0.6	0.4	0.0	0.0	0.0	1.5	4.14
		9.8	99.5	0.4	0.5	0.3	0.0	0.0	0.0	1.3	3.52
Option 3	2	13.1	98.9	0.3	0.4	0.2	0.0	0.0	0.0	0.9	2.45
			99.3	0.2	0.2	0.2	0.0	0.0	0.0	0.6	1.56
		9.8	98.9	0.2	0.4	0.2	0.0	0.0	0.0	0.8	2.30
			99.3	0.1	0.2	0.1	0.0	0.0	0.0	0.5	1.47
	3	13.1	98.9	0.3	0.4	0.3	0.0	0.0	0.0	1.0	2.73
			99.3	0.2	0.3	0.2	0.0	0.0	0.0	0.6	1.74
		9.8	98.9	0.3	0.4	0.2	0.0	0.0	0.0	0.9	2.57
			99.3	0.2	0.3	0.2	0.0	0.0	0.0	0.6	1.64

6.1.634 The most likely impact (and most realistic worst case) for the Round 4 Plan alone from Table 6.259 is considered to be 0.5-0.6 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the densities for lesser black-backed gull from the MERP dataset potentially overestimate lesser black-backed gull abundance.
- The appropriate apportioning value to apply. It is considered highly unlikely that a significant proportion of lesser black-backed gulls from Rathlin Island SPA will forage in the sea areas in which the Preferred Projects will be located. A value of 10% has been applied however, this is considered to be highly precautionary with large gulls unlikely to be found foraging at distances offshore commensurate with the distance between Rathlin Island SPA and the Preferred Projects.

6.1.635 An impact of 0.5-0.6 collisions/annum represents 1.47-1.64% of the baseline mortality of the Rathlin Island SPA lesser black-backed gull population (310 breeding adults). When considering the highest impact estimated in Table 6.259, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 1.3-1.5 collisions/annum represents an increase in baseline mortality of 3.71-4.14%.

6.1.636 Despite the predicted collision risk exceeding the 1% baseline mortality threshold of the Rathlin Island SPA population, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.637 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Rathlin Island SPA.

Kittiwake

Alone

6.1.638 Collision risk modelling has been undertaken for kittiwake using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.260. In the breeding season, there is only connectivity between the Rathlin Island SPA and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.260: Collision risk estimates for kittiwake (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																
				Breeding season				Post-breeding							Pre-breeding						
				PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	98.9	3	2	3	8	29	21	5	2	1	2	59	21	15	3	1	0	1	41
			99.0	3	2	3	7	26	19	4	2	1	2	54	19	14	3	1	0	0	37
		8.71	98.9	2	2	2	6	22	16	3	1	1	1	45	16	12	2	0	0	0	31
			99.0	2	1	2	5	20	14	3	1	1	1	41	15	11	2	0	0	0	29
	3	13.1	98.9	4	2	3	9	37	26	6	2	1	2	75	28	20	4	1	0	1	53
			99.0	3	2	3	8	34	24	5	2	1	2	68	25	18	4	1	0	1	49
		8.71	98.9	3	2	2	7	28	20	4	2	1	2	58	21	15	3	1	0	1	41
			99.0	2	2	2	6	26	18	4	2	1	1	52	19	14	3	1	0	0	37
Option 3	2	13.1	98	1	1	1	3	14	10	1	1	0	1	27	10	7	1	0	0	0	19
		8.71	98	1	1	1	2	12	9	1	1	0	0	23	9	6	1	0	0	0	16
	3	13.1	98	1	1	1	3	18	13	2	1	1	1	34	13	9	1	0	0	0	24
		8.71	98	1	1	1	3	15	11	2	1	1	1	30	12	8	1	0	0	0	21

6.1.639 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.261, Table 6.262 and Table 6.263.

Table 6.261: Breeding season apportioning for kittiwake at Rathlin Island SPA for the impact from Preferred Project 4

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.3	0.6	0.9	1.2	1.6	1.9	2.2	2.5	2.8	3.1
			99.0	0.3	0.6	0.8	1.1	1.4	1.7	2.0	2.3	2.5	2.8
		8.71	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.3
			99.0	0.2	0.4	0.6	0.8	1.1	1.3	1.5	1.7	1.9	2.1
	3	13.1	98.9	0.4	0.7	1.1	1.4	1.8	2.1	2.5	2.8	3.2	3.5
			99.0	0.3	0.6	1.0	1.3	1.6	1.9	2.2	2.6	2.9	3.2
		8.71	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
			99.0	0.2	0.5	0.7	0.9	1.2	1.4	1.7	1.9	2.1	2.4
Option 3	2	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		8.71	98	0.1	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.8	0.9
	3	13.1	98	0.1	0.2	0.3	0.5	0.6	0.7	0.8	0.9	1.0	1.2
		8.71	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

Table 6.262: Breeding season apportioning for kittiwake at Rathlin Island SPA for the impact from Preferred Project 5

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.9
			99.0	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.4	1.5	1.7
		8.71	98.9	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.6
			99.0	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4
	3	13.1	98.9	0.2	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.9	2.1
			99.0	0.2	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9
		8.71	98.9	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.6	1.7
			99.0	0.2	0.3	0.5	0.6	0.8	1.0	1.1	1.3	1.4	1.6
Option 3	2	13.1	98	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
		8.71	98	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
	3	13.1	98	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8
		8.71	98	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8

Table 6.263: Breeding season apportioning for kittiwake at Rathlin Island SPA for the impact from Preferred Project 6

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.3	0.6	0.8	1.1	1.4	1.7	2.0	2.2	2.5	2.8
			99.0	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.0	2.3	2.6
		8.71	98.9	0.2	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.9	2.1
			99.0	0.2	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9
	3	13.1	98.9	0.3	0.6	0.9	1.3	1.6	1.9	2.2	2.5	2.8	3.2
			99.0	0.3	0.6	0.9	1.2	1.4	1.7	2.0	2.3	2.6	2.9
		8.71	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.4
			99.0	0.2	0.4	0.6	0.9	1.1	1.3	1.5	1.7	1.9	2.1
Option 3	2	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.8	0.9
		8.71	98	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.6	0.7	0.8
	3	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		8.71	98	0.1	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8	0.9

6.1.640 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.261, Table 6.262 and Table 6.263. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All of the Preferred Projects are beyond the mean-maximum foraging range of kittiwake from the Rathlin Island SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%.

6.1.641 All of the Preferred Projects are however, within the foraging range of kittiwake when using the mean-maximum foraging range plus one standard deviation (300.5 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual kittiwakes from the Rathlin Island SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.642 A total of 23 kittiwakes were tagged at Rathlin Island in 2009 (13) and 2010 (10) with 14 of these considered to represent foraging trips (five in both years). The maximum distance travelled by birds whilst foraging was 26.3 km in 2009 and 51.4 km in 2010 both considerably shorter than the distance between the colony and the Preferred Projects (Chivers *et al.,* 2012). A further 17 birds were tagged in 2017 (Trevail *et al.,* 2019). The mean-maximum distance from the colony was similarly short (13.5±1.3 km) with foraging trips again occurring to the north of the colony.

6.1.643 The UK and Eire-wide utilisation distributions presented in Cleasby *et al.* (2018) suggest that the Preferred Projects lie beyond the 75% utilisation distribution band of kittiwake. This suggests that the sea areas in which the Preferred Projects are located do not represent an important area for kittiwakes and any usage of these areas is likely by birds from more local colonies. However, if on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Rathlin Island SPA then this should only be a limited amount (e.g. 10%).

6.1.644 In the post-breeding and pre-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, and pre-breeding seasons for the Preferred Projects in the Irish Sea are 1.0% and 1.8% and for the Preferred Projects in the North Sea are 0.02% and 0.03%. The apportioned values from each of the Preferred Projects combined to the Rathlin Island SPA are presented in Table 6.264.

Table 6.264: Apportioning for kittiwake at the Rathlin Island SPA in the post- and pre-breeding season for the impact from all Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
Option 2	2	13.1	98.9	0.1	0.0
			99.0	0.1	0.0
		8.71	98.9	0.0	0.0
			99.0	0.0	0.0
	3	13.1	98.9	0.1	0.0
			99.0	0.1	0.0
		8.71	98.9	0.1	0.0
			99.0	0.1	0.0
Option 3	2	13.1	98	0.0	0.0
		8.71	98	0.0	0.0
	3	13.1	98	0.0	0.0
		8.71	98	0.0	0.0

6.1.645 The annual apportioned impact for kittiwake at the Rathlin Island SPA is provided in Table 6.265.

Table 6.265: Calculation of total impact attributable to kittiwake at the Rathlin Island SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding season			Post-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP4	PP5	PP6	All projects	All projects		
Option 2	2	13.1	98.9	0.3	0.2	0.3	0.1	0.0	0.9	0.04
			99.0	0.3	0.2	0.3	0.1	0.0	0.8	0.04
		8.71	98.9	0.2	0.2	0.2	0.0	0.0	0.7	0.03
			99.0	0.2	0.1	0.2	0.0	0.0	0.6	0.03
	3	13.1	98.9	0.4	0.2	0.3	0.1	0.0	1.0	0.05
			99.0	0.3	0.2	0.3	0.1	0.0	0.9	0.05
		8.71	98.9	0.3	0.2	0.2	0.1	0.0	0.8	0.04
			99.0	0.2	0.2	0.2	0.1	0.0	0.7	0.03
Option 3	2	13.1	98	0.1	0.1	0.1	0.0	0.0	0.3	0.02
		8.71	98	0.1	0.1	0.1	0.0	0.0	0.3	0.01
	3	13.1	98	0.1	0.1	0.1	0.0	0.0	0.3	0.02
		8.71	98	0.1	0.1	0.1	0.0	0.0	0.3	0.02

6.1.646 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.265 is considered to be 0.3 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that kittiwake densities from the MERP dataset potentially underestimate kittiwake abundance.
- The appropriate apportioning value to apply. It is considered highly unlikely that a significant proportion of kittiwake from the Rathlin Island SPA will forage in the sea areas in which the Preferred Projects will be located. A value of 10% has been applied however, this is considered to be highly precautionary with kittiwake unlikely to be found foraging at distances offshore commensurate with the distance between the Rathlin Island SPA and the Preferred Projects.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.
- The proportion of immatures present at each of the Preferred Projects.

6.1.647 An impact of 0.3 collisions/annum represents 0.01-0.02% of the baseline mortality of the Rathlin Island SPA kittiwake population (13,644 breeding adults). When considering the highest impact estimated Table 6.265, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 0.9-1.0 collisions/annum represents an increase in baseline mortality of 0.04-0.05%. Under any of the scenarios presented, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.648 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Rathlin Island SPA.

Puffin

Alone

6.1.649 Displacement analysis has been undertaken for puffin using the approach advised in JNCC *et al.* (2017) (Annex H.1). To account for uncertainty in the analysis approach a range of displacement and mortality rates have been applied following the recommended approach to defining these in JNCC *et al.* (2017). Table 6.266 presents the unapportioned seasonal displacement mortality for puffin at each of the Preferred Projects using the appropriate range of displacement and mortality rates. In the breeding season, there is only connectivity between the Rathlin Island SPA and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.266: Displacement mortality for puffin at each of the Preferred Projects (unapportioned values) (no. of birds)

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
1	30	N/A				1	2	4	8
	50	N/A				1	3	6	13
	70	N/A				2	4	9	18
2	30	N/A				1	1	3	5
	50	N/A				1	2	5	9
	70	N/A				1	3	6	13
3	30	N/A				1	1	3	6
	50	N/A				1	2	5	9
	70	N/A				1	3	6	13
4	30	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0
	70	0	0	0	0	0	0	0	0
5	30	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0
	70	0	0	0	0	0	0	0	0
6	30	0	0	0	0	0	0	0	0

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
	50	0	0	0	0	0	0	0	0
	70	0	0	0	0	0	0	0	0

6.1.650 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.267.

Table 6.267: Breeding season apportioning for puffin at Rathlin Island SPA for the impact from all Preferred Projects with connectivity in the breeding season

Preferred Project	Displacement / mortality rate (%)	Apportioning value (%)									
		10	20	30	40	50	60	70	80	90	100
4	30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	50 / 5	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	70 / 10	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.4
5	30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	50 / 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	70 / 10	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
6	30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	50 / 5	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
	70 / 10	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2

6.1.651 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.267. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All three of the Preferred Projects are beyond the mean-maximum foraging range of puffin from the Rathlin Island SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. Each of the three projects is however, within the foraging range of puffin when using the mean-maximum foraging range plus one standard deviation (265.4 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual puffins from the Rathlin Island SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of displacement mortality.

6.1.652 There is no site-specific foraging range data available for puffin from the Rathlin Island SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Rathlin Island SPA then this should only be a limited amount (e.g. 10%).

6.1.653 In the non-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning value used for the Preferred Projects in the Irish Sea is 0.08% and for the Preferred Projects in the North Sea is less than 0.01%. The apportioned values from each of the Preferred Projects combined to the Rathlin Island SPA are presented in Table 6.268. In all cases the impact is less than 0.1 birds.

Table 6.268: Apportioned displacement mortality for puffin at the Rathlin Island SPA in the non-breeding season

Displacement / mortality rate (%)	Preferred Project						Total
	1	2	3	4	5	6	
30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50 / 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70 / 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0

6.1.654 The annual apportioned impact for puffin at the Rathlin Island SPA is provided in Table 6.269.

Table 6.269: Calculation of the annual impact attributable puffin at the Rathlin Island SPA from the Round 4 Plan alone

Displacement / mortality assumptions	Breeding season			Non-breeding season						Total	Increase in baseline mortality (%)
	PP4	PP5	PP6	PP1	PP2	PP3	PP4	PP5	PP6		
30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
50 / 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01
70 / 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.03

6.1.655 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.269 is considered to be less than one bird. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that puffin densities from the MERP dataset potentially over-estimate puffin abundance.
- The apportioning value applied in the breeding season, it is unlikely that a significant proportion of puffin from the Rathlin Island SPA will utilize the Preferred Project areas and the assumption of 10% is likely an over-estimate but is applied on a precautionary basis.

6.1.656 In all cases the impact is less than one bird representing 0.01% of the baseline mortality of the Rathlin Island SPA puffin population (2,398 breeding adults). Under any of the scenarios presented, the actual displacement mortality is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.657 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Rathlin Island SPA.

Ribble and Alt Estuaries SPA and Ramsar

Lesser black-backed gull

Alone

6.1.658 Collision risk modelling for the Round 4 Plan has been undertaken for lesser black-backed gull using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated a range of values for a number of input parameters. The results of collision risk modelling for each Preferred Project are presented on an unapportioned seasonal basis in Table 6.270. In the breeding season, there is only connectivity between the designated site and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.270: Collision risk estimates for lesser black-backed gull (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																								
				Breeding season				Post-breeding							Non-breeding							Pre-breeding						
				PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	99.5	4	5	4	13	1	1	0	1	1	0	5	2	2	1	1	1	1	7	1	1	0	0	0	0	3
		9.8	99.5	3	5	3	11	1	1	0	0	1	0	4	1	2	0	1	1	0	6	1	1	0	0	0	0	3
	3	13.1	99.5	5	6	4	15	1	2	0	1	1	1	6	2	3	1	1	1	1	9	1	1	0	0	1	0	4
		9.8	99.5	4	5	3	12	1	1	0	1	1	0	5	2	3	1	1	1	1	7	1	1	0	0	0	0	3
Option 3	2	13.1	98.9	3	4	2	9	1	1	0	0	0	0	4	1	2	0	0	1	0	5	1	1	0	0	0	0	3
			99.3	2	2	2	6	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
		9.8	98.9	2	4	2	8	1	1	0	0	0	0	3	1	2	0	0	1	0	5	1	1	0	0	0	0	2
			99.3	1	2	1	5	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
	3	13.1	98.9	3	4	3	10	1	1	0	0	1	0	4	2	3	0	1	1	0	7	1	1	0	0	0	0	3
			99.3	2	3	2	6	1	1	0	0	0	0	3	1	2	0	0	0	0	4	1	1	0	0	0	0	2
		9.8	98.9	3	4	2	9	1	1	0	0	1	0	4	2	2	0	0	1	0	6	1	1	0	0	0	0	3
			99.3	2	3	2	6	1	1	0	0	0	0	2	1	2	0	0	0	0	4	1	1	0	0	0	0	2

6.1.659 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.271, Table 6.272 and Table 6.273.

Table 6.271: Breeding season apportioning for lesser black-backed gull at the Ribble and Alt Estuaries SPA for the impact from Preferred Project 4

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.4	0.8	1.2	1.6	2.0	2.4	2.9	3.3	3.7	4.1
		9.8	99.5	0.3	0.7	1.0	1.3	1.7	2.0	2.4	2.7	3.0	3.4
	3	13.1	99.5	0.5	0.9	1.4	1.8	2.3	2.7	3.2	3.6	4.1	4.5
		9.8	99.5	0.4	0.8	1.1	1.5	1.9	2.3	2.6	3.0	3.4	3.8
Option 3	2	13.1	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
			99.3	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.6
		9.8	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.4
			99.3	0.1	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.3	1.5
	3	13.1	98.9	0.3	0.6	0.9	1.2	1.4	1.7	2.0	2.3	2.6	2.9
			99.3	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.8
		9.8	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.4	2.6
			99.3	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.7

Table 6.272: Breeding season apportioning for lesser black-backed gull at the Ribble and Alt Estuaries SPA for the impact from Preferred Project 5

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.5	1.1	1.6	2.1	2.6	3.2	3.7	4.2	4.8	5.3
		9.8	99.5	0.5	0.9	1.4	1.9	2.3	2.8	3.3	3.7	4.2	4.7
	3	13.1	99.5	0.6	1.2	1.8	2.4	2.9	3.5	4.1	4.7	5.3	5.9
		9.8	99.5	0.5	1.0	1.6	2.1	2.6	3.1	3.6	4.2	4.7	5.2
Option 3	2	13.1	98.9	0.4	0.7	1.1	1.5	1.8	2.2	2.6	2.9	3.3	3.7
			99.3	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.3
		9.8	98.9	0.4	0.7	1.1	1.4	1.8	2.2	2.5	2.9	3.3	3.6
			99.3	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.8	2.1	2.3
	3	13.1	98.9	0.4	0.8	1.2	1.6	2.0	2.4	2.9	3.3	3.7	4.1
			99.3	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
		9.8	98.9	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0
			99.3	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.1	2.3	2.6

Table 6.273: Breeding season apportioning for lesser black-backed gull at the Ribble and Alt Estuaries SPA for the impact from Preferred Project 6

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.4	0.8	1.1	1.5	1.9	2.3	2.7	3.0	3.4	3.8
		9.8	99.5	0.3	0.6	0.9	1.3	1.6	1.9	2.2	2.5	2.8	3.1
	3	13.1	99.5	0.4	0.8	1.3	1.7	2.1	2.5	3.0	3.4	3.8	4.2
		9.8	99.5	0.3	0.7	1.0	1.4	1.7	2.1	2.4	2.8	3.1	3.5
Option 3	2	13.1	98.9	0.2	0.5	0.7	1.0	1.2	1.4	1.7	1.9	2.2	2.4
			99.3	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5
		9.8	98.9	0.2	0.4	0.7	0.9	1.1	1.3	1.5	1.7	2.0	2.2
			99.3	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4
	3	13.1	98.9	0.3	0.5	0.8	1.1	1.3	1.6	1.9	2.1	2.4	2.7
			99.3	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.5	1.7
		9.8	98.9	0.2	0.5	0.7	1.0	1.2	1.5	1.7	1.9	2.2	2.4
			99.3	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5

6.1.660 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.271, Table 6.272 and Table 6.273. The three components of the population present at each of the Preferred Projects in the breeding season have been considered (see Annex H.3). The values associated with each of these population components is presented in Table 6.274 and multiplied together to provide an apportioning value for each of the Preferred Projects.

Table 6.274: Breeding season apportioning values for lesser black-backed gull at the Ribble and Alt Estuaries SPA based on the approach applied in Annex H.3

Preferred Project	Proportion of breeding adult birds from SPA	Proportion of immature birds	Proportion of non-breeding birds	Overall breeding season apportioning value
4	0.39	0.38	0.34	0.16
5	0.43	0.38	0.34	0.17
6	0.30	0.38	0.34	0.12

6.1.661 The results of the apportioning approach in Annex H.3 suggest that between 12-17% of the predicted impact at each of the Preferred Projects is attributable to Ribble and Alt Estuaries SPA. As mentioned in Section 5.2, the estimated proportion of immature birds in Table 6.274 does not take account of the distribution of immature birds and may therefore over-estimate this component of the population present at each of the Preferred Projects.

6.1.662 There is no site-specific foraging range data available for lesser black-backed gull from the Ribble and Alt Estuaries SPA however, a total of 11 birds were tagged at the BAE Warton aerodrome in 2016 which is located adjacent to the SPA. These data show foraging areas utilised by birds from the colony at BAE Warton with these foraging areas potentially used by birds breeding at the SPA. Of the 11 birds tagged usable data was collected from 7. Of these seven birds, few showed any connectivity with the marine environment and none with the area in which the Preferred Projects are located with the large majority of tracks radiating to the south-east towards urban areas, fields, landfill sites and ground workings. Of those tracks that interacted with the marine environment, these tracks were to intertidal mudflats and saltmarsh (Scragg *et al.*, 2016).

6.1.663 It is likely that birds from the SPA utilise the same foraging areas as birds from the Warton aerodrome, showing little utilisation of the marine environment. The apportioning values calculated for each of the Preferred Projects are therefore considered appropriate, and potentially over-estimates, for the purposes of attributing impacts from the Preferred Projects to the Ribble and Alt Estuaries SPA.

6.1.664 In the post-, non- and pre-breeding seasons, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, non- and pre-breeding seasons for the Preferred Projects in the Irish Sea are 5.1%, 8.0% and 5.1%, respectively. For the Preferred Projects in the North Sea the values applied are 4.0%, 4.2% and 4.2%, respectively. The apportioned values

from each of the Preferred Projects combined to the Ribble and Alt Estuaries SPA are presented in Table 6.275.

Table 6.275: Apportioned collision risk estimates for lesser black-backed gull at the Ribble and Alt Estuaries SPA in non-breeding seasons

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values		
				Post-breeding	Non-breeding	Pre-breeding
Option 2	2	13.1	99.5	0.2	0.4	0.1
		9.8	99.5	0.2	0.3	0.1
	3	13.1	99.5	0.2	0.5	0.2
		9.8	99.5	0.2	0.4	0.2
Option 3	2	13.1	98.9	0.2	0.3	0.1
			99.3	0.1	0.2	0.1
		9.8	98.9	0.1	0.2	0.1
			99.3	0.1	0.2	0.1
	3	13.1	98.9	0.2	0.4	0.1
			99.3	0.1	0.2	0.1
		9.8	98.9	0.2	0.3	0.1
			99.3	0.1	0.2	0.1

6.1.665 The annual apportioned impact for lesser black-backed gull at the Ribble and Alt Estuaries SPA is provided in Table 6.276.

Table 6.276: Calculation of the annual impact attributable to lesser black-backed gull at the Ribble and Alt Estuaries SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding			Post-breeding	Non-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP4	PP5	PP6	All projects	All projects	All projects		
Option 2	2	13.1	99.5	0.6	0.9	0.5	0.2	0.4	0.1	2.7	0.66
		9.8	99.5	0.5	0.8	0.4	0.2	0.3	0.1	2.3	0.56
	3	13.1	99.5	0.7	1.0	0.5	0.2	0.5	0.2	3.1	0.76
		9.8	99.5	0.6	0.9	0.4	0.2	0.4	0.2	2.7	0.64
Option 3	2	13.1	98.9	0.4	0.6	0.3	0.2	0.3	0.1	1.9	0.45
			99.3	0.3	0.4	0.2	0.1	0.2	0.1	1.2	0.29
		9.8	98.9	0.4	0.6	0.3	0.1	0.2	0.1	1.8	0.42
			99.3	0.2	0.4	0.2	0.1	0.2	0.1	1.1	0.27
	3	13.1	98.9	0.5	0.7	0.3	0.2	0.4	0.1	2.2	0.52
			99.3	0.3	0.5	0.2	0.1	0.2	0.1	1.4	0.33
		9.8	98.9	0.4	0.7	0.3	0.2	0.3	0.1	2.0	0.49
			99.3	0.3	0.4	0.2	0.1	0.2	0.1	1.3	0.31

6.1.666 The most likely impact (and most realistic worst case) for the Round 4 Plan alone from Table 6.276 is considered to be 1.1-1.3 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the densities for lesser black-backed gull from the MERP dataset potentially overestimate lesser black-backed gull abundance.

6.1.667 An impact of 1.1-1.3 collisions/annum represents 0.27-0.31% of the baseline mortality of the Ribble and Alt Estuaries SPA lesser black-backed gull population (3,600 breeding adults). When considering the highest impact estimated in Table 6.276, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 2.7-3.1 collisions/annum represents an increase in baseline mortality of 0.66-0.76%. Under any of the scenarios presented in Table 6.276 the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.668 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Ribble and Alt Estuaries SPA.

Rockabill SPA

Kittiwake

Alone

6.1.669 Collision risk modelling has been undertaken for kittiwake using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.277. In the breeding season, there is only connectivity between the Rockabill SPA and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.277: Collision risk estimates for kittiwake (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																
				Breeding season				Post-breeding							Pre-breeding						
				PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	98.9	3	2	3	8	29	21	5	2	1	2	59	21	15	3	1	0	1	41
			99.0	3	2	3	7	26	19	4	2	1	2	54	19	14	3	1	0	0	37
		8.71	98.9	2	2	2	6	22	16	3	1	1	1	45	16	12	2	0	0	0	31
			99.0	2	1	2	5	20	14	3	1	1	1	41	15	11	2	0	0	0	29
	3	13.1	98.9	4	2	3	9	37	26	6	2	1	2	75	28	20	4	1	0	1	53
			99.0	3	2	3	8	34	24	5	2	1	2	68	25	18	4	1	0	1	49
		8.71	98.9	3	2	2	7	28	20	4	2	1	2	58	21	15	3	1	0	1	41
			99.0	2	2	2	6	26	18	4	2	1	1	52	19	14	3	1	0	0	37
Option 3	2	13.1	98	1	1	1	3	14	10	1	1	0	1	27	10	7	1	0	0	0	19
		8.71	98	1	1	1	2	12	9	1	1	0	0	23	9	6	1	0	0	0	16
	3	13.1	98	1	1	1	3	18	13	2	1	1	1	34	13	9	1	0	0	0	24
		8.71	98	1	1	1	3	15	11	2	1	1	1	30	12	8	1	0	0	0	21

6.1.670 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.278, Table 6.279 and Table 6.280.

Table 6.278: Breeding season apportioning for kittiwake at Rockabill SPA for the impact from Preferred Project 4

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.3	0.6	0.9	1.2	1.6	1.9	2.2	2.5	2.8	3.1
			99.0	0.3	0.6	0.8	1.1	1.4	1.7	2.0	2.3	2.5	2.8
		8.71	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.3
			99.0	0.2	0.4	0.6	0.8	1.1	1.3	1.5	1.7	1.9	2.1
	3	13.1	98.9	0.4	0.7	1.1	1.4	1.8	2.1	2.5	2.8	3.2	3.5
			99.0	0.3	0.6	1.0	1.3	1.6	1.9	2.2	2.6	2.9	3.2
		8.71	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
			99.0	0.2	0.5	0.7	0.9	1.2	1.4	1.7	1.9	2.1	2.4
Option 3	2	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		8.71	98	0.1	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.8	0.9
	3	13.1	98	0.1	0.2	0.3	0.5	0.6	0.7	0.8	0.9	1.0	1.2
		8.71	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

Table 6.279: Breeding season apportioning for kittiwake at Rockabill SPA for the impact from Preferred Project 5

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.9
			99.0	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.4	1.5	1.7
		8.71	98.9	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.6
			99.0	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4
	3	13.1	98.9	0.2	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.9	2.1
			99.0	0.2	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9
		8.71	98.9	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.6	1.7
			99.0	0.2	0.3	0.5	0.6	0.8	1.0	1.1	1.3	1.4	1.6
Option 3	2	13.1	98	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
		8.71	98	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
	3	13.1	98	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8
		8.71	98	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8

Table 6.280: Breeding season apportioning for kittiwake at Rockabill SPA for the impact from Preferred Project 6

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.3	0.6	0.8	1.1	1.4	1.7	2.0	2.2	2.5	2.8
			99.0	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.0	2.3	2.6
		8.71	98.9	0.2	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.9	2.1
			99.0	0.2	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9
	3	13.1	98.9	0.3	0.6	0.9	1.3	1.6	1.9	2.2	2.5	2.8	3.2
			99.0	0.3	0.6	0.9	1.2	1.4	1.7	2.0	2.3	2.6	2.9
		8.71	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.4
			99.0	0.2	0.4	0.6	0.9	1.1	1.3	1.5	1.7	1.9	2.1
Option 3	2	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.8	0.9
		8.71	98	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.6	0.7	0.8
	3	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		8.71	98	0.1	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8	0.9

6.1.671 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.278, Table 6.279 and Table 6.280. All three of the Preferred Projects are within the mean-maximum foraging range of kittiwake from Rockabill SPA. Preferred Project 5 is on the edge of the mean-maximum foraging range, with the centre of the wind farm, used in the apportioning approach in Annex H.3 lying outside of the mean-maximum foraging range. As a result the apportioning value calculated for Preferred Project 5 is 0%. For the remaining two Preferred Projects, the three components of the population present at each project have been considered (see Annex H.3). The values associated with each of these population components are presented in Table 6.281 and multiplied together to provide an apportioning value for each of the Preferred Projects.

Table 6.281: Breeding season apportioning values for kittiwake at the Rockabill SPA based on the approach applied in Annex H.3

Preferred Project	Proportion of breeding adult birds from SPA	Proportion of immature birds	Proportion of non-breeding birds	Overall breeding season apportioning value
4	<0.01	0.44	0.1	<0.01
6	<0.01	0.44	0.1	<0.01

6.1.672 The results of the apportioning approach in Annex H.3 suggest that less than 1% (0.20-0.24%) of the predicted impact at each of the Preferred Projects is attributable to the Rockabill SPA. This is due to the small population of kittiwake present at the SPA. As mentioned in Section 5.2, the estimated proportion of immature birds in Table 6.281 does not take account of the distribution of immature birds and may therefore over-estimate this component of the population present at each of the Preferred Projects. If it were to be assumed that no immature birds were to be present at Preferred Projects 4 and 6, an ecologically invalid assumption, then the apportioning value at Preferred Projects 4 and 6 would still remain below 1% (0.36-0.43%).

6.1.673 There is no site-specific information in relation to the foraging behaviour of kittiwake from the Rockabill SPA. However, the UK and Eire-wide utilisation distributions presented in Cleasby *et al.* (2018) suggest that the Preferred Projects lie beyond the 75% utilisation distribution band. This suggests limited connectivity between any kittiwake colony and the Preferred Projects and supports the use of a low apportioning value. Therefore if, due to the lack of site-specific data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Rockabill SPA then this should only be a limited amount and it is proposed that the highest value from Table 6.281 be applied to Preferred Project 5.

6.1.674 As there is no information on the proportion of immature birds present at the Preferred Projects it is proposed that this component of the population be discounted accepting that this is will result in an over-estimation of the impact on the Rockabill SPA. The apportioning value in the breeding season for Preferred Project 4, 5 and 6 would therefore be 0.35%, 0.43% and 0.43%, respectively.

6.1.675 In the post-breeding and pre-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, and pre-breeding seasons for the Preferred Projects in the Irish Sea are 0.01% and

0.03% and for the Preferred Projects in the North Sea less than 0.01%. The apportioned values from each of the Preferred Projects combined to the Rockabill SPA are presented in Table 6.282.

Table 6.282: Apportioning for kittiwake at Rockabill SPA in the post- and pre-breeding season for the impact from all Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
Option 2	2	13.1	98.9	0.0	0.0
			99.0	0.0	0.0
		8.71	98.9	0.0	0.0
			99.0	0.0	0.0
	3	13.1	98.9	0.0	0.0
			99.0	0.0	0.0
		8.71	98.9	0.0	0.0
			99.0	0.0	0.0
Option 3	2	13.1	98	0.0	0.0
		8.71	98	0.0	0.0
	3	13.1	98	0.0	0.0
		8.71	98	0.0	0.0

6.1.676 The annual apportioned impact for kittiwake at Rockabill SPA is provided in Table 6.283.

Table 6.283: Calculation of total impact attributable to kittiwake at the Rockabill SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding			Post-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP4	PP5	PP6	All projects	All projects		
Option 2	2	13.1	98.9	0.0	0.0	0.0	0.0	0.0	0.0	0.10
			99.0	0.0	0.0	0.0	0.0	0.0	0.0	0.09
		8.71	98.9	0.0	0.0	0.0	0.0	0.0	0.0	0.08
			99.0	0.0	0.0	0.0	0.0	0.0	0.0	0.07
	3	13.1	98.9	0.0	0.0	0.0	0.0	0.0	0.0	0.11
			99.0	0.0	0.0	0.0	0.0	0.0	0.0	0.10
		8.71	98.9	0.0	0.0	0.0	0.0	0.0	0.0	0.09
			99.0	0.0	0.0	0.0	0.0	0.0	0.0	0.08
Option 3	2	13.1	98	0.0	0.0	0.0	0.0	0.0	0.0	0.03
		8.71	98	0.0	0.0	0.0	0.0	0.0	0.0	0.03
	3	13.1	98	0.0	0.0	0.0	0.0	0.0	0.0	0.04
		8.71	98	0.0	0.0	0.0	0.0	0.0	0.0	0.04

6.1.677 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.283 is considered to be less than 0.1 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that kittiwake densities from the MERP dataset potentially underestimate kittiwake abundance.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.
- The proportion of immatures present at each of the Preferred Projects.

6.1.678 In all cases an impact of less than 0.1 collisions/annum represents between 0.03-0.11% of the baseline mortality of the Rockabill SPA kittiwake population (222 breeding adults). Under any of the scenarios presented, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.679 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Rockabill SPA.

Saltee Islands SAC and SPA

Kittiwake

Alone

6.1.680 Collision risk modelling has been undertaken for kittiwake using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.284. In the breeding season, there is only connectivity between the Saltee Islands SPA and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.284: Collision risk estimates for kittiwake (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																
				Breeding season				Post-breeding							Pre-breeding						
				PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	98.9	3	2	3	8	29	21	5	2	1	2	59	21	15	3	1	0	1	41
			99.0	3	2	3	7	26	19	4	2	1	2	54	19	14	3	1	0	0	37
		8.71	98.9	2	2	2	6	22	16	3	1	1	1	45	16	12	2	0	0	0	31
			99.0	2	1	2	5	20	14	3	1	1	1	41	15	11	2	0	0	0	29
	3	13.1	98.9	4	2	3	9	37	26	6	2	1	2	75	28	20	4	1	0	1	53
			99.0	3	2	3	8	34	24	5	2	1	2	68	25	18	4	1	0	1	49
		8.71	98.9	3	2	2	7	28	20	4	2	1	2	58	21	15	3	1	0	1	41
			99.0	2	2	2	6	26	18	4	2	1	1	52	19	14	3	1	0	0	37
Option 3	2	13.1	98	1	1	1	3	14	10	1	1	0	1	27	10	7	1	0	0	0	19
		8.71	98	1	1	1	2	12	9	1	1	0	0	23	9	6	1	0	0	0	16
	3	13.1	98	1	1	1	3	18	13	2	1	1	1	34	13	9	1	0	0	0	24
		8.71	98	1	1	1	3	15	11	2	1	1	1	30	12	8	1	0	0	0	21

6.1.681 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.285, Table 6.286 and Table 6.287.

Table 6.285: Breeding season apportioning for kittiwake at Saltee Islands SPA for the impact from Preferred Project 4

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.3	0.6	0.9	1.2	1.6	1.9	2.2	2.5	2.8	3.1
			99.0	0.3	0.6	0.8	1.1	1.4	1.7	2.0	2.3	2.5	2.8
		8.71	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.3
			99.0	0.2	0.4	0.6	0.8	1.1	1.3	1.5	1.7	1.9	2.1
	3	13.1	98.9	0.4	0.7	1.1	1.4	1.8	2.1	2.5	2.8	3.2	3.5
			99.0	0.3	0.6	1.0	1.3	1.6	1.9	2.2	2.6	2.9	3.2
		8.71	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
			99.0	0.2	0.5	0.7	0.9	1.2	1.4	1.7	1.9	2.1	2.4
Option 3	2	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		8.71	98	0.1	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.8	0.9
	3	13.1	98	0.1	0.2	0.3	0.5	0.6	0.7	0.8	0.9	1.0	1.2
		8.71	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

Table 6.286: Breeding season apportioning for kittiwake at Saltee Islands SPA for the impact from Preferred Project 5

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.9
			99.0	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.4	1.5	1.7
		8.71	98.9	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.6
			99.0	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4
	3	13.1	98.9	0.2	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.9	2.1
			99.0	0.2	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9
		8.71	98.9	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.6	1.7
			99.0	0.2	0.3	0.5	0.6	0.8	1.0	1.1	1.3	1.4	1.6
Option 3	2	13.1	98	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
		8.71	98	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
	3	13.1	98	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8
		8.71	98	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8

Table 6.287: Breeding season apportioning for kittiwake at Saltee Islands SPA for the impact from Preferred Project 6

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.3	0.6	0.8	1.1	1.4	1.7	2.0	2.2	2.5	2.8
			99.0	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.0	2.3	2.6
		8.71	98.9	0.2	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.9	2.1
			99.0	0.2	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9
	3	13.1	98.9	0.3	0.6	0.9	1.3	1.6	1.9	2.2	2.5	2.8	3.2
			99.0	0.3	0.6	0.9	1.2	1.4	1.7	2.0	2.3	2.6	2.9
		8.71	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.4
			99.0	0.2	0.4	0.6	0.9	1.1	1.3	1.5	1.7	1.9	2.1
Option 3	2	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.8	0.9
		8.71	98	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.6	0.7	0.8
	3	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		8.71	98	0.1	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8	0.9

6.1.682 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.285, Table 6.286 and Table 6.287. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All of the Preferred Projects are beyond the mean-maximum foraging range of kittiwake from the Saltee Islands SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%.

6.1.683 All of the Preferred Projects are however, within the foraging range of kittiwake when using the mean-maximum foraging range plus one standard deviation (300.5 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al.* (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual kittiwakes from the Saltee Islands SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.684 There is no site-specific foraging range data available for kittiwake from the Saltee Islands SPA. However, the UK and Eire-wide utilisation distributions presented in Cleasby *et al.* (2018) suggest that the Preferred Projects lie beyond the 75% utilisation distribution band. This suggests limited connectivity between any kittiwake colony and the Preferred Projects and supports the use of a low apportioning value. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Saltee Islands SPA then this should only be a limited amount (e.g. 10%).

6.1.685 In the post-breeding and pre-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, and pre-breeding seasons for the Preferred Projects in the Irish Sea are 0.28% and 0.49% and for the Preferred Projects in the North Sea are 0.01% and 0.01%. The apportioned values from each of the Preferred Projects combined to the Saltee Islands SPA are presented in Table 6.288.

Table 6.288: Apportioning for kittiwake at the Saltee Islands SPA in the post- and pre-breeding season for the impact from all Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
Option 2	2	13.1	98.9	0.0	0.0

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
			99.0	0.0	0.0
		8.71	98.9	0.0	0.0
			99.0	0.0	0.0
	3	13.1	98.9	0.0	0.0
			99.0	0.0	0.0
		8.71	98.9	0.0	0.0
			99.0	0.0	0.0
Option 3	2	13.1	98	0.0	0.0
		8.71	98	0.0	0.0
	3	13.1	98	0.0	0.0
		8.71	98	0.0	0.0

6.1.686 The annual apportioned impact for kittiwake at The Saltee Islands SPA is provided in Table 6.289.

Table 6.289: Calculation of total impact attributable to kittiwake at The Saltee Islands SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding			Post-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP4	PP5	PP6	All projects	All projects		
Option 2	2	13.1	98.9	0.3	0.2	0.3	0.0	0.0	0.8	0.13
			99.0	0.3	0.2	0.3	0.0	0.0	0.7	0.12
		8.71	98.9	0.2	0.2	0.2	0.0	0.0	0.6	0.10
			99.0	0.2	0.1	0.2	0.0	0.0	0.6	0.09
	3	13.1	98.9	0.4	0.2	0.3	0.0	0.0	0.9	0.15
			99.0	0.3	0.2	0.3	0.0	0.0	0.8	0.13
		8.71	98.9	0.3	0.2	0.2	0.0	0.0	0.7	0.11
			99.0	0.2	0.2	0.2	0.0	0.0	0.6	0.10
Option 3	2	13.1	98	0.1	0.1	0.1	0.0	0.0	0.3	0.04
		8.71	98	0.1	0.1	0.1	0.0	0.0	0.2	0.04
	3	13.1	98	0.1	0.1	0.1	0.0	0.0	0.3	0.05
		8.71	98	0.1	0.1	0.1	0.0	0.0	0.3	0.05

6.1.687 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.289 is considered to be 0.2-0.3 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that kittiwake densities from the MERP dataset potentially underestimate kittiwake abundance.
- The appropriate apportioning value to apply. It is considered highly unlikely that a significant proportion of kittiwake from the Saltee Islands SPA will forage in the sea areas in which the Preferred Projects will be located. A value of 10% has been applied however, this is considered to be highly precautionary with kittiwake unlikely to be found foraging at distances offshore commensurate with the distance between the Saltee Islands SPA and the Preferred Projects.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.
- The proportion of immatures present at each of the Preferred Projects.

6.1.688 An impact of 0.2-0.3 collisions/annum represents 0.04-0.05% of the baseline mortality of the Saltee Islands SPA kittiwake population (4,250 breeding adults). When considering the highest impact estimated in Table 6.289, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 0.8-0.9 collisions/annum represents an increase in baseline mortality of 0.13-0.15%. Under any of the scenarios presented, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.689 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Saltee Islands SPA.

Puffin

Alone

6.1.690 Displacement analysis has been undertaken for puffin using the approach advised in JNCC *et al.* (2017) (Annex H.1). To account for uncertainty in the analysis approach a range of displacement and mortality rates have been applied following the recommended approach to defining these in JNCC *et al.* (2017). Table 6.290 presents the unapportioned seasonal displacement mortality for puffin at each of the Preferred Projects using the appropriate range of displacement and mortality rates. In the breeding season, there is only connectivity between the Saltee Islands SPA and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.290: Displacement mortality for puffin at each of the Preferred Projects (unapportioned values) (no. of birds)

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
1	30	N/A				1	2	4	8
	50	N/A				1	3	6	13
	70	N/A				2	4	9	18
2	30	N/A				1	1	3	5
	50	N/A				1	2	5	9
	70	N/A				1	3	6	13
3	30	N/A				1	1	3	6
	50	N/A				1	2	5	9
	70	N/A				1	3	6	13
4	30	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0
	70	0	0	0	0	0	0	0	0
5	30	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0
	70	0	0	0	0	0	0	0	0
6	30	0	0	0	0	0	0	0	0

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
	50	0	0	0	0	0	0	0	0
	70	0	0	0	0	0	0	0	0

6.1.691 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.291.

Table 6.291: Breeding season apportioning for puffin at the Saltee Islands SPA for the impact from all Preferred Projects with connectivity in the breeding season

Preferred Project	Displacement / mortality rate (%)	Apportioning value (%)									
		10	20	30	40	50	60	70	80	90	100
4	30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	50 / 5	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	70 / 10	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.4
5	30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	50 / 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	70 / 10	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
6	30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	50 / 5	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
	70 / 10	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2

6.1.692 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.291. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All three of the Preferred Projects are beyond the mean-maximum foraging range of puffin from the Saltee Islands SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. Each of the three projects is however, within the foraging range of puffin when using the mean-maximum foraging range plus one standard deviation (265.4 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual puffins from the Saltee Islands SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of displacement mortality.

6.1.693 There is no site-specific foraging range data available for puffin from the Saltee Islands SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Saltee Islands SPA then this should only be a limited amount (e.g. 10%).

6.1.694 In the non-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning value used for the Preferred Projects in the Irish Sea is 0.11% and for the Preferred Projects in the North Sea is less than 0.01%. The apportioned values from each of the Preferred Projects combined to the Saltee Islands SPA are presented in Table 6.292. In all cases the impact is less than 0.1 birds.

Table 6.292: Apportioned displacement mortality for puffin at the Saltee Islands SPA in the non-breeding season

Displacement / mortality rate (%)	Preferred Project						Total
	1	2	3	4	5	6	
30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50 / 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70 / 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0

6.1.695 The annual apportioned impact for puffin at the Saltee Islands SPA is provided in Table 6.293.

Table 6.293: Calculation of the annual impact attributable puffin at the Saltee Islands SPA from the Round 4 Plan alone

Displacement / mortality assumptions	Breeding season			Non-breeding season						Total	Increase in baseline mortality (%)
	PP4	PP5	PP6	PP1	PP2	PP3	PP4	PP5	PP6		
30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
50 / 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01
70 / 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.04

6.1.696 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.293 is considered to be less than one bird. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that puffin densities from the MERP dataset potentially over-estimate puffin abundance.
- The apportioning value applied in the breeding season, it is unlikely that a significant proportion of puffin from the Saltee Islands SPA will utilize the Preferred Project areas and the assumption of 10% is likely an over-estimate but is applied on a precautionary basis.

6.1.697 In all cases the impact is less than one bird representing 0.01% of the baseline mortality of the Saltee Islands SPA puffin population (2,398 breeding adults). Under any of the scenarios presented, the actual displacement mortality is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.698 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Saltee Islands SPA.

Skomer, Skokholm and Seas off Pembrokeshire SPA

Lesser black-backed gull

Alone

6.1.699 Collision risk modelling for the Round 4 Plan has been undertaken for lesser black-backed gull using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated a range of values for a number of input parameters. The results of collision risk modelling for each Preferred Project are presented on an unapportioned seasonal basis in Table 6.294. In the breeding season, there is only connectivity between the designated site and Preferred Project 4 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.294: Collision risk estimates for lesser black-backed gull (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																				
				Breeding season	Post-breeding							Non-breeding							Pre-breeding						
				PP4	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	99.5	4	1	1	0	1	1	0	5	2	2	1	1	1	1	7	1	1	0	0	0	0	3
		9.8	99.5	3	1	1	0	0	1	0	4	1	2	0	1	1	0	6	1	1	0	0	0	0	3
	3	13.1	99.5	5	1	2	0	1	1	1	6	2	3	1	1	1	1	9	1	1	0	0	1	0	4
		9.8	99.5	4	1	1	0	1	1	0	5	2	3	1	1	1	1	7	1	1	0	0	0	0	3
Option 3	2	13.1	98.9	3	1	1	0	0	0	0	4	1	2	0	0	1	0	5	1	1	0	0	0	0	3
			99.3	2	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
		9.8	98.9	2	1	1	0	0	0	0	3	1	2	0	0	1	0	5	1	1	0	0	0	0	2
			99.3	1	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
	3	13.1	98.9	3	1	1	0	0	1	0	4	2	3	0	1	1	0	7	1	1	0	0	0	0	3
			99.3	2	1	1	0	0	0	0	3	1	2	0	0	0	0	4	1	1	0	0	0	0	2
		9.8	98.9	3	1	1	0	0	1	0	4	2	2	0	0	1	0	6	1	1	0	0	0	0	3
			99.3	2	1	1	0	0	0	0	2	1	2	0	0	0	0	4	1	1	0	0	0	0	2

6.1.700 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.295.

Table 6.295: Breeding season apportioning for lesser black-backed gull at the Skomer, Skokholm and Seas off Pembrokeshire SPA for the impact from Preferred Project 4

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.4	0.8	1.2	1.6	2.0	2.4	2.9	3.3	3.7	4.1
		9.8	99.5	0.3	0.7	1.0	1.3	1.7	2.0	2.4	2.7	3.0	3.4
	3	13.1	99.5	0.5	0.9	1.4	1.8	2.3	2.7	3.2	3.6	4.1	4.5
		9.8	99.5	0.4	0.8	1.1	1.5	1.9	2.3	2.6	3.0	3.4	3.8
Option 3	2	13.1	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
			99.3	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.6
		9.8	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.4
			99.3	0.1	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.3	1.5
	3	13.1	98.9	0.3	0.6	0.9	1.2	1.4	1.7	2.0	2.3	2.6	2.9
			99.3	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.8
		9.8	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.4	2.6
			99.3	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.7

6.1.701 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.295. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al*. (2019). All of the Preferred Projects are beyond the mean-maximum foraging range of lesser black-backed gull from the Skomer, Skokholm and Seas off Pembrokeshire SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. Preferred Project 4 is however, within the foraging range of lesser black-backed gull when using the mean-maximum foraging range plus one standard deviation for lesser black-backed gull (236 km) presented in Woodward *et al*. (2019). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual lesser black-backed gulls from the Skomer, Skokholm and Seas off Pembrokeshire SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.702 Woodward *et al.* (2019) indicates that the maximum foraging range of lesser black-backed gull from Skomer, Skokholm and Seas off Pemborkeshire SPA is 150.5 km. This is a distance far short of the Preferred Projects and therefore suggests no connectivity between birds from the Skomer, Skokholm and Seas off Pembrokeshire SPA and the Preferred Projects. Therefore no impact from any of the Preferred Projects has been apportioned to the Skomer, Skokholm and Seas off Pembrokeshire SPA in the breeding season.

6.1.703 In the post-, non- and pre-breeding seasons, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, non- and pre-breeding seasons for the Preferred Projects in the Irish Sea are 8.3%, 9.4% and 8.3%, respectively. For the Preferred Projects in the North Sea, 2.8%, 4.9% and 2.9% in each season respectively.

Table 6.296: Apportioned collision risk estimates for lesser black-backed gull at the Skomer, Skokholm and Seas off Pembrokeshire SPA in non-breeding seasons

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values		
				Post-breeding	Non-breeding	Pre-breeding
Option 2	2	13.1	99.5	0.2	0.4	0.2
		9.8	99.5	0.2	0.4	0.1
	3	13.1	99.5	0.3	0.5	0.2
		9.8	99.5	0.2	0.5	0.2
Option 3	2	13.1	98.9	0.2	0.3	0.1
			99.3	0.1	0.2	0.1
		9.8	98.9	0.1	0.3	0.1
			99.3	0.1	0.2	0.1
	3	13.1	98.9	0.2	0.4	0.1
			99.3	0.1	0.3	0.1
		9.8	98.9	0.2	0.4	0.1
			99.3	0.1	0.2	0.1

6.1.704 The annual apportioned impact for lesser black-backed gull at the Skomer, Skokholm and Seas off Pembrokeshire SPA is provided in Table 6.297.

Table 6.297: Calculation of the annual impact attributable to lesser black-backed gull at the Skomer, Skokholm and Seas off Pembrokeshire SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Post-breeding	Non-breeding	Pre-breeding	Total	Baseline mortality (%)
				All projects	All projects	All projects		
Option 2	2	13.1	99.5	0.2	0.4	0.2	0.8	0.02
		9.8	99.5	0.2	0.4	0.1	0.7	0.01
	3	13.1	99.5	0.3	0.5	0.2	1.0	0.02
		9.8	99.5	0.2	0.5	0.2	0.8	0.02
Option 3	2	13.1	98.9	0.2	0.3	0.1	0.6	0.01
			99.3	0.1	0.2	0.1	0.4	0.01
		9.8	98.9	0.1	0.3	0.1	0.5	0.01
			99.3	0.1	0.2	0.1	0.3	0.01
	3	13.1	98.9	0.2	0.4	0.1	0.7	0.02
			99.3	0.1	0.3	0.1	0.5	0.01
		9.8	98.9	0.2	0.4	0.1	0.7	0.01
			99.3	0.1	0.2	0.1	0.4	0.01

6.1.705 The most likely impact (and most realistic worst case) for the Round 4 Plan alone from Table 6.297 is considered to be 0.3-0.4 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the densities for lesser black-backed gull from the MERP dataset potentially overestimate lesser black-backed gull abundance.

6.1.706 An impact of 0.3-0.4 collisions/annum represents 0.01% of the baseline mortality of the Skomer, Skokholm and Seas off Pembrokeshire SPA lesser black-backed gull population (40,600 breeding adults). When considering the highest impact estimated in Table 6.297, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 0.8-1.0 collisions/annum represents an increase in baseline mortality of 0.02%. Under any of the scenarios presented, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.707 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Skomer, Skokholm and Seas off Pembrokeshire SPA.

Kittiwake

Alone

6.1.708 Collision risk modelling has been undertaken for kittiwake using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.298. In the breeding season, there is only connectivity between the Skomer, Skokholm and Seas off Pembrokeshire SPA and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.298: Collision risk estimates for kittiwake (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																
				Breeding season				Post-breeding							Pre-breeding						
				PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	98.9	3	2	3	8	29	21	5	2	1	2	59	21	15	3	1	0	1	41
			99.0	3	2	3	7	26	19	4	2	1	2	54	19	14	3	1	0	0	37
		8.71	98.9	2	2	2	6	22	16	3	1	1	1	45	16	12	2	0	0	0	31
			99.0	2	1	2	5	20	14	3	1	1	1	41	15	11	2	0	0	0	29
	3	13.1	98.9	4	2	3	9	37	26	6	2	1	2	75	28	20	4	1	0	1	53
			99.0	3	2	3	8	34	24	5	2	1	2	68	25	18	4	1	0	1	49
		8.71	98.9	3	2	2	7	28	20	4	2	1	2	58	21	15	3	1	0	1	41
			99.0	2	2	2	6	26	18	4	2	1	1	52	19	14	3	1	0	0	37
Option 3	2	13.1	98	1	1	1	3	14	10	1	1	0	1	27	10	7	1	0	0	0	19
		8.71	98	1	1	1	2	12	9	1	1	0	0	23	9	6	1	0	0	0	16
	3	13.1	98	1	1	1	3	18	13	2	1	1	1	34	13	9	1	0	0	0	24
		8.71	98	1	1	1	3	15	11	2	1	1	1	30	12	8	1	0	0	0	21

6.1.709 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.299, Table 6.300 and Table 6.301.

Table 6.299: Breeding season apportioning for kittiwake at Skomer, Skokholm and Seas off Pembrokeshire SPA for the impact from Preferred Project 4

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.3	0.6	0.9	1.2	1.6	1.9	2.2	2.5	2.8	3.1
			99.0	0.3	0.6	0.8	1.1	1.4	1.7	2.0	2.3	2.5	2.8
		8.71	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.3
			99.0	0.2	0.4	0.6	0.8	1.1	1.3	1.5	1.7	1.9	2.1
	3	13.1	98.9	0.4	0.7	1.1	1.4	1.8	2.1	2.5	2.8	3.2	3.5
			99.0	0.3	0.6	1.0	1.3	1.6	1.9	2.2	2.6	2.9	3.2
		8.71	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
			99.0	0.2	0.5	0.7	0.9	1.2	1.4	1.7	1.9	2.1	2.4
Option 3	2	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		8.71	98	0.1	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.8	0.9
	3	13.1	98	0.1	0.2	0.3	0.5	0.6	0.7	0.8	0.9	1.0	1.2
		8.71	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

Table 6.300: Breeding season apportioning for kittiwake at Skomer, Skokholm and Seas off Pembrokeshire SPA for the impact from Preferred Project 5

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.9
			99.0	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.4	1.5	1.7
		8.71	98.9	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.6
			99.0	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4
	3	13.1	98.9	0.2	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.9	2.1
			99.0	0.2	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9
		8.71	98.9	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.6	1.7
			99.0	0.2	0.3	0.5	0.6	0.8	1.0	1.1	1.3	1.4	1.6
Option 3	2	13.1	98	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
		8.71	98	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
	3	13.1	98	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8
		8.71	98	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8

Table 6.301: Breeding season apportioning for kittiwake at Skomer, Skokholm and Seas off Pembrokeshire SPA for the impact from Preferred Project 6

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.3	0.6	0.8	1.1	1.4	1.7	2.0	2.2	2.5	2.8
			99.0	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.0	2.3	2.6
		8.71	98.9	0.2	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.9	2.1
			99.0	0.2	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9
	3	13.1	98.9	0.3	0.6	0.9	1.3	1.6	1.9	2.2	2.5	2.8	3.2
			99.0	0.3	0.6	0.9	1.2	1.4	1.7	2.0	2.3	2.6	2.9
		8.71	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.4
			99.0	0.2	0.4	0.6	0.9	1.1	1.3	1.5	1.7	1.9	2.1
Option 3	2	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.8	0.9
		8.71	98	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.6	0.7	0.8
	3	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		8.71	98	0.1	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8	0.9

6.1.710 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.299, Table 6.300 and Table 6.301. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All of the Preferred Projects are beyond the mean-maximum foraging range of kittiwake from the Skomer, Skokholm and Seas off Pembrokeshire SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%.

6.1.711 All of the Preferred Projects are however, within the foraging range of kittiwake when using the mean-maximum foraging range plus one standard deviation (300.5 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual kittiwakes from the Skomer, Skokholm and Seas off Pembrokeshire SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.712 A total of 14 kittiwakes were tagged on Skomer Island, 11 in 2016 and 6 in 2017. The data collected show no connectivity between the sea areas in which the Preferred Projects are located and the foraging trips of kittiwake from Skomer Island. The mean-maximum foraging trip of birds from Skomer Island was 22 ± 2.6 km. These foraging distances are however, only representative of a small number of birds and may therefore not reflect the foraging behaviour of birds at the colony.

6.1.713 The UK and Eire-wide utilisation distributions presented in Cleasby *et al.* (2018) suggest that the Preferred Projects lie beyond the 75% utilisation distribution band of kittiwake. This suggests that the sea areas in which the Preferred Projects are located do not represent an important area for kittiwakes and any usage of these areas is likely by birds from more local colonies. However, if on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Skomer, Skokholm and Seas off Pembrokeshire SPA then this should only be a limited amount (e.g. 10%).

6.1.714 In the post-breeding and pre-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, and pre-breeding seasons for the Preferred Projects in the Irish Sea are 0.14% and 0.24% and for the Preferred Projects in the North Sea are less than 0.01%. The apportioned values from each of the Preferred Projects combined to the Skomer, Skokholm and Seas off Pembrokeshire SPA are presented in Table 6.302.

Table 6.302: Apportioning for kittiwake at the Skomer, Skokholm and Seas off Pembrokeshire SPA in the post- and pre-breeding season for the impact from all Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
Option 2	2	13.1	98.9	0.0	0.0
			99.0	0.0	0.0
		8.71	98.9	0.0	0.0
			99.0	0.0	0.0
	3	13.1	98.9	0.0	0.0
			99.0	0.0	0.0
		8.71	98.9	0.0	0.0
			99.0	0.0	0.0
Option 3	2	13.1	98	0.0	0.0
		8.71	98	0.0	0.0
	3	13.1	98	0.0	0.0
		8.71	98	0.0	0.0

6.1.715 The annual apportioned impact for kittiwake at the Skomer, Skokholm and Seas off Pembrokeshire SPA is provided in Table 6.303.

Table 6.303: Calculation of total impact attributable to kittiwake at the Skomer, Skokholm and Seas off Pembrokeshire SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding			Post-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP4	PP5	PP6	All projects	All projects		
Option 2	2	13.1	98.9	0.3	0.2	0.3	0.0	0.0	0.8	0.22
			99.0	0.3	0.2	0.3	0.0	0.0	0.7	0.20
		8.71	98.9	0.2	0.2	0.2	0.0	0.0	0.6	0.17
			99.0	0.2	0.1	0.2	0.0	0.0	0.6	0.15
	3	13.1	98.9	0.4	0.2	0.3	0.0	0.0	0.9	0.25
			99.0	0.3	0.2	0.3	0.0	0.0	0.8	0.22
		8.71	98.9	0.3	0.2	0.2	0.0	0.0	0.7	0.19
			99.0	0.2	0.2	0.2	0.0	0.0	0.6	0.17
Option 3	2	13.1	98	0.1	0.1	0.1	0.0	0.0	0.3	0.08
		8.71	98	0.1	0.1	0.1	0.0	0.0	0.2	0.07
	3	13.1	98	0.1	0.1	0.1	0.0	0.0	0.3	0.08
		8.71	98	0.1	0.1	0.1	0.0	0.0	0.3	0.08

6.1.716 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.303 is considered to be 0.2-0.3 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that kittiwake densities from the MERP dataset potentially underestimate kittiwake abundance.
- The appropriate apportioning value to apply. It is considered highly unlikely that a significant proportion of kittiwake from the Skomer, Skokholm and Seas off Pembrokeshire SPA will forage in the sea areas in which the Preferred Projects will be located. A value of 10% has been applied however, this is considered to be highly precautionary with kittiwake unlikely to be found foraging at distances offshore commensurate with the distance between the Skomer, Skokholm and Seas off Pembrokeshire SPA and the Preferred Projects.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.
- The proportion of immatures present at each of the Preferred Projects.

6.1.717 An impact of 0.2-0.3 collisions/annum represents 0.07-0.08% of the baseline mortality of the Skomer, Skokholm and Seas off Pembrokeshire SPA kittiwake population (2,472 breeding adults). When considering the highest impact estimated Table 6.303, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 0.8-0.9 collisions/annum represents an increase in baseline mortality of 0.22-0.25%. Under any of the scenarios presented, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.718 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Skomer, Skokholm and Seas off Pembrokeshire SPA.

Puffin

Alone

6.1.719 Displacement analysis has been undertaken for puffin using the approach advised in JNCC *et al.* (2017) (Annex H.1). To account for uncertainty in the analysis approach a range of displacement and mortality rates have been applied following the recommended approach to defining these in JNCC *et al.* (2017). Table 6.304 presents the unapportioned seasonal displacement mortality for puffin at each of the Preferred Projects using the appropriate range of displacement and mortality rates. In the breeding season, there is only connectivity between the Skomer, Skokholm and Seas off Pembrokeshire SPA and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.304: Displacement mortality for puffin at each of the Preferred Projects (unapportioned values) (no. of birds)

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
1	30	N/A				1	2	4	8
	50	N/A				1	3	6	13
	70	N/A				2	4	9	18
2	30	N/A				1	1	3	5
	50	N/A				1	2	5	9
	70	N/A				1	3	6	13
3	30	N/A				1	1	3	6
	50	N/A				1	2	5	9
	70	N/A				1	3	6	13
4	30	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0
	70	0	0	0	0	0	0	0	0
5	30	0	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0	0
	70	0	0	0	0	0	0	0	0
6	30	0	0	0	0	0	0	0	0

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
	50	0	0	0	0	0	0	0	0
	70	0	0	0	0	0	0	0	0

6.1.720 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.305.

Table 6.305: Breeding season apportioning for puffin at the Skomer, Skokholm and Seas off Pembrokeshire SPA for the impact from all Preferred Projects with connectivity in the breeding season

Preferred Project	Displacement / mortality rate (%)	Apportioning value (%)									
		10	20	30	40	50	60	70	80	90	100
4	30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	50 / 5	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	70 / 10	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.4
5	30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	50 / 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	70 / 10	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
6	30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	50 / 5	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
	70 / 10	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2

6.1.721 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.305. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All three of the Preferred Projects are beyond the mean-maximum foraging range of puffin from the Skomer, Skokholm and Seas off Pembrokeshire SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. Each of the three projects is however, within the foraging range of puffin when using the mean-maximum foraging range plus one standard deviation (265.4 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual puffins from the Skomer, Skokholm and Seas off Pembrokeshire SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of displacement mortality.

6.1.722 There is no site-specific foraging range data available for puffin from the Skomer, Skokholm and Seas off Pembrokeshire SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Skomer, Skokholm and Seas off Pembrokeshire SPA then this should only be a limited amount (e.g. 10%).

6.1.723 In the non-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning value used for the Preferred Projects in the Irish Sea is 2.85% and for the Preferred Projects in the North Sea is 0.02%. The apportioned values from each of the Preferred Projects combined to the Skomer, Skokholm and Seas off Pembrokeshire SPA are presented in Table 6.306.

Table 6.306: Apportioned displacement mortality for puffin at the Skomer, Skokholm and Seas off Pembrokeshire SPA in the non-breeding season

Displacement / mortality rate (%)	Preferred Project						Total
	1	2	3	4	5	6	
30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50 / 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70 / 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0

6.1.724 The annual apportioned impact for puffin at the Skomer, Skokholm and Seas off Pembrokeshire SPA is provided in Table 6.307.

Table 6.307: Calculation of the annual impact attributable puffin at the Skomer, Skokholm and Seas off Pembrokeshire SPA from the Round 4 Plan alone

Displacement / mortality assumptions	Breeding season			Non-breeding season						Total	Increase in baseline mortality (%)
	PP4	PP5	PP6	PP1	PP2	PP3	PP4	PP5	PP6		
30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
50 / 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
70 / 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.01

6.1.725 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.307 is considered to be less than one bird. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that puffin densities from the MERP dataset potentially over-estimate puffin abundance.
- The apportioning value applied in the breeding season, it is unlikely that a significant proportion of puffin from the Skomer, Skokholm and Seas off Pembrokeshire SPA will utilize the Preferred Project areas and the assumption of 10% is likely an over-estimate but is applied on a precautionary basis.

6.1.726 In all cases the impact is less than one bird representing less than 0.01% of the baseline mortality of the Skomer, Skokholm and Seas off Pembrokeshire SPA puffin population (19,000 breeding adults). Under any of the scenarios presented, the actual displacement mortality is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.727 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Skomer, Skokholm and Seas off Pembrokeshire SPA.

St Abb's to Fast Castle SPA

Kittiwake

Alone

6.1.728 Collision risk modelling has been undertaken for kittiwake using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.308. In the breeding season, there is only connectivity between the St Abb's to Fast Castle SPA and Preferred Projects 1 and 2 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.308: Collision risk estimates for kittiwake (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)															
				Breeding season			Post-breeding							Pre-breeding						
				PP1	PP2	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	98.9	73	52	124	29	21	5	2	1	2	59	21	15	3	1	0	1	41
			99.0	66	47	113	26	19	4	2	1	2	54	19	14	3	1	0	0	37
		8.71	98.9	56	40	95	22	16	3	1	1	1	45	16	12	2	0	0	0	31
			99.0	51	36	87	20	14	3	1	1	1	41	15	11	2	0	0	0	29
	3	13.1	98.9	82	59	141	37	26	6	2	1	2	75	28	20	4	1	0	1	53
			99.0	75	54	128	34	24	5	2	1	2	68	25	18	4	1	0	1	49
		8.71	98.9	63	45	108	28	20	4	2	1	2	58	21	15	3	1	0	1	41
			99.0	57	41	99	26	18	4	2	1	1	52	19	14	3	1	0	0	37
Option 3	2	13.1	98	34	25	59	14	10	1	1	0	1	27	10	7	1	0	0	0	19
		8.71	98	30	22	52	12	9	1	1	0	0	23	9	6	1	0	0	0	16
	3	13.1	98	39	28	67	18	13	2	1	1	1	34	13	9	1	0	0	0	24
		8.71	98	34	24	59	15	11	2	1	1	1	30	12	8	1	0	0	0	21

6.1.729 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.309 and Table 6.310.

Table 6.309: Breeding season apportioning for kittiwake at St Abb's to Fast Castle SPA for the impact from Preferred Project 1

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	7.3	14.5	21.8	29.0	36.3	43.5	50.8	58.0	65.3	72.6
			99.0	6.6	13.2	19.8	26.4	33.0	39.6	46.2	52.8	59.4	66.0
		8.71	98.9	5.6	11.1	16.7	22.3	27.8	33.4	39.0	44.5	50.1	55.7
			99.0	5.1	10.1	15.2	20.2	25.3	30.4	35.4	40.5	45.6	50.6
	3	13.1	98.9	8.2	16.5	24.7	32.9	41.2	49.4	57.6	65.9	74.1	82.3
			99.0	7.5	15.0	22.5	29.9	37.4	44.9	52.4	59.9	67.4	74.9
		8.71	98.9	6.3	12.6	19.0	25.3	31.6	37.9	44.2	50.6	56.9	63.2
			99.0	5.7	11.5	17.2	23.0	28.7	34.5	40.2	46.0	51.7	57.4
Option 3	2	13.1	98	3.4	6.9	10.3	13.8	17.2	20.7	24.1	27.6	31.0	34.5
		8.71	98	3.0	6.0	9.0	12.1	15.1	18.1	21.1	24.1	27.1	30.1
	3	13.1	98	3.9	7.8	11.7	15.6	19.6	23.5	27.4	31.3	35.2	39.1
		8.71	98	3.4	6.8	10.3	13.7	17.1	20.5	23.9	27.4	30.8	34.2

Table 6.310: Breeding season apportioning for kittiwake at St Abb's to Fast Castle SPA for the impact from Preferred Project 2

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	5.2	10.4	15.6	20.8	25.9	31.1	36.3	41.5	46.7	51.9
			99.0	4.7	9.4	14.2	18.9	23.6	28.3	33.0	37.7	42.5	47.2
		8.71	98.9	4.0	8.0	11.9	15.9	19.9	23.9	27.9	31.9	35.8	39.8
			99.0	3.6	7.2	10.9	14.5	18.1	21.7	25.3	29.0	32.6	36.2
	3	13.1	98.9	5.9	11.8	17.7	23.6	29.5	35.3	41.2	47.1	53.0	58.9
			99.0	5.4	10.7	16.1	21.4	26.8	32.1	37.5	42.8	48.2	53.6
		8.71	98.9	4.5	9.0	13.6	18.1	22.6	27.1	31.6	36.2	40.7	45.2
			99.0	4.1	8.2	12.3	16.4	20.5	24.7	28.8	32.9	37.0	41.1
Option 3	2	13.1	98	2.5	4.9	7.4	9.9	12.3	14.8	17.2	19.7	22.2	24.6
		8.71	98	2.2	4.3	6.5	8.6	10.8	12.9	15.1	17.2	19.4	21.6
	3	13.1	98	2.8	5.6	8.4	11.2	14.0	16.8	19.6	22.4	25.2	28.0
		8.71	98	2.4	4.9	7.3	9.8	12.2	14.7	17.1	19.6	22.0	24.5

6.1.730 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.309 and Table 6.310. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). Both of the Preferred Projects are beyond the mean-maximum foraging range of kittiwake from the St Abb's to Fast Castle SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. Both of the Preferred Projects are however, within the foraging range of kittiwake when using the mean-maximum foraging range plus one standard deviation from Woodward *et al.* (2019) (300.6 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual kittiwakes from the St Abb's to Fast Castle SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.731 The apportioning results in Annex H.3 have been reviewed against relevant site specific data. These data, which are included in Woodward *et al.,* 2019, provide an average foraging range of 82.4 km and a maximum foraging range of 108.7 km distances significantly shorter than the distance between the St Abb's to Fast Castle SPA and the closest Preferred Project. The apportioning value for all of the Preferred Projects in the breeding season is therefore set to 0%.

6.1.732 In the post-breeding and pre-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post- and pre-breeding seasons for the Preferred Projects in the North Sea are 0.5% and 0.7%, respectively and for the Preferred Projects in the Irish Sea are 0.2% and 0.2%, respectively. The apportioned values from each of the Preferred Projects combined to the St Abb's to Fast Castle SPA are presented in Table 6.311.

Table 6.311: Apportioned collision risk estimates for kittiwake at the St Abb's to Fast Castle SPA in non-breeding seasons

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
Option 2	2	13.1	98.9	0.3	0.3
			99.0	0.2	0.2

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
		8.71	98.9	0.2	0.2
			99.0	0.2	0.2
	3	13.1	98.9	0.4	0.3
			99.0	0.3	0.3
		8.71	98.9	0.3	0.3
			99.0	0.2	0.2
Option 3	2	13.1	98	0.1	0.1
		8.71	98	0.1	0.1
	3	13.1	98	0.2	0.2
		8.71	98	0.1	0.1

6.1.733 The annual apportioned impact for kittiwake at the St Abb's to Fast Castle SPA is provided in Table 6.312.

Table 6.312: Calculation of the annual impact attributable to kittiwake at the St Abb's to Fast Castle SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Post-breeding	Pre-breeding	Total	Baseline mortality (%)
				All projects	All projects		
Option 2	2	13.1	98.9	0.3	0.3	0.5	0.01
			99.0	0.2	0.2	0.5	0.01
		8.71	98.9	0.2	0.2	0.4	0.01
			99.0	0.2	0.2	0.4	0.01
	3	13.1	98.9	0.4	0.3	0.7	0.01
			99.0	0.3	0.3	0.6	0.01
		8.71	98.9	0.3	0.3	0.5	0.01
			99.0	0.2	0.2	0.5	0.01
Option 3	2	13.1	98	0.1	0.1	0.2	0.00
		8.71	98	0.1	0.1	0.2	0.00
	3	13.1	98	0.2	0.2	0.3	0.01
		8.71	98	0.1	0.1	0.3	0.00

6.1.734 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.312 is considered to be 0.2-0.3 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that kittiwake densities from the MERP dataset potentially underestimate kittiwake abundance.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.
- The apportioning value applied in the breeding season, it is unlikely that a significant proportion of kittiwake from the St Abb's to Fast Castle SPA SPA will utilize the Preferred Project areas and the assumption of 10% is likely an over-estimate but is applied on a precautionary basis.

6.1.735 An impact of 0.2-0.3 collisions/annum represents less than 0.01% of the baseline mortality of the St Abb's to Fast Castle SPA kittiwake population (21,170 pairs). When considering the highest impact estimated in Table 6.312, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 0.5-0.7 collisions/annum represents an increase in baseline mortality of less than 0.01%. Under any of the scenarios presented, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.736 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the St Abb's to Fast Castle SPA.

Strangford Lough Ramsar

Lesser black-backed gull

Alone

6.1.737 Collision risk modelling for the Round 4 Plan has been undertaken for lesser black-backed gull using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated a range of values for a number of input parameters. The results of collision risk modelling for each Preferred Project are presented on an unapportioned seasonal basis in Table 6.313. In the breeding season, there is only connectivity between the designated site and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.313: Collision risk estimates for lesser black-backed gull (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																								
				Breeding season				Post-breeding							Non-breeding							Pre-breeding						
				PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	99.5	4	5	4	13	1	1	0	1	1	0	5	2	2	1	1	1	1	7	1	1	0	0	0	0	3
		9.8	99.5	3	5	3	11	1	1	0	0	1	0	4	1	2	0	1	1	0	6	1	1	0	0	0	0	3
	3	13.1	99.5	5	6	4	15	1	2	0	1	1	1	6	2	3	1	1	1	1	9	1	1	0	0	1	0	4
		9.8	99.5	4	5	3	12	1	1	0	1	1	0	5	2	3	1	1	1	1	7	1	1	0	0	0	0	3
Option 3	2	13.1	98.9	3	4	2	9	1	1	0	0	0	0	4	1	2	0	0	1	0	5	1	1	0	0	0	0	3
			99.3	2	2	2	6	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
		9.8	98.9	2	4	2	8	1	1	0	0	0	0	3	1	2	0	0	1	0	5	1	1	0	0	0	0	2
			99.3	1	2	1	5	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
	3	13.1	98.9	3	4	3	10	1	1	0	0	1	0	4	2	3	0	1	1	0	7	1	1	0	0	0	0	3
			99.3	2	3	2	6	1	1	0	0	0	0	3	1	2	0	0	0	0	4	1	1	0	0	0	0	2
		9.8	98.9	3	4	2	9	1	1	0	0	1	0	4	2	2	0	0	1	0	6	1	1	0	0	0	0	3
			99.3	2	3	2	6	1	1	0	0	0	0	2	1	2	0	0	0	0	4	1	1	0	0	0	0	2

6.1.738 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.314, Table 6.315 and Table 6.316.

Table 6.314: Breeding season apportioning for lesser black-backed gull at the Strangford Lough SPA for the impact from Preferred Project 4

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.4	0.8	1.2	1.6	2.0	2.4	2.9	3.3	3.7	4.1
		9.8	99.5	0.3	0.7	1.0	1.3	1.7	2.0	2.4	2.7	3.0	3.4
	3	13.1	99.5	0.5	0.9	1.4	1.8	2.3	2.7	3.2	3.6	4.1	4.5
		9.8	99.5	0.4	0.8	1.1	1.5	1.9	2.3	2.6	3.0	3.4	3.8
Option 3	2	13.1	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
			99.3	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.6
		9.8	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.4
			99.3	0.1	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.3	1.5
	3	13.1	98.9	0.3	0.6	0.9	1.2	1.4	1.7	2.0	2.3	2.6	2.9
			99.3	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.8
		9.8	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.4	2.6
			99.3	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.7

Table 6.315: Breeding season apportioning for lesser black-backed gull at the Strangford Lough SPA for the impact from Preferred Project 5

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.5	1.1	1.6	2.1	2.6	3.2	3.7	4.2	4.8	5.3
		9.8	99.5	0.5	0.9	1.4	1.9	2.3	2.8	3.3	3.7	4.2	4.7
	3	13.1	99.5	0.6	1.2	1.8	2.4	2.9	3.5	4.1	4.7	5.3	5.9
		9.8	99.5	0.5	1.0	1.6	2.1	2.6	3.1	3.6	4.2	4.7	5.2
Option 3	2	13.1	98.9	0.4	0.7	1.1	1.5	1.8	2.2	2.6	2.9	3.3	3.7
			99.3	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.3
		9.8	98.9	0.4	0.7	1.1	1.4	1.8	2.2	2.5	2.9	3.3	3.6
			99.3	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.8	2.1	2.3
	3	13.1	98.9	0.4	0.8	1.2	1.6	2.0	2.4	2.9	3.3	3.7	4.1
			99.3	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
		9.8	98.9	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0
			99.3	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.1	2.3	2.6

Table 6.316: Breeding season apportioning for lesser black-backed gull at the Strangford Lough SPA for the impact from Preferred Project 6

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.4	0.8	1.1	1.5	1.9	2.3	2.7	3.0	3.4	3.8
		9.8	99.5	0.3	0.6	0.9	1.3	1.6	1.9	2.2	2.5	2.8	3.1
	3	13.1	99.5	0.4	0.8	1.3	1.7	2.1	2.5	3.0	3.4	3.8	4.2
		9.8	99.5	0.3	0.7	1.0	1.4	1.7	2.1	2.4	2.8	3.1	3.5
Option 3	2	13.1	98.9	0.2	0.5	0.7	1.0	1.2	1.4	1.7	1.9	2.2	2.4
			99.3	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5
		9.8	98.9	0.2	0.4	0.7	0.9	1.1	1.3	1.5	1.7	2.0	2.2
			99.3	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4
	3	13.1	98.9	0.3	0.5	0.8	1.1	1.3	1.6	1.9	2.1	2.4	2.7
			99.3	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.5	1.7
		9.8	98.9	0.2	0.5	0.7	1.0	1.2	1.5	1.7	1.9	2.2	2.4
			99.3	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5

6.1.739 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.314, Table 6.315 and Table 6.316. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). Preferred Project 5 is beyond the mean-maximum foraging range of lesser black-backed gull from the Strangford Lough Ramsar and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. Preferred Project 5 is however, within the foraging range of lesser black-backed gull when using the mean-maximum foraging range plus one standard deviation (236 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual lesser black-backed gulls from the Strangford Lough Ramsar could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.740 Preferred Project 4 is on the edge of the mean-maximum foraging range, with the centre of the wind farm, used in the apportioning approach in Annex H.3 lying outside of the mean-maximum foraging range. As a result the apportioning value calculated for Preferred Project 4 is 0%.

6.1.741 For Preferred Project 6, the three components of the population present at each project have been considered (see Annex H.3). The values associated with each of these population components are presented in Table 6.317 and multiplied together to provide an apportioning value for each of the Preferred Projects.

Table 6.317: Breeding season apportioning values for lesser black-backed gull at the Strangford Lough Ramsar SPA based on the approach applied in Annex H.3

Preferred Project	Proportion of breeding adult birds from SPA	Proportion of immature birds	Proportion of non-breeding birds	Overall breeding season apportioning value
6	<0.01	0.38	0.34	<0.01

6.1.742 The results of the apportioning approach in Annex H.3 suggest that less than 1% (0.12%) of the predicted impact at Preferred Project 6 is attributable to the Strangford Lough Ramsar. As mentioned in Section 5.2, the estimated proportion of immature birds in Table 6.317 does not take account of the distribution of

immature birds and may therefore over-estimate this component of the population present at Preferred Project 6.

6.1.743 As there is no information on the proportion of immature birds present at Preferred Projects it is proposed that this component of the population be discounted accepting that this is will result in an over-estimation of the impact on the Strangford Lough SPA. The apportioning value in the breeding season would therefore be 0.2% for Preferred Project 6.

6.1.744 There is no site-specific foraging range data available for lesser black-backed gull from the Strangford Lough SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from Preferred Projects 4 and 5 is to be apportioned to the Strangford Lough SPA then it is proposed the value calculated for Preferred Project 6, discounting immature birds is used.

6.1.745 In the post-, non- and pre-breeding seasons, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, non- and pre-breeding seasons for the Preferred Projects in the Irish Sea are 0.08%, 0.12% and 0.08%, respectively. For the Preferred Projects in the North Sea, the values are 0.06%, 0.07% and 0.06% in each season respectively. The apportioned values from each of the Preferred Projects combined to the Strangford Lough SPA are presented in Table 6.318. In all cases the impact is less than 0.1 collisions.

Table 6.318: Apportioned collision risk estimates for lesser black-backed gull at the Strangford Lough SPA in non-breeding seasons

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values		
				Post-breeding	Non-breeding	Pre-breeding
Option 2	2	13.1	99.5	0.0	0.0	0.0
		9.8	99.5	0.0	0.0	0.0
	3	13.1	99.5	0.0	0.0	0.0
		9.8	99.5	0.0	0.0	0.0
Option 3	2	13.1	98.9	0.0	0.0	0.0
			99.3	0.0	0.0	0.0
		9.8	98.9	0.0	0.0	0.0
			99.3	0.0	0.0	0.0
	3	13.1	98.9	0.0	0.0	0.0
			99.3	0.0	0.0	0.0
		9.8	98.9	0.0	0.0	0.0

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values		
				Post-breeding	Non-breeding	Pre-breeding
			99.3	0.0	0.0	0.0

6.1.746 The annual apportioned impact for lesser black-backed gull at the Strangford Lough SPA is provided in Table 6.319.

Table 6.319: Calculation of the annual impact attributable to lesser black-backed gull at the Strangford Lough SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding			Post-breeding	Non-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP4	PP5	PP6	All projects	All projects	All projects		
Option 2	2	13.1	99.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.13
		9.8	99.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.11
	3	13.1	99.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.15
		9.8	99.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.12
Option 3	2	13.1	98.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.09
			99.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.06
		9.8	98.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.08
			99.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.05
	3	13.1	98.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.10
			99.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.06
		9.8	98.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.09
			99.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.06

6.1.747 The most likely impact (and most realistic worst case) for the Round 4 Plan alone from Table 6.319 is considered to be less than one collision/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the densities for lesser black-backed gull from the MERP dataset potentially overestimate lesser black-backed gull abundance.

6.1.748 An impact of less than one collisions/annum represents 0.05-0.06% of the baseline mortality of the Strangford Lough SPA lesser black-backed gull population (256 breeding adults). When considering the highest impact estimated in Table 6.319, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of less than one collisions/annum represents an increase in baseline mortality of 0.13-0.15%. Under any of the scenarios presented, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.749 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Strangford Lough SPA.

The Wash Ramsar

Lesser black-backed gull

Alone

6.1.750 Collision risk modelling has been undertaken for lesser black-backed gull using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.320. In the breeding season, there is only connectivity between The Wash Ramsar and Preferred Projects 1, 2 and 3 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.320: Collision risk estimates for lesser black-backed gull (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																							
				Breeding season			Post-breeding							Non-breeding							Pre-breeding							
				PP1	PP2	PP3	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	99.5	7	10	3	1	1	0	1	1	0	5	2	2	1	1	1	1	7	1	1	0	0	0	0	3
		9.8	99.5	6	8	2	1	1	0	0	1	0	4	1	2	0	1	1	0	6	1	1	0	0	0	0	3
	3	13.1	99.5	8	11	3	1	2	0	1	1	1	6	2	3	1	1	1	1	9	1	1	0	0	1	0	4
		9.8	99.5	7	9	2	1	1	0	1	1	0	5	2	3	1	1	1	1	7	1	1	0	0	0	0	3
Option 3	2	13.1	98.9	7	9	2	1	1	0	0	0	0	4	1	2	0	0	1	0	5	1	1	0	0	0	0	3
			99.3	4	6	1	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
		9.8	98.9	6	8	1	1	1	0	0	0	0	3	1	2	0	0	1	0	5	1	1	0	0	0	0	2
			99.3	4	5	1	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
	3	13.1	98.9	7	10	2	1	1	0	0	1	0	4	2	3	0	1	1	0	7	1	1	0	0	0	0	3
			99.3	5	6	1	1	1	0	0	0	0	3	1	2	0	0	0	0	4	1	1	0	0	0	0	2
		9.8	98.9	7	9	2	1	1	0	0	1	0	4	2	2	0	0	1	0	6	1	1	0	0	0	0	3
			99.3	4	6	1	1	1	0	0	0	0	2	1	2	0	0	0	0	4	1	1	0	0	0	0	2

6.1.751 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.321, Table 6.322 and Table 6.323.

Table 6.321: Breeding season apportioning for lesser black-backed gull at the Wash Ramsar for the impact from Preferred Project 1

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.7	1.5	2.2	3.0	3.7	4.4	5.2	5.9	6.7	7.4
		9.8	99.5	0.6	1.3	1.9	2.5	3.1	3.8	4.4	5.0	5.7	6.3
	3	13.1	99.5	0.8	1.7	2.5	3.3	4.1	5.0	5.8	6.6	7.4	8.3
		9.8	99.5	0.7	1.4	2.1	2.8	3.5	4.2	4.9	5.6	6.3	7.0
Option 3	2	13.1	98.9	0.7	1.3	2.0	2.6	3.3	3.9	4.6	5.2	5.9	6.5
			99.3	0.4	0.8	1.2	1.7	2.1	2.5	2.9	3.3	3.7	4.2
		9.8	98.9	0.6	1.2	1.8	2.4	3.0	3.6	4.2	4.8	5.4	5.9
			99.3	0.4	0.8	1.1	1.5	1.9	2.3	2.6	3.0	3.4	3.8
	3	13.1	98.9	0.7	1.5	2.2	2.9	3.6	4.4	5.1	5.8	6.6	7.3
			99.3	0.5	0.9	1.4	1.9	2.3	2.8	3.2	3.7	4.2	4.6
		9.8	98.9	0.7	1.3	2.0	2.7	3.3	4.0	4.6	5.3	6.0	6.6
			99.3	0.4	0.8	1.3	1.7	2.1	2.5	3.0	3.4	3.8	4.2

Table 6.322: Breeding season apportioning for lesser black-backed gull at the Wash Ramsar for the impact from Preferred Project 2

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	1.0	2.0	3.0	4.0	4.9	5.9	6.9	7.9	8.9	9.9
		9.8	99.5	0.8	1.7	2.5	3.4	4.2	5.0	5.9	6.7	7.5	8.4
	3	13.1	99.5	1.1	2.2	3.3	4.4	5.5	6.6	7.7	8.8	9.9	11.0
		9.8	99.5	0.9	1.9	2.8	3.7	4.7	5.6	6.5	7.5	8.4	9.3
Option 3	2	13.1	98.9	0.9	1.7	2.6	3.5	4.4	5.2	6.1	7.0	7.9	8.7
			99.3	0.6	1.1	1.7	2.2	2.8	3.3	3.9	4.4	5.0	5.6
		9.8	98.9	0.8	1.6	2.4	3.2	4.0	4.8	5.6	6.3	7.1	7.9
			99.3	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
	3	13.1	98.9	1.0	1.9	2.9	3.9	4.9	5.8	6.8	7.8	8.8	9.7
			99.3	0.6	1.2	1.9	2.5	3.1	3.7	4.3	5.0	5.6	6.2
		9.8	98.9	0.9	1.8	2.7	3.5	4.4	5.3	6.2	7.1	8.0	8.8
			99.3	0.6	1.1	1.7	2.3	2.8	3.4	3.9	4.5	5.1	5.6

Table 6.323: Breeding season apportioning for lesser black-backed gull at the Wash Ramsar for the impact from Preferred Project 3

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.3	0.5	0.8	1.1	1.3	1.6	1.9	2.1	2.4	2.7
		9.8	99.5	0.2	0.4	0.7	0.9	1.1	1.3	1.5	1.8	2.0	2.2
	3	13.1	99.5	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0
		9.8	99.5	0.2	0.5	0.7	1.0	1.2	1.5	1.7	2.0	2.2	2.5
Option 3	2	13.1	98.9	0.2	0.3	0.5	0.7	0.8	1.0	1.1	1.3	1.5	1.6
			99.3	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		9.8	98.9	0.1	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.3	1.5
			99.3	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.8	0.9
	3	13.1	98.9	0.2	0.4	0.5	0.7	0.9	1.1	1.3	1.5	1.6	1.8
			99.3	0.1	0.2	0.3	0.5	0.6	0.7	0.8	0.9	1.0	1.2
		9.8	98.9	0.2	0.3	0.5	0.7	0.8	1.0	1.1	1.3	1.5	1.6
			99.3	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

6.1.752 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.321, Table 6.322 and Table 6.323. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). Preferred Projects 1 and 2 are beyond the mean-maximum foraging range of lesser black-backed gull from The Wash Ramsar and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%.

6.1.753 Both projects are however, within the foraging range of lesser black-backed gull when using the mean-maximum foraging range plus one standard deviation (236 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual lesser black-backed gulls from the The Wash Ramsar could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.754 Preferred Project 3 is within the mean-maximum foraging range of lesser black-backed gull and in order to identify the most realistic apportioning value to apply in the breeding season, the three components of the population present at Preferred Project 3 have been considered (see Annex H.3). The values associated with each of these population components is presented in Table 6.324 and multiplied together to provide an apportioning value for each of the Preferred Projects.

Table 6.324: Breeding season apportioning values for lesser black-backed gull at The Wash Ramsar SPA based on the approach applied in Annex H.3

Preferred Project	Proportion of breeding adult birds from SPA	Proportion of immature birds	Proportion of non-breeding birds	Overall breeding season apportioning value
3	0.83	0.38	0.34	0.34

6.1.755 The results of the apportioning approach in Annex H.3 suggest that 24% of the predicted impact at Preferred Project 3 is attributable to The Wash Ramsar. As mentioned in Section 5.2, the estimated proportion of immature birds in Table 6.324 does not take account of the distribution of immature birds and may therefore over-estimate this component of the population present at each of the Preferred Projects.

6.1.756 There is no site-specific information in relation to the foraging behaviour of lesser black-backed gull from the Wash. The breeding colony, which is located on the Outer Trial Bank is located nearly 90 km from Preferred Project 3. The foraging behaviour of lesser black-backed gull from other colonies where tracking data has been collected would suggest that foraging at such distances does occur but would only involve a small proportion of birds with the majority of foraging behaviour occurring much closer to the breeding colony (Thaxter *et al.,* 2015). The breeding season apportioning value calculated using the approach in Annex H.3 is therefore considered appropriate.

6.1.757 If, due to the lack of such data and on a precautionary basis, any impact from Preferred Projects 1 and 2 is to be apportioned to The Wash Ramsar then this should only be a limited amount (e.g. 10%).

6.1.758 In the post-, non- and pre-breeding seasons, the apportioning values presented in Annex H.3 have been applied. In the North Sea the apportioning values used in the post-, non- and pre-breeding seasons for the Preferred Projects in the North Sea are 1.3%, 3.5% and 1.4%, respectively. For the Preferred Projects in the Irish Sea, 0% has been applied to all seasons. The apportioned values from each of the Preferred Projects combined to the Wash Ramsar are presented in Table 6.325.

Table 6.325: Apportioned collision risk estimates for lesser black-backed gull at The Wash Ramsar in non-breeding seasons

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values		
				Post-breeding	Non-breeding	Pre-breeding
Option 2	2	13.1	99.5	0.0	0.2	0.0
		9.8	99.5	0.0	0.1	0.0
	3	13.1	99.5	0.0	0.2	0.0
		9.8	99.5	0.0	0.2	0.0
Option 3	2	13.1	98.9	0.0	0.1	0.0
			99.3	0.0	0.1	0.0
		9.8	98.9	0.0	0.1	0.0
			99.3	0.0	0.1	0.0
	3	13.1	98.9	0.0	0.2	0.0
			99.3	0.0	0.1	0.0
		9.8	98.9	0.0	0.2	0.0
			99.3	0.0	0.1	0.0

6.1.759 The annual apportioned impact for lesser black-backed gull at The Wash Ramsar is provided in Table 6.326.

Table 6.326: Calculation of total impact attributable to lesser black-backed gull at The Wash Ramsar from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding			Post-breeding	Non-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP1	PP2	PP3	All projects	All projects	All projects		
Option 2	2	13.1	99.5	0.7	1.0	0.9	0.0	0.2	0.0	2.9	0.91
		9.8	99.5	0.6	0.8	0.7	0.0	0.1	0.0	2.4	0.76
	3	13.1	99.5	0.8	1.1	1.0	0.0	0.2	0.0	3.2	1.02
		9.8	99.5	0.7	0.9	0.8	0.0	0.2	0.0	2.7	0.86
Option 3	2	13.1	98.9	0.7	0.9	0.6	0.0	0.1	0.0	2.3	0.72
			99.3	0.4	0.6	0.4	0.0	0.1	0.0	1.4	0.46
		9.8	98.9	0.6	0.8	0.5	0.0	0.1	0.0	2.1	0.65
			99.3	0.4	0.5	0.3	0.0	0.1	0.0	1.3	0.41
	3	13.1	98.9	0.7	1.0	0.6	0.0	0.2	0.0	2.6	0.81
			99.3	0.5	0.6	0.4	0.0	0.1	0.0	1.6	0.52
		9.8	98.9	0.7	0.9	0.6	0.0	0.2	0.0	2.3	0.74
			99.3	0.4	0.6	0.4	0.0	0.1	0.0	1.5	0.47

6.1.760 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.326 is considered to be 1.3-1.5 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the densities for lesser black-backed gull from the MERP dataset potentially overestimate lesser black-backed gull abundance.
- The appropriate apportioning value to apply. There is no site-specific information available on the foraging behaviour of lesser black-backed gulls from The Wash Ramsar. However, the apportioning value calculated in Annex H.3 has been considered appropriate based on the behaviour of birds from other colonies

6.1.761 An impact of 1.3-1.5 collisions/annum represents 0.41-0.47% of the baseline mortality of The Wash Ramsar lesser black-backed gull population (1,378 pairs). When considering the highest impact estimated in Table 6.326, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 2.9-3.2 collisions/annum represents an increase in baseline mortality of 0.91-1.02%. However, the actual number of collisions predicted remains low and there are considered to be significant assumptions which lead to over-estimation associated with the collision risk estimates. If the apportioning value for preferred Project 3 were assumed to be 100%, a highly precautionary value given the presence of several other breeding colonies within foraging range, the resulting most likely impact would be 2.2-2.4 collision/annum and under a worst case scenario, 4.6-5.2 collisions/annum. These impacts are still considered to be low.

In-combination

6.1.762 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact The Wash Ramsar.

Upper Solway Flats and Marshes Ramsar

Lesser black-backed gull

Alone

6.1.763 Collision risk modelling for the Round 4 Plan has been undertaken for lesser black-backed gull using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated a range of values for a number of input parameters. The results of collision risk modelling for each Preferred Project are presented on an unapportioned seasonal basis in Table 6.327. In the breeding season, there is only connectivity between the designated site and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.327: Collision risk estimates for lesser black-backed gull (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																								
				Breeding season				Post-breeding							Non-breeding								Pre-breeding						
				PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	99.5	4	5	4	13	1	1	0	1	1	0	5	2	2	1	1	1	1	7	1	1	0	0	0	0	3
		9.8	99.5	3	5	3	11	1	1	0	0	1	0	4	1	2	0	1	1	0	6	1	1	0	0	0	0	3
	3	13.1	99.5	5	6	4	15	1	2	0	1	1	1	6	2	3	1	1	1	1	9	1	1	0	0	1	0	4
		9.8	99.5	4	5	3	12	1	1	0	1	1	0	5	2	3	1	1	1	1	7	1	1	0	0	0	0	3
Option 3	2	13.1	98.9	3	4	2	9	1	1	0	0	0	0	4	1	2	0	0	1	0	5	1	1	0	0	0	0	3
			99.3	2	2	2	6	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
		9.8	98.9	2	4	2	8	1	1	0	0	0	0	3	1	2	0	0	1	0	5	1	1	0	0	0	0	2
			99.3	1	2	1	5	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
	3	13.1	98.9	3	4	3	10	1	1	0	0	1	0	4	2	3	0	1	1	0	7	1	1	0	0	0	0	3
			99.3	2	3	2	6	1	1	0	0	0	0	3	1	2	0	0	0	0	4	1	1	0	0	0	0	2
		9.8	98.9	3	4	2	9	1	1	0	0	1	0	4	2	2	0	0	1	0	6	1	1	0	0	0	0	3
			99.3	2	3	2	6	1	1	0	0	0	0	2	1	2	0	0	0	0	4	1	1	0	0	0	0	2

6.1.764 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.328, Table 6.329 and Table 6.330.

Table 6.328: Breeding season apportioning for lesser black-backed gull at the Upper Solway Flats and Marshes Ramsar for the impact from Preferred Project 4

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.4	0.8	1.2	1.6	2.0	2.4	2.9	3.3	3.7	4.1
		9.8	99.5	0.3	0.7	1.0	1.3	1.7	2.0	2.4	2.7	3.0	3.4
	3	13.1	99.5	0.5	0.9	1.4	1.8	2.3	2.7	3.2	3.6	4.1	4.5
		9.8	99.5	0.4	0.8	1.1	1.5	1.9	2.3	2.6	3.0	3.4	3.8
Option 3	2	13.1	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
			99.3	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.6
		9.8	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.4
			99.3	0.1	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.3	1.5
	3	13.1	98.9	0.3	0.6	0.9	1.2	1.4	1.7	2.0	2.3	2.6	2.9
			99.3	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.8
		9.8	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.4	2.6
			99.3	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.7

Table 6.329: Breeding season apportioning for lesser black-backed gull at the Upper Solway Flats and Marshes Ramsar for the impact from Preferred Project 5

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.5	1.1	1.6	2.1	2.6	3.2	3.7	4.2	4.8	5.3
		9.8	99.5	0.5	0.9	1.4	1.9	2.3	2.8	3.3	3.7	4.2	4.7
	3	13.1	99.5	0.6	1.2	1.8	2.4	2.9	3.5	4.1	4.7	5.3	5.9
		9.8	99.5	0.5	1.0	1.6	2.1	2.6	3.1	3.6	4.2	4.7	5.2
Option 3	2	13.1	98.9	0.4	0.7	1.1	1.5	1.8	2.2	2.6	2.9	3.3	3.7
			99.3	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.3
		9.8	98.9	0.4	0.7	1.1	1.4	1.8	2.2	2.5	2.9	3.3	3.6
			99.3	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.8	2.1	2.3
	3	13.1	98.9	0.4	0.8	1.2	1.6	2.0	2.4	2.9	3.3	3.7	4.1
			99.3	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
		9.8	98.9	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0
			99.3	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.1	2.3	2.6

Table 6.330: Breeding season apportioning for lesser black-backed gull at the Upper Solway Flats and Marshes Ramsar for the impact from Preferred Project 6

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.4	0.8	1.1	1.5	1.9	2.3	2.7	3.0	3.4	3.8
		9.8	99.5	0.3	0.6	0.9	1.3	1.6	1.9	2.2	2.5	2.8	3.1
	3	13.1	99.5	0.4	0.8	1.3	1.7	2.1	2.5	3.0	3.4	3.8	4.2
		9.8	99.5	0.3	0.7	1.0	1.4	1.7	2.1	2.4	2.8	3.1	3.5
Option 3	2	13.1	98.9	0.2	0.5	0.7	1.0	1.2	1.4	1.7	1.9	2.2	2.4
			99.3	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5
		9.8	98.9	0.2	0.4	0.7	0.9	1.1	1.3	1.5	1.7	2.0	2.2
			99.3	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4
	3	13.1	98.9	0.3	0.5	0.8	1.1	1.3	1.6	1.9	2.1	2.4	2.7
			99.3	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.5	1.7
		9.8	98.9	0.2	0.5	0.7	1.0	1.2	1.5	1.7	1.9	2.2	2.4
			99.3	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5

6.1.765 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.328, Table 6.329 and Table 6.330. Preferred Projects 4 and 5 are on the edge of the mean-maximum foraging range, with the centre of the wind farm, used in the apportioning approach in Annex H.3 lying outside of the mean-maximum foraging range of lesser black-backed gulls from the colonies that form part of the Upper Solway Flats and Marshes Ramsar. As a result the apportioning values calculated for these Preferred Projects is 0%.

6.1.766 Preferred Projects 4 and 5 are however, within the foraging range of lesser black-backed gull when using the mean-maximum foraging range plus one standard deviation (300.5 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual lesser black-backed gulls from the Upper Solway Flats and Marshes Ramsar could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.767 For Preferred Project 6, the three components of the population present at each of the Preferred Projects in the breeding season have been considered (see Annex H.3). The values associated with each of these population components is presented in Table 6.331 and multiplied together to provide an apportioning value for each of the Preferred Projects.

Table 6.331: Breeding season apportioning values for lesser black-backed gull at Upper Solway Flats and Marshes Ramsar based on the approach applied in Annex H.3

Preferred Project	Proportion of breeding adult birds from SPA	Proportion of immature birds	Proportion of non-breeding birds	Overall breeding season apportioning value
6	<0.01	0.38	0.34	<0.01

6.1.768 The results of the apportioning approach in Annex H.3 suggest that less than 1% of the predicted impact from Preferred Project 6 is attributable to the Upper Solway Flats and Marshes Ramsar. As mentioned in Section 5.2, the estimated proportion of immature birds in Table 6.331 does not take account of the distribution of immature birds and may therefore over-estimate this component of the population present at each of the Preferred Projects however, even if it is

assumed that no immature birds are present at Preferred Project 6 the apportioning value would still be less than 1% due to the small population of birds present at the Upper Solway Flats and Marshes Ramsar (a population that is now much smaller than included on the designation for the Ramsar) incorporated into the apportioning approach in Annex H.3.

6.1.769 There is no site-specific foraging range data available for lesser black-backed gull from the Strangford Lough SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from Preferred Projects 4 and 5 is to be apportioned to the Strangford Lough SPA then it is proposed the value calculated for Preferred Project 6, discounting immature birds is used.

6.1.770 In the post-, non- and pre-breeding seasons, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, non- and pre-breeding seasons for the Preferred Projects in the Irish Sea are 1.5%, 5.8% and 0.6%, respectively. For the Preferred Projects in the North Sea the values are 1.1%, 6.1% and 0.2%, respectively. The apportioned values from each of the Preferred Projects combined to the Upper Solway Flats and Marshes Ramsar are presented in Table 6.332.

Table 6.332: Apportioned collision risk estimates for lesser black-backed gull at the Upper Solway Flats and Marshes Ramsar in non-breeding seasons

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values		
				Post-breeding	Non-breeding	Pre-breeding
Option 2	2	13.1	99.5	0.1	0.4	0.0
		9.8	99.5	0.0	0.3	0.0
	3	13.1	99.5	0.1	0.5	0.0
		9.8	99.5	0.1	0.4	0.0
Option 3	2	13.1	98.9	0.0	0.3	0.0
			99.3	0.0	0.2	0.0
		9.8	98.9	0.0	0.3	0.0
			99.3	0.0	0.2	0.0
	3	13.1	98.9	0.1	0.4	0.0
			99.3	0.0	0.3	0.0
		9.8	98.9	0.0	0.4	0.0
			99.3	0.0	0.2	0.0

6.1.771 The annual apportioned impact for lesser black-backed gull at the Upper Solway Flats and Marshes Ramsar is provided in Table 6.333.

Table 6.333: Calculation of the annual impact attributable to lesser black-backed gull at the Upper Solway Flats and Marshes Ramsar from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding			Post-breeding	Non-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP4	PP5	PP6	All projects	All projects	All projects		
Option 2	2	13.1	99.5	0.0	0.0	0.0	0.1	0.4	0.0	0.5	0.08
		9.8	99.5	0.0	0.0	0.0	0.0	0.3	0.0	0.4	0.07
	3	13.1	99.5	0.0	0.0	0.0	0.1	0.5	0.0	0.6	0.11
		9.8	99.5	0.0	0.0	0.0	0.1	0.4	0.0	0.5	0.09
Option 3	2	13.1	98.9	0.0	0.0	0.0	0.0	0.3	0.0	0.4	0.07
			99.3	0.0	0.0	0.0	0.0	0.2	0.0	0.2	0.04
		9.8	98.9	0.0	0.0	0.0	0.0	0.3	0.0	0.3	0.06
			99.3	0.0	0.0	0.0	0.0	0.2	0.0	0.2	0.04
	3	13.1	98.9	0.0	0.0	0.0	0.1	0.4	0.0	0.5	0.09
			99.3	0.0	0.0	0.0	0.0	0.3	0.0	0.3	0.06
		9.8	98.9	0.0	0.0	0.0	0.0	0.4	0.0	0.4	0.08
			99.3	0.0	0.0	0.0	0.0	0.2	0.0	0.3	0.05

6.1.772 The most likely impact (and most realistic worst case) for the Round 4 Plan alone from Table 6.333 is considered to be 0.2-0.3 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the densities for lesser black-backed gull from the MERP dataset potentially overestimate lesser black-backed gull abundance.

6.1.773 An impact of 0.2-0.3 collisions/annum represents 0.05-0.06% of the baseline mortality of the Upper Solway Flats and Marshes Ramsar lesser black-backed gull population (4,804 breeding adults). When considering the highest impact estimated in Table 6.333, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 0.5-0.6 collisions/annum represents an increase in baseline mortality of 0.08-0.11%. Under any of the scenarios presented, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.774 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Upper Solway Flats and Marshes Ramsar.

Herring gull

Alone

6.1.775 Collision risk modelling for the Round 4 Plan has been undertaken for herring gull using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated a range of values for a number of input parameters. The results of collision risk modelling for each Preferred Project are presented on an unapportioned seasonal basis in Table 6.334. In the breeding season, there is only connectivity between the designated site and Preferred Project 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.334: Collision risk estimates for herring gull (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)							
				Breeding season	Non-breeding						
				PP6	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	12.8	99.5	3	16	18	6	3	2	3	48
		9.8	99.5	3	13	16	5	2	2	3	41
	3	12.8	99.5	3	20	24	7	4	2	4	62
		9.8	99.5	3	18	21	6	3	2	3	53
Option 3	2	12.8	99.0	2	14	16	3	2	1	2	39
			99.3	1	10	11	2	1	1	1	27
		9.8	99.0	2	13	15	3	2	1	2	35
			99.3	1	9	10	2	1	1	1	25
	3	12.8	99.0	2	18	21	4	2	2	3	50
			99.3	2	13	15	3	2	1	2	35
		9.8	99.0	2	16	19	4	2	2	2	46
			99.3	1	11	13	3	2	1	2	32

6.1.776 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.335.

Table 6.335: Breeding season apportioning for herring gull at the Upper Solway Flats and Marshes Ramsar for the impact from Preferred Project 6

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	12.8	99.5	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0
		9.8	99.5	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.0	2.3	2.5
	3	12.8	99.5	0.3	0.7	1.0	1.4	1.7	2.0	2.4	2.7	3.0	3.4
		9.8	99.5	0.3	0.6	0.9	1.1	1.4	1.7	2.0	2.3	2.6	2.8
Option 3	2	12.8	99.0	0.2	0.4	0.6	0.8	0.9	1.1	1.3	1.5	1.7	1.9
			99.3	0.1	0.3	0.4	0.5	0.7	0.8	0.9	1.1	1.2	1.3
		9.8	99.0	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.6	1.7
			99.3	0.1	0.2	0.4	0.5	0.6	0.7	0.8	1.0	1.1	1.2
	3	12.8	99.0	0.2	0.4	0.6	0.9	1.1	1.3	1.5	1.7	1.9	2.1
			99.3	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5
		9.8	99.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
			99.3	0.1	0.3	0.4	0.5	0.7	0.8	1.0	1.1	1.2	1.4

6.1.777 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.335. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All of the Preferred Projects are beyond the mean-maximum foraging range of herring gull from the Solway Flats and Marshes Ramsar and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. Preferred Project 6 is however, within the foraging range of herring gull when using the mean-maximum foraging range plus one standard deviation (85.6 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual lesser black-backed gulls from the Upper Solway Flats and Marshes Ramsar could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.778 There is no site-specific foraging range data available for herring gull from the Upper Solway Flats and Marshes Ramsar. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Upper Solway Flats and Marshes Ramsar then this should only be a limited amount (e.g. 10%).

6.1.779 In the non-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning value used for the Preferred Projects in the Irish Sea is 6.7% and for the Preferred Projects in the North Sea is 0.2%. The apportioned values from each of the Preferred Projects combined to the Solway Flats and Marshes Ramsar are presented in Table 6.336.

Table 6.336: Apportioned collision risk estimates for herring gull at the Upper Solway Flats and Marshes Ramsar in non-breeding seasons

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values
				Non-breeding
Option 2	2	12.8	99.5	0.6
		9.8	99.5	0.5
	3	12.8	99.5	0.8

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values
				Non-breeding
		9.8	99.5	0.6
Option 3	2	12.8	99.0	0.4
			99.3	0.3
		9.8	99.0	0.4
			99.3	0.3
	3	12.8	99.0	0.5
			99.3	0.4
		9.8	99.0	0.5
			99.3	0.3

6.1.780 The annual apportioned impact for herring gull at the Upper Solway Flats and Marshes Ramsar is provided in Table 6.337.

Table 6.337: Calculation of the annual impact attributable to herring gull at the Upper Solway Flats and Marshes Ramsar from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding season	Non-breeding	Total	Baseline mortality (%)
				PP6	All projects		
Option 2	2	12.8	99.5	0.3	0.6	0.9	0.05
		9.8	99.5	0.3	0.5	0.8	0.05
	3	12.8	99.5	0.3	0.8	1.1	0.07
		9.8	99.5	0.3	0.6	0.9	0.06
Option 3	2	12.8	99.0	0.2	0.4	0.6	0.04
			99.3	0.1	0.3	0.4	0.02
		9.8	99.0	0.2	0.4	0.5	0.03
			99.3	0.1	0.3	0.4	0.02
	3	12.8	99.0	0.2	0.5	0.7	0.04
			99.3	0.2	0.4	0.5	0.03
		9.8	99.0	0.2	0.5	0.7	0.04
			99.3	0.1	0.3	0.5	0.03

6.1.781 The most likely impact (and most realistic worst case) for the Round 4 Plan alone from Table 6.337 is considered to be 0.4-0.5 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the densities for herring gull from the MERP dataset potentially overestimate herring gull abundance.
- The appropriate apportioning value to apply. It is considered highly unlikely that a significant proportion of herring gulls from Upper Solway Flats and Marshes Ramsar will forage in the sea areas in which the Preferred Projects will be located. A value of 10% has been applied however, this is considered to be highly precautionary with large gulls unlikely to be found foraging at distances offshore commensurate with the distance between Upper Solway Flats and Marshes Ramsar and the Preferred Projects.

6.1.782 An impact of 0.4-0.5 collisions/annum represents 0.02-0.03% of the baseline mortality of the Upper Solway Flats and Marshes Ramsar herring gull population (14,422 breeding adults). When considering the highest impact estimated in Table 6.337, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 0.9-1.1 collisions/annum represents an increase in baseline mortality of 0.05-0.07%. Under any of the scenarios presented, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.783 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Upper Solway Flats and Marshes Ramsar.

Waddenzee SPA

Lesser black-backed gull

Alone

6.1.784 Collision risk modelling has been undertaken for lesser black-backed gull using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.338. In the breeding season, there is only connectivity between the Waddenzee SPA and Preferred Projects 2 and 3 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.338: Collision risk estimates for lesser black-backed gull (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																						
				Breeding season		Post-breeding							Non-breeding							Pre-breeding						
				PP2	PP3	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	99.5	10	3	1	1	0	1	1	0	5	2	2	1	1	1	1	7	1	1	0	0	0	0	3
		9.8	99.5	8	2	1	1	0	0	1	0	4	1	2	0	1	1	0	6	1	1	0	0	0	0	3
	3	13.1	99.5	11	3	1	2	0	1	1	1	6	2	3	1	1	1	1	9	1	1	0	0	1	0	4
		9.8	99.5	9	2	1	1	0	1	1	0	5	2	3	1	1	1	1	7	1	1	0	0	0	0	3
Option 3	2	13.1	98.9	9	2	1	1	0	0	0	0	4	1	2	0	0	1	0	5	1	1	0	0	0	0	3
			99.3	6	1	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
		9.8	98.9	8	1	1	1	0	0	0	0	3	1	2	0	0	1	0	5	1	1	0	0	0	0	2
			99.3	5	1	1	1	0	0	0	0	2	1	1	0	0	0	0	3	0	1	0	0	0	0	2
	3	13.1	98.9	10	2	1	1	0	0	1	0	4	2	3	0	1	1	0	7	1	1	0	0	0	0	3
			99.3	6	1	1	1	0	0	0	0	3	1	2	0	0	0	0	4	1	1	0	0	0	0	2
		9.8	98.9	9	2	1	1	0	0	1	0	4	2	2	0	0	1	0	6	1	1	0	0	0	0	3
			99.3	6	1	1	1	0	0	0	0	2	1	2	0	0	0	0	4	1	1	0	0	0	0	2

6.1.785 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.339 and Table 6.340.

Table 6.339: Breeding season apportioning for lesser black-backed gull at the Waddenzee SPA for the impact from Preferred Project 2

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	1.0	2.0	3.0	4.0	4.9	5.9	6.9	7.9	8.9	9.9
		9.8	99.5	0.8	1.7	2.5	3.4	4.2	5.0	5.9	6.7	7.5	8.4
	3	13.1	99.5	1.1	2.2	3.3	4.4	5.5	6.6	7.7	8.8	9.9	11.0
		9.8	99.5	0.9	1.9	2.8	3.7	4.7	5.6	6.5	7.5	8.4	9.3
Option 3	2	13.1	98.9	0.9	1.7	2.6	3.5	4.4	5.2	6.1	7.0	7.9	8.7
			99.3	0.6	1.1	1.7	2.2	2.8	3.3	3.9	4.4	5.0	5.6
		9.8	98.9	0.8	1.6	2.4	3.2	4.0	4.8	5.6	6.3	7.1	7.9
			99.3	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
	3	13.1	98.9	1.0	1.9	2.9	3.9	4.9	5.8	6.8	7.8	8.8	9.7
			99.3	0.6	1.2	1.9	2.5	3.1	3.7	4.3	5.0	5.6	6.2
		9.8	98.9	0.9	1.8	2.7	3.5	4.4	5.3	6.2	7.1	8.0	8.8
			99.3	0.6	1.1	1.7	2.3	2.8	3.4	3.9	4.5	5.1	5.6

Table 6.340: Breeding season apportioning for lesser black-backed gull at the Waddenzee SPA for the impact from Preferred Project 3

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	99.5	0.3	0.5	0.8	1.1	1.3	1.6	1.9	2.1	2.4	2.7
		9.8	99.5	0.2	0.4	0.7	0.9	1.1	1.3	1.5	1.8	2.0	2.2
	3	13.1	99.5	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0
		9.8	99.5	0.2	0.5	0.7	1.0	1.2	1.5	1.7	2.0	2.2	2.5
Option 3	2	13.1	98.9	0.2	0.3	0.5	0.7	0.8	1.0	1.1	1.3	1.5	1.6
			99.3	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		9.8	98.9	0.1	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.3	1.5
			99.3	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.8	0.9
	3	13.1	98.9	0.2	0.4	0.5	0.7	0.9	1.1	1.3	1.5	1.6	1.8
			99.3	0.1	0.2	0.3	0.5	0.6	0.7	0.8	0.9	1.0	1.2
		9.8	98.9	0.2	0.3	0.5	0.7	0.8	1.0	1.1	1.3	1.5	1.6
			99.3	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

6.1.786 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.339 and Table 6.340. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). Preferred Projects 1 and 2 are beyond the mean-maximum foraging range of lesser black-backed gull from the Waddenzee SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%.

6.1.787 Both projects are however, within the foraging range of lesser black-backed gull when using the mean-maximum foraging range plus one standard deviation (236 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual lesser black-backed gulls from the Waddenzee SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.788 There is no site-specific foraging range data available for lesser black-backed gull from the Waddenzee SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Waddenzee SPA then this should only be a limited amount (e.g. 10%).

6.1.789 In the post-, non- and pre-breeding seasons, the apportioning values presented in Annex H.3 have been applied. In the North Sea the apportioning values used in the post-, non- and pre-breeding seasons for the Preferred Projects in the North Sea are 24.9%, 66.1% and 26.3%, respectively. For the Preferred Projects in the Irish Sea, 0% has been applied to all seasons. The apportioned values from each of the Preferred Projects combined to the Waddenzee SPA are presented in Table 6.341.

Table 6.341: Apportioned collision risk estimates for lesser black-backed gull at the Waddenzee SPA in non-breeding seasons

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values		
				Post-breeding	Non-breeding	Pre-breeding
Option 2	2	13.1	99.5	0.7	3.0	0.6
		9.8	99.5	0.6	2.5	0.5

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values		
				Post-breeding	Non-breeding	Pre-breeding
Option 3	3	13.1	99.5	0.8	3.9	0.7
		9.8	99.5	0.7	3.3	0.6
	2	13.1	98.9	0.6	2.5	0.5
			99.3	0.4	1.6	0.3
		9.8	98.9	0.5	2.3	0.5
			99.3	0.3	1.5	0.3
	3	13.1	98.9	0.7	3.4	0.6
			99.3	0.5	2.1	0.4
		9.8	98.9	0.6	3.0	0.6
			99.3	0.4	1.9	0.4

6.1.790 The annual apportioned impact for lesser black-backed gull at the Waddenzee SPA is provided in Table 6.342.

Table 6.342: Calculation of total impact attributable to lesser black-backed gull at the Waddenzee SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding		Post-breeding	Non-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP2	PP3	All projects	All projects	All projects		
Option 2	2	13.1	99.5	1.0	0.3	0.7	3.0	0.6	5.5	0.09
		9.8	99.5	0.8	0.2	0.6	2.5	0.5	4.7	0.08
	3	13.1	99.5	1.1	0.3	0.8	3.9	0.7	6.9	0.11
		9.8	99.5	0.9	0.2	0.7	3.3	0.6	5.8	0.10
Option 3	2	13.1	98.9	0.9	0.2	0.6	2.5	0.5	4.7	0.08
			99.3	0.6	0.1	0.4	1.6	0.3	3.0	0.05
		9.8	98.9	0.8	0.1	0.5	2.3	0.5	4.2	0.07
			99.3	0.5	0.1	0.3	1.5	0.3	2.7	0.04
	3	13.1	98.9	1.0	0.2	0.7	3.4	0.6	5.8	0.10
			99.3	0.6	0.1	0.5	2.1	0.4	3.7	0.06
		9.8	98.9	0.9	0.2	0.6	3.0	0.6	5.3	0.09
			99.3	0.6	0.1	0.4	1.9	0.4	3.4	0.06

6.1.791 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.342 is considered to be 2.7-3.4 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that the densities for lesser black-backed gull from the MERP dataset potentially overestimate lesser black-backed gull abundance.
- The appropriate apportioning value to apply. It is considered highly unlikely that a significant proportion of lesser black-backed gulls from the Waddenzee SPA will forage in the sea areas in which the Preferred Projects will be located. A value of 10% has been applied however, this is considered to be highly precautionary with large gulls unlikely to be found foraging at distances offshore commensurate with the distance between the Waddenzee SPA and the Preferred Projects.

6.1.792 An impact of 2.7-3.4 collisions/annum represents 0.04-0.06% of the baseline mortality of the Waddenzee SPA lesser black-backed gull population (26,200 pairs). When considering the highest impact estimated in Table 6.342, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 5.5-6.9 collisions/annum represents an increase in baseline mortality of 0.09-0.11%. Under any of the scenarios presented, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.793 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan will not materially contribute to any in-combination impact on the lesser black-backed gull feature of the Waddenzee SPA.

Wicklow Head SPA

Kittiwake

Alone

6.1.794 Collision risk modelling has been undertaken for kittiwake using the Band (2012) CRM (Annex H.2). To account for variability and uncertainty, the modelling process has incorporated varying values for a number of input parameters. The results of collision risk modelling are presented on an unapportioned seasonal basis in Table 6.343. In the breeding season, there is only connectivity between the Wicklow Head SPA and Preferred Projects 4, 5 and 6 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.343: Collision risk estimates for kittiwake (unapportioned values) (no. of collisions) at each of the Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Seasonal collision risk estimates at each Preferred Project (no. of birds)																
				Breeding season				Post-breeding							Pre-breeding						
				PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot	PP1	PP2	PP3	PP4	PP5	PP6	Tot
Option 2	2	13.1	98.9	3	2	3	8	29	21	5	2	1	2	59	21	15	3	1	0	1	41
			99.0	3	2	3	7	26	19	4	2	1	2	54	19	14	3	1	0	0	37
		8.71	98.9	2	2	2	6	22	16	3	1	1	1	45	16	12	2	0	0	0	31
			99.0	2	1	2	5	20	14	3	1	1	1	41	15	11	2	0	0	0	29
	3	13.1	98.9	4	2	3	9	37	26	6	2	1	2	75	28	20	4	1	0	1	53
			99.0	3	2	3	8	34	24	5	2	1	2	68	25	18	4	1	0	1	49
		8.71	98.9	3	2	2	7	28	20	4	2	1	2	58	21	15	3	1	0	1	41
			99.0	2	2	2	6	26	18	4	2	1	1	52	19	14	3	1	0	0	37
Option 3	2	13.1	98	1	1	1	3	14	10	1	1	0	1	27	10	7	1	0	0	0	19
		8.71	98	1	1	1	2	12	9	1	1	0	0	23	9	6	1	0	0	0	16
	3	13.1	98	1	1	1	3	18	13	2	1	1	1	34	13	9	1	0	0	0	24
		8.71	98	1	1	1	3	15	11	2	1	1	1	30	12	8	1	0	0	0	21

6.1.795 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.344, Table 6.345 and Table 6.346.

Table 6.344: Breeding season apportioning for kittiwake at Wicklow Head SPA for the impact from Preferred Project 4

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.3	0.6	0.9	1.2	1.6	1.9	2.2	2.5	2.8	3.1
			99.0	0.3	0.6	0.8	1.1	1.4	1.7	2.0	2.3	2.5	2.8
		8.71	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.3
			99.0	0.2	0.4	0.6	0.8	1.1	1.3	1.5	1.7	1.9	2.1
	3	13.1	98.9	0.4	0.7	1.1	1.4	1.8	2.1	2.5	2.8	3.2	3.5
			99.0	0.3	0.6	1.0	1.3	1.6	1.9	2.2	2.6	2.9	3.2
		8.71	98.9	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.3	2.6
			99.0	0.2	0.5	0.7	0.9	1.2	1.4	1.7	1.9	2.1	2.4
Option 3	2	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		8.71	98	0.1	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.8	0.9
	3	13.1	98	0.1	0.2	0.3	0.5	0.6	0.7	0.8	0.9	1.0	1.2
		8.71	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

Table 6.345: Breeding season apportioning for kittiwake at Wicklow Head SPA for the impact from Preferred Project 5

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.9
			99.0	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.4	1.5	1.7
		8.71	98.9	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.6
			99.0	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.4
	3	13.1	98.9	0.2	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.9	2.1
			99.0	0.2	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9
		8.71	98.9	0.2	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.6	1.7
			99.0	0.2	0.3	0.5	0.6	0.8	1.0	1.1	1.3	1.4	1.6
Option 3	2	13.1	98	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
		8.71	98	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
	3	13.1	98	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8
		8.71	98	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8

Table 6.346: Breeding season apportioning for kittiwake at Wicklow Head SPA for the impact from Preferred Project 6

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioning value (%)									
				10	20	30	40	50	60	70	80	90	100
Option 2	2	13.1	98.9	0.3	0.6	0.8	1.1	1.4	1.7	2.0	2.2	2.5	2.8
			99.0	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.0	2.3	2.6
		8.71	98.9	0.2	0.4	0.6	0.8	1.0	1.3	1.5	1.7	1.9	2.1
			99.0	0.2	0.4	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9
	3	13.1	98.9	0.3	0.6	0.9	1.3	1.6	1.9	2.2	2.5	2.8	3.2
			99.0	0.3	0.6	0.9	1.2	1.4	1.7	2.0	2.3	2.6	2.9
		8.71	98.9	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	2.4
			99.0	0.2	0.4	0.6	0.9	1.1	1.3	1.5	1.7	1.9	2.1
Option 3	2	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.8	0.9
		8.71	98	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.6	0.7	0.8
	3	13.1	98	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
		8.71	98	0.1	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8	0.9

6.1.796 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.344, Table 6.345 and Table 6.346. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). Preferred Projects 5 and 6 are beyond the mean-maximum foraging range of kittiwake from the Wicklow Head SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%.

6.1.797 Preferred Projects 5 and 6 are however, within the foraging range of kittiwake when using the mean-maximum foraging range plus one standard deviation (300.5 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al*. (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual kittiwakes from the Wicklow Head SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of collision mortality.

6.1.798 Preferred Project 4 is on the edge of the mean-maximum foraging range, with the centre of the wind farm, used in the apportioning approach in Annex H.3 lying outside of the mean-maximum foraging range. As a result the apportioning value calculated for Preferred Project 4 is 0%.

6.1.799 There is no site-specific information in relation to the foraging behaviour of kittiwake from the Wicklow Head SPA. However, the UK and Eire-wide utilisation distributions presented in Cleasby *et al.* (2018) suggest that the Preferred Projects lie beyond the 75% utilisation distribution band. This suggests limited connectivity between any kittiwake colony and the Preferred Projects and supports the use of a low apportioning value. If however, due to the lack of site-specific data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Wicklow Head SPA then this should only be a limited amount (e.g. 10%).

6.1.800 In the post-breeding and pre-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning values used in the post-, and pre-breeding seasons for the Preferred Projects in the Irish Sea are 0.13% and 0.22% and for the Preferred Projects in the North Sea are less than 0.01% in both seasons. The apportioned values from each of the Preferred Projects combined to the Wicklow Head SPA are presented in Table 6.347.

Table 6.347: Apportioning for kittiwake at the Wicklow Head SPA in the post- and pre-breeding season for the impact from all Preferred Projects

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Apportioned values	
				Post-breeding	Pre-breeding
Option 2	2	13.1	98.9	0.0	0.0
			99.0	0.0	0.0
		8.71	98.9	0.0	0.0
			99.0	0.0	0.0
	3	13.1	98.9	0.0	0.0
			99.0	0.0	0.0
		8.71	98.9	0.0	0.0
			99.0	0.0	0.0
Option 3	2	13.1	98	0.0	0.0
		8.71	98	0.0	0.0
	3	13.1	98	0.0	0.0
		8.71	98	0.0	0.0

6.1.801 The annual apportioned impact for kittiwake at the Wicklow Head SPA is provided in Table 6.348.

Table 6.348: Calculation of total impact attributable to kittiwake at the Wicklow Head SPA from the Round 4 Plan alone

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding			Post-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP4	PP5	PP6	All projects	All projects		
Option 2	2	13.1	98.9	0.3	0.2	0.3	0.0	0.0	0.8	0.28
			99.0	0.3	0.2	0.3	0.0	0.0	0.7	0.26
		8.71	98.9	0.2	0.2	0.2	0.0	0.0	0.6	0.22
			99.0	0.2	0.1	0.2	0.0	0.0	0.5	0.20
	3	13.1	98.9	0.4	0.2	0.3	0.0	0.0	0.9	0.32
			99.0	0.3	0.2	0.3	0.0	0.0	0.8	0.29
		8.71	98.9	0.3	0.2	0.2	0.0	0.0	0.7	0.24
			99.0	0.2	0.2	0.2	0.0	0.0	0.6	0.22
Option 3	2	13.1	98	0.1	0.1	0.1	0.0	0.0	0.3	0.10
		8.71	98	0.1	0.1	0.1	0.0	0.0	0.2	0.09
	3	13.1	98	0.1	0.1	0.1	0.0	0.0	0.3	0.11
		8.71	98	0.1	0.1	0.1	0.0	0.0	0.3	0.10

6.1.802 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.348 is considered to be 0.2-0.3 collisions/annum. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that kittiwake densities from the MERP dataset potentially underestimate kittiwake abundance.
- The appropriate apportioning value to apply. It is considered highly unlikely that a significant proportion of kittiwake from the Wicklow Head SPA will forage in the sea areas in which the Preferred Projects will be located. A value of 10% has been applied however, this is considered to be highly precautionary with kittiwake unlikely to be found foraging at distances offshore commensurate with the distance between the North Wicklow Head SPA and the Preferred Projects.
- The seasonal definitions applied and the influence on apportioning values. Apportioning has used a breeding season definition which incorporates migratory periods and is therefore likely to represent an approach that will over-estimate the impact in the breeding season.
- The proportion of immatures present at each of the Preferred Projects.

6.1.803 An impact of 0.2-0.3 collisions/annum represents 0.09-0.10% of the baseline mortality of the Wicklow Head SPA kittiwake population (1,912 breeding adults). When considering the highest impact estimated in Table 6.348, which is considered unrealistic due to an over-application of precaution, an annual collision risk estimate of 0.6-0.8 collisions/annum represents an increase in baseline mortality of 0.22-0.28%. Under any of the scenarios presented, the actual number of collisions is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.804 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Wicklow head SPA.

Guillemot

Alone

6.1.805 Displacement analysis has been undertaken for guillemot using the approach advised in JNCC *et al.* (2017) (Annex H.1). To account for uncertainty in the analysis approach, a range of displacement and mortality rates have been applied following the recommended approach to defining these in JNCC *et al.* (2017). Table 6.349 presents the unapportioned seasonal displacement mortality for guillemot at each of the Preferred Projects using the appropriate range of displacement and mortality rates. In the breeding season, there is only connectivity between the Wicklow Head SPA and Preferred Project 4 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.349: Displacement mortality for guillemot at each of the Preferred Projects (unapportioned values) (no. of birds)

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
1	30	N/A				7	13	33	67
	50	N/A				11	22	56	112
	70	N/A				16	31	78	156
2	30	N/A				6	12	30	60
	50	N/A				10	20	50	100
	70	N/A				14	28	70	140
3	30	N/A				6	11	29	57
	50	N/A				10	19	48	95
	70	N/A				13	27	67	134
4	30	2	3	8	17	2	4	10	20
	50	3	6	14	28	3	7	17	34
	70	4	8	20	39	5	9	24	47
5	30	N/A				1	1	3	6
	50	N/A				1	2	5	10
	70	N/A				1	3	7	14
6	30	N/A				1	3	7	13

Preferred Project	Displacement rate (%)	Mortality rate (%)							
		Breeding				Non-breeding			
		1	2	5	10	1	2	5	10
	50	N/A				2	4	11	22
	70	N/A				3	6	16	31

6.1.806 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.350.

Table 6.350: Breeding season apportioning for guillemot at Wicklow Head SPA for the impact from all Preferred Projects with connectivity in the breeding season

Preferred Project	Displacement / mortality rate (%)	Apportioning value (%)									
		10	20	30	40	50	60	70	80	90	100
4	30 / 1	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.7
	50 / 5	1.4	2.8	4.2	5.6	7.0	8.4	9.8	11.2	12.6	14.1
	70 / 10	3.9	7.9	11.8	15.7	19.7	23.6	27.5	31.5	35.4	39.3

6.1.807 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.350. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All of the Preferred Projects are beyond the mean-maximum foraging range of guillemot from the Wicklow Head SAC and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. Preferred Projects 4 and 6 however, are within the foraging range of guillemot when using the mean-maximum foraging range plus one standard deviation (153.7 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al.* (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual guillemots from the Wicklow Head SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of displacement mortality.

6.1.808 There is no site-specific foraging range data available for guillemot from the Wicklow Head SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Wicklow Head SPA then this should only be a limited amount (e.g. 10%).

6.1.809 In the non-breeding season, the apportioning values presented in Annex H.3 have been applied. The apportioning value used for the Preferred Projects in the Irish Sea is 0.04% and for the Preferred Projects in the North Sea is 0%. The apportioned values from each of the Preferred Projects combined to the Wicklow Head SPA are presented in Table 6.351.

Table 6.351: Apportioned displacement mortality for guillemot at the Wicklow Head SPA in non-breeding season

Displacement / mortality rate (%)	Preferred Project						Total
	1	2	3	4	5	6	
30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50 / 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70 / 10	0.0	0.0	0.0	0.0	0.0	0.0	0.0

6.1.810 The annual apportioned impact for guillemot at the Wicklow Head SPA is provided in Table 6.352.

Table 6.352: Calculation of the annual impact attributable to guillemot at the Wicklow Head SPA from the Round 4 Plan alone

Displacement / mortality assumptions	Breeding season	Non-breeding season						Total	Increase in baseline mortality (%)
	PP4	PP1	PP2	PP3	PP4	PP5	PP6		
30 / 1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.5
50 / 5	1.4	0.0	0.0	0.0	0.0	0.0	0.0	1.4	4.1
70 / 10	3.9	0.0	0.0	0.0	0.0	0.0	0.0	4.0	11.6

6.1.811 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.352 is considered to be one bird. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that guillemot densities from the MERP dataset potentially underestimate guillemot abundance.
- The apportioning value applied in the breeding season, it is unlikely that a significant proportion of guillemot from the Wicklow Head SPA will utilize the Preferred Project areas and the assumption of 10% is likely an over-estimate but is applied on a precautionary basis.

6.1.812 A wider range of displacement rates are defined in JNCC *et al.* (2017) and these have been considered in the displacement analyses conducted. A precautionary approach has also been applied when considering the apportioning value to apply for all Preferred Projects.

6.1.813 Despite the predicted increase in baseline mortality (4.1%) exceeding the 1% baseline mortality threshold of the Wicklow Head SPA population (563 breeding adults), the actual number of birds displaced is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.814 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Wicklow Head SPA.

<u>Razorbill</u>

Alone

6.1.815 Displacement analysis has been undertaken for razorbill using the approach advised in JNCC *et al.* (2017) (Annex H.1). To account for uncertainty in the analysis approach a range of displacement and mortality rates have been applied following the recommended approach to defining these in JNCC *et al.* (2017). Table 6.353 presents the unapportioned seasonal displacement mortality for razorbill at each of the Preferred Projects using the appropriate range of displacement and mortality rates. In the breeding season, there is only connectivity between the Wicklow Head SPA and Preferred Project 4 based on the mean-maximum foraging range plus one standard deviation of the species presented in Woodward *et al.* (2019). The seasons used are those presented in Furness (2015) with the full UK breeding season applied.

Table 6.353: Displacement mortality for razorbill at each of the Preferred Projects (unapportioned values) (no. of birds)

Preferred Project	Displacement rate (%)	Mortality rate (%)															
		Breeding				Post-breeding				Non-breeding				Pre-breeding			
		1	2	5	10	1	2	5	10	1	2	5	10	1	2	5	10
1	30	N/A				1	1	4	7	1	2	5	9	1	2	5	11
	40	N/A				1	2	5	10	1	3	6	13	1	3	7	14
	70	N/A				2	3	9	17	2	4	11	22	2	5	12	25
2	30	N/A				1	1	3	6	1	2	4	8	1	2	5	9
	40	N/A				1	2	4	8	1	2	5	10	1	2	6	12
	70	N/A				1	3	7	13	2	4	9	18	2	4	11	21
3	30	N/A				1	1	3	6	1	1	4	7	1	2	4	8
	40	N/A				1	1	4	7	1	2	5	10	1	2	6	11
	70	N/A				1	3	7	13	2	3	9	17	2	4	10	20
4	30	0	0	1	1	0	1	1	3	0	1	2	4	0	1	2	4
	40	0	0	1	2	0	1	2	4	0	1	2	5	1	1	3	5
	70	0	1	2	3	1	1	3	7	1	2	4	8	1	2	5	10
5	30	N/A				0	0	0	1	0	0	1	1	0	0	1	1
	40	N/A				0	0	1	1	0	0	1	2	0	0	1	2
	70	N/A				0	0	1	2	0	1	1	3	0	1	2	3
6	30	N/A				0	0	1	2	0	0	1	2	0	0	1	2

Preferred Project	Displacement rate (%)	Mortality rate (%)															
		Breeding				Post-breeding				Non-breeding				Pre-breeding			
		1	2	5	10	1	2	5	10	1	2	5	10	1	2	5	10
	40	N/A				0	0	1	2	0	1	1	3	0	1	2	3
	70	N/A				0	1	2	4	1	1	3	5	1	1	3	6

6.1.816 In the breeding season, the population of birds present in an area of sea will be composed of breeding adult birds, immature birds and non-breeding birds. In order to identify the contribution of any Preferred Project to a given SPA each of these components need to be considered as part of any apportioning value. As a first step, and in line with Natural England advice, the total breeding season value for each Preferred Project has been apportioned using a range of apportioning values in Table 6.354.

Table 6.354: Breeding season apportioning for razorbill at Wicklow Head SPA for the impact from all Preferred Projects with connectivity in the breeding season

Preferred Project	Displacement / mortality rate (%)	Apportioning value (%)									
		10	20	30	40	50	60	70	80	90	100
4	30 / 1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	40 / 5	0.1	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8	0.9
	70 / 10	0.3	0.6	1.0	1.3	1.6	1.9	2.2	2.6	2.9	3.2

6.1.817 Annex H.3 presents an approach to enable the estimation of an appropriate apportioning value in Table 6.354. This approach utilises the generic mean-maximum foraging range of a species from Woodward *et al.* (2019). All of the Preferred Projects are beyond the mean-maximum foraging range of razorbill from the Wicklow Head SPA and therefore the approach presented in Annex H.3 suggests an apportioning rate of 0%. All of the Preferred Projects are however, within the foraging range of razorbill when using the mean-maximum foraging range plus one standard deviation (164.6 km). The mean-maximum foraging range for a species represents the average of the maximum foraging ranges recorded during relevant studies. Some individuals will exhibit extreme behaviours and forage over distances considerably greater than those of the large majority of individuals within a population. It can be seen in Woodward *et al.* (2019), for example, that the maximum ranges cited are often significantly higher than the corresponding mean values for the same population. For this reason a mean of maximum ranges ("mean-maximum range") is often used, this is considered to be precautionary as it will capture the distance from the colony within which birds will spend the very large majority of their time. To make this distance even more precautionary, particularly for screening purposes, SNCBs advise that it is further extended by a distance equivalent to one standard deviation (1 SD) of the mean-maximum foraging range. This can result in very large assumed foraging ranges, which may occasionally be observed in the behaviour of individuals, but which are not reflective of the typical distribution of birds. The risk to birds in this extended region is, therefore, considered to be very low. In this case, whilst the risk that individual razorbills from the Wicklow Head SPA could potentially forage within the area of a Preferred Project cannot be discounted, it is considered that birds will not be present in sufficient numbers to be at significant risk of displacement mortality.

6.1.818 There is no site-specific foraging range data available for razorbill from the Wicklow Head SPA. Therefore if, due to the lack of such data and on a precautionary basis, any impact from the Preferred Projects is to be apportioned to the Wicklow Head SPA then this should only be a limited amount (e.g. 10%).

6.1.819 In the post-, non- and pre-breeding seasons, the apportioning values presented in Annex H.3 have been applied. In the Irish Sea the apportioning values used in the post-, non- and pre-breeding seasons 0.04%, 0.03% and 0.04%, respectively and for the Preferred Projects in the North Sea the values are less than 0.01% in the post- and pre-breeding seasons and 0.01% in the non-breeding season. The apportioned values from each of the Preferred Projects combined to the Wicklow Head SPA are presented in Table 6.355. In all cases the impact is less than 0.1 birds.

Table 6.355: Apportioned displacement mortality for razorbill at the Wicklow Head SPA in non-breeding seasons

Preferred Project	Displacement rate (%)	Mortality rate (%)	Apportioned values		
			Post-breeding	Non-breeding	Pre-breeding
1	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0

Preferred Project	Displacement rate (%)	Mortality rate (%)	Apportioned values		
			Post-breeding	Non-breeding	Pre-breeding
	70	10	0.0	0.0	0.0
2	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0
3	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0
4	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0
5	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0
6	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0
Total	30	1	0.0	0.0	0.0
	40	5	0.0	0.0	0.0
	70	10	0.0	0.0	0.0

6.1.820 The annual apportioned impact for razorbill at the Wicklow Head SPA is provided in Table 6.356.

Table 6.356: Calculation of the annual impact attributable to razorbill at the Wicklow Head SPA from the Round 4 Plan alone

Displacement / mortality assumptions	Breeding season	Non-breeding seasons (post-, non- and pre-seasons combined)						Total	Increase in baseline mortality (%)
	PP4	PP1	PP2	PP3	PP4	PP5	PP6		
30 / 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
40 / 5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.7
70 / 10	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	2.4

6.1.821 The most likely impact (and most realistic worst case) from the Round 4 Plan alone from Table 6.356 is considered to be less than one bird. This value is considered to be the most likely, taking into account the uncertainty described in Section 5.2. There are also a number of feature specific uncertainties associated with this range including:

- The representativeness of the density data used. Comparisons with baseline survey data for Round 3 projects would suggest that razorbill densities from the MERP dataset potentially underestimate razorbill abundance.
- The apportioning value applied in the breeding season, it is unlikely that a significant proportion of razorbill from the Wicklow Head SPA will utilize the Preferred Project areas and the assumption of 10% is likely an over-estimate but is applied on a precautionary basis.

6.1.822 A wider range of displacement rates are defined in JNCC *et al.* (2017) and these have been considered in the displacement analyses conducted. A precautionary approach has also been applied when considering the apportioning value to apply for all Preferred Projects with all three of the Preferred Projects beyond the mean-maximum foraging range of razorbill from Wicklow Head SPA.

6.1.823 An impact of less than one bird represents 0.7% of the baseline mortality of the Wicklow Head SPA razorbill population (249 breeding adults). When considering the highest impact in Table 6.356, which is considered unrealistic due to an over-application of precaution, an annual displacement mortality of 0.3 birds is estimated. This represents an increase in baseline mortality of 2.4%. Under any of the scenarios presented, the actual displacement mortality is considered to be negligible and likely indiscernible from background mortality, especially when the precaution incorporated into the assessment is taken into account.

In-combination

6.1.824 Due to the limited impact from the Preferred Projects it is considered that the Round 4 Plan would not be expected to make an appreciable difference to the in-combination impact on the Wicklow Head SPA.

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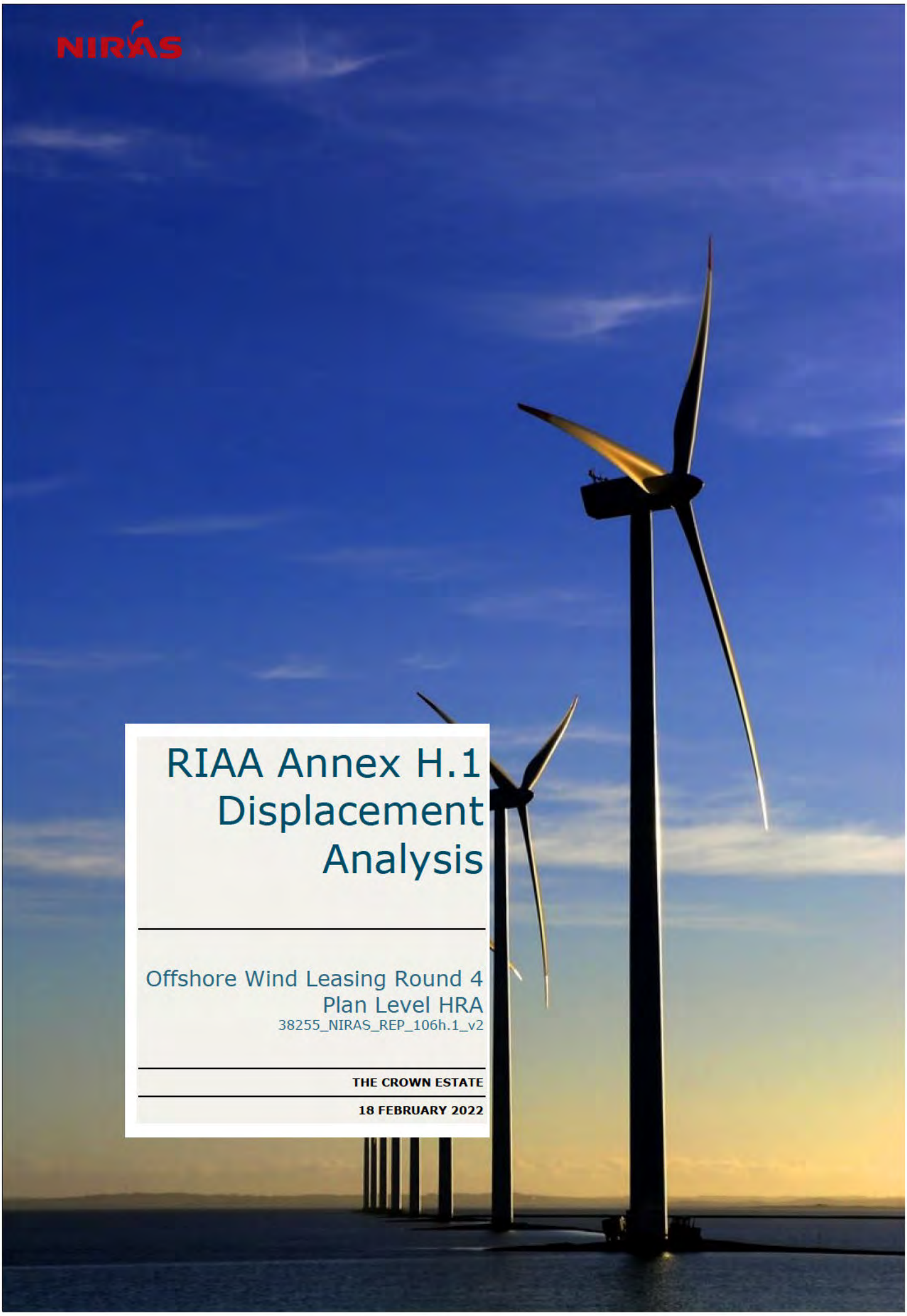
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Offshore Wind Leasing Round 4 Plan Level HRA

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THE CROWN ESTATE

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2	Final	18/02/2022	MHAZ	DAST	TNO

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1. Introduction

1.1.1 This Annex presents the bird displacement methodology and results used to inform the Plan alone Array Assessment (Part 2) in the RIAA.

2. Background

2.1.1 The presence of wind turbines has the potential to directly disturb and displace birds from within and around an offshore wind farm. Displacement may impact bird populations by affecting site usage which may be for foraging, resting or moulting purposes. As a result of displacement an individual bird may experience a decrease in fitness, due to the effect of re-locating to alternative foraging grounds and/or changes to energy budgets due to the increased energy expenditure when avoiding a wind farm. These impacts, in turn, may have indirect effects on birds in areas that may be some distance from the wind farm including reduced energy acquisition as a result of increased competition at other foraging sites which can result in further reductions in fitness affecting reproductive success. However, due to limited empirical evidence quantifying the likely energetic consequences of displacement, Statutory Nature Conservation Body ("SNCB") advice is to consider displacement impacts in terms of direct mortality on bird populations (JNCC *et al*., 2017) This guidance has been followed to develop the methods set out below.

3. Methodology

3.1 Species for consideration

3.1.1 Following the results of the Screening Report (NIRAS, 2021) and the Array Assessment (Part 1), displacement analysis has been undertaken for the following species, which were screened in for pressure P7 (Physical Presence):

- Northern gannet
- Common guillemot
- Atlantic puffin
- Razorbill
- Red-throated diver
- Common scoter
- Red-breasted merganser

3.1.2 It should be noted that in addition to the species above, cormorant, little gull and storm petrel were also screened in to the assessment in relation to P7. However, displacement analysis has not been conducted for these species as these were screened in due to the physical presence of vessels operating in the Preferred Project areas rather than due to displacement associated with offshore windfarm arrays (for which these species exhibit no vulnerability (Wade *et al.,* 2016; Bradbury *et al.,* 2014)). A qualitative assessment of displacement associated with vessel traffic has therefore been provided in the results for these species.

3.1.3 The list of Preferred Projects for which displacement analysis was required (Table 3.1) has been identified in view of connectivity to the above species, and their location as features of the Protected Sites 'screened in' (i.e. the Protected Sites for which a risk of a likely significant effect ("LSE") was established) in the Screening Report. For breeding birds, all Preferred Projects within foraging range of the screened in Protected Sites have been subject to displacement analysis. For

non-breeding birds, an overlap with a BDMPS population has been used to establish connectivity with Preferred Projects. The foraging ranges and BDMPS populations used matched those presented in the Screening Report. This is an additional step to that presented in the Screening Report, which only identified the risk of LSE occurring with the Round 4 Plan, but not specific Preferred Projects.

Table 3.1: Species to be considered for displacement analysis at each of the Preferred Projects

Feature	Season as used in Round 4 Plan Level HRA screening exercise	Preferred Project					
		Bidding Region 1: Dogger Bank		Bidding Region 2: Eastern Regions	Bidding Region 4: Northern Wales and Irish Sea		
		1	2	3	4	5	6
Gannet	Breeding	✓	✓	✓	✓	✓	✓
	Non-breeding (BDMPS)	✓	✓	✓	✓	✓	✓
Guillemot	Breeding	✓	✓	✓	✓	✓	✓
	Non-breeding (BDMPS)	✓	✓	✓	✓	✓	✓
Razorbill	Breeding	✓	✓	✓	✓	✓	✓
	Non-breeding (BDMPS)	✓	✓	✓	✓	✓	✓
Puffin	Breeding	✓	✓	✓	✓	✓	✓
	Non-breeding (BDMPS)	✓	✓	✓	✓	✓	✓
Red-throated diver	Non-breeding (coastal)					✓	
Common scoter	Non-breeding (coastal)					✓	
Red-breasted merganser	Non-breeding (coastal)					✓	

3.2 Population estimates

Overview

3.2.1 JNCC *et al.* (2017) recommends that a 2km buffer around a wind farm array area is used to calculate population estimates for the majority of species. The exception to this is divers and seaducks for which a 4km buffer should be used. However, SNCBs have, during the consultation process for the Round 4 Plan, recommended that a 10 km buffer be used for red-throated diver.

3.2.2 JNCC *et al.* (2017) also recommends that population estimates for use in displacement analysis are collected monthly for two years. However, it is not practicable to undertake data collection to this extent at the plan-level. Instead, abundance data has been sourced in line with the recommendations presented in Johnston *et al.* (2020) – a report produced as part of The Crown Estate's series of HRA Front Loading projects:

- "…density data collected as part of individual survey programs, such as the strategic aerial surveys for Rounds 1 and 2, should be used in the plan-level HRA for wintering red-throated divers and common scoters."
- "…where a project boundary is within, or close to, an area covered as part of baseline surveys for Round 3, density estimates from these surveys (where available) should be used within the plan-level HRA in relation to that project."
- "Where data from appropriate individual surveys are not available, for the species covered (Atlantic Puffin, Black-legged Kittiwake, Common Guillemot, European Shag, European Storm Petrel, Great Skua, Herring Gull, Lesser Black-backed Gull, Manx Shearwater, Northern Fulmar, Northern Gannet and Razorbill) density estimates from the MERP dataset should be used for the Round 4 plan-level HRA."
- "For species not covered by MERP in areas for which data from individual surveys are not available, density estimates from the SeaMAST dataset should be used for the Round 4 plan-level HRA."

3.2.3 Table 3.2 identifies the availability of potential data sources at each of the Preferred Projects for each of the species for which displacement analysis is required.

Table 3.2: Sources of abundance data for each species at each Preferred Project

Preferred Project	Species	Strategic data	Round 3 project	MERP	SEAMAST
1	Gannet	No	Dogger Bank Creyke Beck A located approximately 7.5km to the north	Yes	Yes
	Guillemot	No		Yes	Yes
	Razorbill	No		Yes	Yes
	Puffin	No		Yes	Yes
2	Gannet	No	Dogger Bank Creyke Beck A located approximately	Yes	Yes
	Guillemot	No		Yes	Yes
	Razorbill	No		Yes	Yes

Preferred Project	Species	Strategic data	Round 3 project	MERP	SEAMAST
	Puffin	No	7.5km to the north	Yes	Yes
3	Gannet	No	No	Yes	Yes
	Guillemot	No	No	Yes	Yes
	Razorbill	No	No	Yes	Yes
	Puffin	No	No	Yes	Yes
4	Gannet	No	No	Yes	Yes
	Guillemot	No	No	Yes	Yes
	Razorbill	No	No	Yes	Yes
	Puffin	No	No	Yes	Yes
	Red-throated diver	Yes	No	No	Yes
5	Gannet	No	No	Yes	Yes
	Guillemot	No	No	Yes	Yes
	Razorbill	No	No	Yes	Yes
	Puffin	No	No	Yes	Yes
	Red-throated diver	Yes	No	No	Yes
	Common scoter	Yes	No	No	Yes
	Red-breasted merganser	No	No	No	Yes
6	Gannet	No	No	Yes	Yes
	Guillemot	No	No	Yes	Yes
	Razorbill	No	No	Yes	Yes
	Puffin	No	No	Yes	Yes

3.2.4 Table 3.2 identifies that abundance data from the MERP project is available for all species at all Preferred Projects except for red-throated diver, common scoter and red-breasted merganser, for which density data from appropriate strategic level surveys has been obtained instead. Data from Round 3 projects are also available for Preferred Projects 1 and 2, so a comparison between the data derived from MERP and data from Dogger Bank Creyke Beck A has been conducted (Sub-Annex 1) to determine how representative the densities derived from MERP are for each species.

Marine Ecosystems Research Programme (MERP)

3.2.5 The use of monthly abundance data from MERP is available for gannet, guillemot, razorbill and puffin at all of the Preferred Projects. Monthly densities for these species have therefore been estimated from the MERP dataset across the three Round 4 Bidding Areas in which Preferred Projects have been proposed. Where a Preferred Project footprint lies across more than one MERP 10x10km square then a weighted density estimate is derived based on the densities in each square and the proportion of the Preferred Project footprint overlapping with each.

3.2.6 Displacement analysis requires seasonal mean-peak population estimates (JNCC *et al.*, 2017). However, as the MERP dataset only provides a single monthly density value it has not been possible to calculate seasonal mean-peak populations, as described in the JNCC *et al.* (2017) guidance. Taking a precautionary approach, the maximum monthly population estimate within relevant seasons for each species has been used. The maximum population estimates used for each species for which MERP data is available at each of the Preferred Projects are presented in Table 3.3. The monthly estimates used for this calculation are provided in (Sub-Annex 2)

Table 3.3: Seasonal maximum population estimates for species considered for displacement analysis at each of the Preferred Projects (MERP)

Species	Preferred Project	Breeding season	Post-breeding season	Non-breeding season	Pre-breeding season
Gannet	1	211	147	N/A	125
	2	144	99	N/A	84
	3	204	139	N/A	117
	4	230	15	N/A	11
	5	72	4	N/A	3
	6	154	10	N/A	8
Guillemot	1	1,817	N/A	2,233	N/A
	2	1,582	N/A	1,995	N/A
	3	1,526	N/A	1,907	N/A
	4	562	N/A	673	N/A

Species	Preferred Project	Breeding season	Post-breeding season	Non-breeding season	Pre-breeding season
	5	169	N/A	207	N/A
	6	367	N/A	444	N/A
Razorbill	1	111	248	313	354
	2	91	190	258	304
	3	86	186	243	281
	4	46	96	121	136
	5	14	27	39	47
	6	28	56	72	82
Puffin	1	153	N/A	251	N/A
	2	102	N/A	181	N/A
	3	105	N/A	184	N/A
	4	5	N/A	6	N/A
	5	1	N/A	2	N/A
	6	3	N/A	3	N/A

Red-throated diver and common scoter

3.2.7 LSEs for red-throated diver and common scoter have been identified in relation to potential impacts associated with the species as features of the Liverpool Bay SPA.

3.2.8 Strategic aerial survey data used to support the designation of the Liverpool Bay SPA has been used to calculate a population estimate for displacement analysis. These data come from Lawson *et al.,* (2016), who used winter aerial survey data (2001-2011) of Liverpool Bay to create density surfaces. Density surfaces were provided for red-throated diver and common scoter by JNCC.

3.2.9 A shapefile for the relevant Preferred Projects was imported into a GIS and spatial buffers of increasing distance (0-1km, 1-2km, etc up to 10 km) were created. The aforementioned strategic aerial data was imported and clipped to the extent of the Liverpool Bay SPA. Within each buffer ring the underlying Liverpool Bay SPA gridded density surface was extracted and the total number of birds calculated by multiplying the density value in each grid cell within a buffer ring by the proportional area of the overlap between the grid cell and the buffer ring and then summing the resulting values. All of these analyses were performed in R using the 'sf' package. The analysis, calculations and resulting values are presented in Appendix H and not included in this report.

3.2.10 More recent data, including that collected as part of the post-consent monitoring requirements for Burbo Bank Extension, have been reviewed but these data do not cover the entirety of the SPA and therefore cannot be used for analyses.

Red-breasted merganser

3.2.11 The SEAMAST dataset includes data for red-breasted merganser. However, it has not been possible to utilise the SEAMAST dataset to obtain density data for red—breasted merganser due to the necessity to scale density data from the SEAMAST dataset to known density data, which in the case of the relevant Preferred Projects are not available. Where necessary assessments required for red-breasted merganser will be undertaken on a qualitative basis.

3.3 Displacement and mortality rates

3.3.1 Following SNCB guidance (JNCC *et al*., 2017), potential displacement impacts for each species have been calculated based on a full range of potential displacement (0-100%) and mortality rates (0-100%). Under the worst case scenario displacement rates have been applied to the entirety of each Preferred Project plus a species specific buffer. For red-throated diver this is 10 kilometres, for common scoter this is four kilometres. For all other species this is two kilometres.

3.3.2 JNCC *et al.* (2017) provides guidance on the relevant displacement ranges to apply based on the vulnerability scores in Wade *et al.* (2016) (as advised in JNCC *et al.*, 2017). Table 3 presents the vulnerability scores taken from Wade *et al.* (2016) for each species in relation to displacement from structures and habitat flexibility, and the displacement rate selected in view of these scores.

3.3.3 In addition, there exists a body of evidence that allows displacement rates to be defined for certain species. This evidence base was reviewed as part of the Hornsea Three offshore wind farm application (Ørsted, 2018). That review identified specific displacement rates for a number of species with these presented in Table 3. The rates in Table 3 will be presented in the RIAA alongside the ranges presented in JNCC *et al.* (2017).

Table 3: Displacement rates (%) to be applied in displacement analysis

Species	Vulnerability scores from Wade *et al.* (2016) or Bradbury *et al.* (2014)		Displacement rate (%)	
	Displacement: structures[1]	Habitat flexibility[2]	JNCC *et al.* (2017)	Ørsted (2018)
Gannet	4	1	60-80[3],[4]	
Guillemot	4	3	30-70	50

[1] Displacement: structures – 5 = Very high, 1 = Very low
[2] Habitat flexibility – 5 = associates with specific habitat features, 1 = forage over large areas
3 Based on Natural England's advice provided as part of representations to the Norfolk Vanguard offshore wind farm project (Natural England, 2018)
[4] Ørsted (2018) provides a rate for gannet however, the rate range based on Natural England guidance is considered appropriate

Species	Vulnerability scores from Wade *et al.* (2016) or Bradbury *et al.* (2014)		Displacement rate (%)	
	Displacement: structures[1]	Habitat flexibility[2]	JNCC *et al.* (2017)	Ørsted (2018)
Razorbill	4	3	30-70	40
Puffin	3	3	30-70	50
Red-throated diver	5	5	90-100	-
Common scoter	5	5	90-100	-
Red-breasted merganser	3	4	30-70	-

4. Results

4.1.1 Seasonal displacement matrices calculated using MERP data for each species at each of the Preferred Projects for which there is connectivity with an SPA are presented in the following sections. Matrices for red-throated diver and common scoter, for which displacement is calculated using survey data from Liverpool SPA, are found in Appendix H.

4.2 Preferred Project 1

Gannet

Table 4.1: Breeding season displacement mortality for gannet at Preferred Project 1

Project 1 – Gannet – Breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	1	2	4	6	8	11	13	15	17	19	21
	20	0	1	2	4	8	13	17	21	25	30	34	38	42
	30	1	1	3	6	13	19	25	32	38	44	51	57	63
	40	1	2	4	8	17	25	34	42	51	59	67	76	84
	50	1	2	5	11	21	32	42	53	63	74	84	95	105
	60	1	3	6	13	25	38	51	63	76	89	101	114	127
	70	1	3	7	15	30	44	59	74	89	103	118	133	148
	80	2	3	8	17	34	51	67	84	101	118	135	152	169
	90	2	4	9	19	38	57	76	95	114	133	152	171	190
	100	2	4	11	21	42	63	84	105	127	148	169	190	211

Table 4.2: Post-breeding season displacement mortality for gannet at Preferred Project 1

Project 1 – Gannet – Post-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	1	1	3	4	6	7	9	10	12	13	15
	20	0	1	1	3	6	9	12	15	18	21	23	26	29
	30	0	1	2	4	9	13	18	22	26	31	35	40	44
	40	1	1	3	6	12	18	23	29	35	41	47	53	59
	50	1	1	4	7	15	22	29	37	44	51	59	66	73
	60	1	2	4	9	18	26	35	44	53	62	70	79	88
	70	1	2	5	10	21	31	41	51	62	72	82	93	103
	80	1	2	6	12	23	35	47	59	70	82	94	106	117
	90	1	3	7	13	26	40	53	66	79	93	106	119	132
	100	1	3	7	15	29	44	59	73	88	103	117	132	147

Table 4.3: Pre-breeding season displacement mortality for gannet at Preferred Project 1

Project 1 – Gannet – Pre-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	1	1	2	4	5	6	7	9	10	11	12
	20	0	0	1	2	5	7	10	12	15	17	20	22	25
	30	0	1	2	4	7	11	15	19	22	26	30	34	37
	40	0	1	2	5	10	15	20	25	30	35	40	45	50
	50	1	1	3	6	12	19	25	31	37	44	50	56	62
	60	1	1	4	7	15	22	30	37	45	52	60	67	75
	70	1	2	4	9	17	26	35	44	52	61	70	78	87
	80	1	2	5	10	20	30	40	50	60	70	80	90	100
	90	1	2	6	11	22	34	45	56	67	78	90	101	112
	100	1	2	6	12	25	37	50	62	75	87	100	112	125

Guillemot

Table 4.4: Breeding season displacement mortality for guillemot at Preferred Project 1

Project 1 – Guillemot – Breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	2	4	9	18	36	55	73	91	109	127	145	164	182
	20	4	7	18	36	73	109	145	182	218	254	291	327	363
	30	5	11	27	55	109	164	218	273	327	382	436	491	545
	40	7	15	36	73	145	218	291	363	436	509	581	654	727
	50	9	18	45	91	182	273	363	454	545	636	727	818	908
	60	11	22	55	109	218	327	436	545	654	763	872	981	1090
	70	13	25	64	127	254	382	509	636	763	890	1018	1145	1272
	80	15	29	73	145	291	436	581	727	872	1018	1163	1308	1454
	90	16	33	82	164	327	491	654	818	981	1145	1308	1472	1635
	100	18	36	91	182	363	545	727	908	1090	1272	1454	1635	1817

Table 4.5: Non-breeding season displacement mortality for guillemot at Preferred Project 1

Project 1 – Guillemot – Non-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	2	4	11	22	45	67	89	112	134	156	179	201	223
	20	4	9	22	45	89	134	179	223	268	313	357	402	447
	30	7	13	33	67	134	201	268	335	402	469	536	603	670
	40	9	18	45	89	179	268	357	447	536	625	715	804	893
	50	11	22	56	112	223	335	447	558	670	782	893	1005	1116
	60	13	27	67	134	268	402	536	670	804	938	1072	1206	1340
	70	16	31	78	156	313	469	625	782	938	1094	1250	1407	1563
	80	18	36	89	179	357	536	715	893	1072	1250	1429	1608	1786
	90	20	40	100	201	402	603	804	1005	1206	1407	1608	1809	2010
	100	22	45	112	223	447	670	893	1116	1340	1563	1786	2010	2233

Razorbill

Table 4.6: Breeding season displacement mortality for razorbill at Preferred Project 1

Project 1 – Razorbill – Breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	1	1	2	3	4	6	7	8	9	10	11
	20	0	0	1	2	4	7	9	11	13	16	18	20	22
	30	0	1	2	3	7	10	13	17	20	23	27	30	33
	40	0	1	2	4	9	13	18	22	27	31	36	40	44
	50	1	1	3	6	11	17	22	28	33	39	44	50	56
	60	1	1	3	7	13	20	27	33	40	47	53	60	67
	70	1	2	4	8	16	23	31	39	47	54	62	70	78
	80	1	2	4	9	18	27	36	44	53	62	71	80	89
	90	1	2	5	10	20	30	40	50	60	70	80	90	100
	100	1	2	6	11	22	33	44	56	67	78	89	100	111

Table 4.7: Post-breeding season displacement mortality for razorbill at Preferred Project 1

Project 1 – Razorbill – Post-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	1	2	5	7	10	12	15	17	20	22	25
	20	0	1	2	5	10	15	20	25	30	35	40	45	50
	30	1	1	4	7	15	22	30	37	45	52	60	67	75
	40	1	2	5	10	20	30	40	50	60	70	79	89	99
	50	1	2	6	12	25	37	50	62	75	87	99	112	124
	60	1	3	7	15	30	45	60	75	89	104	119	134	149
	70	2	3	9	17	35	52	70	87	104	122	139	156	174
	80	2	4	10	20	40	60	79	99	119	139	159	179	199
	90	2	4	11	22	45	67	89	112	134	156	179	201	224
	100	2	5	12	25	50	75	99	124	149	174	199	224	248

Table 4.8: Non-breeding season displacement mortality for razorbill at Preferred Project 1

Project 1 – Razorbill – Non-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	1	2	3	6	9	13	16	19	22	25	28	31
	20	1	1	3	6	13	19	25	31	38	44	50	56	63
	30	1	2	5	9	19	28	38	47	56	66	75	85	94
	40	1	3	6	13	25	38	50	63	75	88	100	113	125
	50	2	3	8	16	31	47	63	78	94	110	125	141	157
	60	2	4	9	19	38	56	75	94	113	132	150	169	188
	70	2	4	11	22	44	66	88	110	132	153	175	197	219
	80	3	5	13	25	50	75	100	125	150	175	200	225	251
	90	3	6	14	28	56	85	113	141	169	197	225	254	282
	100	3	6	16	31	63	94	125	157	188	219	251	282	313

Table 4.9: Pre-breeding season displacement mortality for razorbill at Preferred Project 1

Project 1 – Razorbill – Pre-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	1	2	4	7	11	14	18	21	25	28	32	35
	20	1	1	4	7	14	21	28	35	43	50	57	64	71
	30	1	2	5	11	21	32	43	53	64	74	85	96	106
	40	1	3	7	14	28	43	57	71	85	99	113	128	142
	50	2	4	9	18	35	53	71	89	106	124	142	159	177
	60	2	4	11	21	43	64	85	106	128	149	170	191	213
	70	2	5	12	25	50	74	99	124	149	174	198	223	248
	80	3	6	14	28	57	85	113	142	170	198	227	255	283
	90	3	6	16	32	64	96	128	159	191	223	255	287	319
	100	4	7	18	35	71	106	142	177	213	248	283	319	354

Puffin

Table 4.10: Breeding season displacement mortality for puffin at Preferred Project 1

Project 1 – Puffin – Breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	1	2	3	5	6	8	9	11	12	14	15
	20	0	1	2	3	6	9	12	15	18	21	25	28	31
	30	0	1	2	5	9	14	18	23	28	32	37	41	46
	40	1	1	3	6	12	18	25	31	37	43	49	55	61
	50	1	2	4	8	15	23	31	38	46	54	61	69	77
	60	1	2	5	9	18	28	37	46	55	64	74	83	92
	70	1	2	5	11	21	32	43	54	64	75	86	97	107
	80	1	2	6	12	25	37	49	61	74	86	98	111	123
	90	1	3	7	14	28	41	55	69	83	97	111	124	138
	100	2	3	8	15	31	46	61	77	92	107	123	138	153

Table 4.11: Non-breeding season displacement mortality for puffin at Preferred Project 1

Project 1 – Puffin – Non-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	1	1	3	5	8	10	13	15	18	20	23	25
	20	1	1	3	5	10	15	20	25	30	35	40	45	50
	30	1	2	4	8	15	23	30	38	45	53	60	68	75
	40	1	2	5	10	20	30	40	50	60	70	80	90	101
	50	1	3	6	13	25	38	50	63	75	88	101	113	126
	60	2	3	8	15	30	45	60	75	90	106	121	136	151
	70	2	4	9	18	35	53	70	88	106	123	141	158	176
	80	2	4	10	20	40	60	80	101	121	141	161	181	201
	90	2	5	11	23	45	68	90	113	136	158	181	204	226
	100	3	5	13	25	50	75	101	126	151	176	201	226	251

4.3 Preferred Project 2

Gannet

Table 4.12: Breeding season displacement mortality for gannet at Preferred Project 2

Project 2 – Gannet – Breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	1	1	3	4	6	7	9	10	12	13	14
	20	0	1	1	3	6	9	12	14	17	20	23	26	29
	30	0	1	2	4	9	13	17	22	26	30	35	39	43
	40	1	1	3	6	12	17	23	29	35	40	46	52	58
	50	1	1	4	7	14	22	29	36	43	50	58	65	72
	60	1	2	4	9	17	26	35	43	52	60	69	78	86
	70	1	2	5	10	20	30	40	50	60	70	81	91	101
	80	1	2	6	12	23	35	46	58	69	81	92	104	115
	90	1	3	6	13	26	39	52	65	78	91	104	117	129
	100	1	3	7	14	29	43	58	72	86	101	115	129	144

Table 4.13: Post-breeding season displacement mortality for gannet at Preferred Project 2

Project 2 – Gannet – Post-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	1	2	3	4	5	6	7	8	9	10
	20	0	0	1	2	4	6	8	10	12	14	16	18	20
	30	0	1	1	3	6	9	12	15	18	21	24	27	30
	40	0	1	2	4	8	12	16	20	24	28	32	36	40
	50	0	1	2	5	10	15	20	25	30	35	40	45	49
	60	1	1	3	6	12	18	24	30	36	42	48	53	59
	70	1	1	3	7	14	21	28	35	42	49	55	62	69
	80	1	2	4	8	16	24	32	40	48	55	63	71	79
	90	1	2	4	9	18	27	36	45	53	62	71	80	89
	100	1	2	5	10	20	30	40	49	59	69	79	89	99

Table 4.14: Pre-breeding season displacement mortality for gannet at Preferred Project 2

Project 2 – Gannet – Pre-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	1	2	3	3	4	5	6	7	8	8
	20	0	0	1	2	3	5	7	8	10	12	13	15	17
	30	0	1	1	3	5	8	10	13	15	18	20	23	25
	40	0	1	2	3	7	10	13	17	20	24	27	30	34
	50	0	1	2	4	8	13	17	21	25	29	34	38	42
	60	1	1	3	5	10	15	20	25	30	35	40	45	50
	70	1	1	3	6	12	18	24	29	35	41	47	53	59
	80	1	1	3	7	13	20	27	34	40	47	54	60	67
	90	1	2	4	8	15	23	30	38	45	53	60	68	76
	100	1	2	4	8	17	25	34	42	50	59	67	76	84

Guillemot

Table 4.15: Breeding season displacement mortality for guillemot at Preferred Project 2

Project 2 – Guillemot – Breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	2	3	8	16	32	47	63	79	95	111	127	142	158
	20	3	6	16	32	63	95	127	158	190	222	253	285	316
	30	5	9	24	47	95	142	190	237	285	332	380	427	475
	40	6	13	32	63	127	190	253	316	380	443	506	570	633
	50	8	16	40	79	158	237	316	396	475	554	633	712	791
	60	9	19	47	95	190	285	380	475	570	665	760	855	949
	70	11	22	55	111	222	332	443	554	665	775	886	997	1108
	80	13	25	63	127	253	380	506	633	760	886	1013	1139	1266
	90	14	28	71	142	285	427	570	712	855	997	1139	1282	1424
	100	16	32	79	158	316	475	633	791	949	1108	1266	1424	1582

Table 4.16: Non-breeding season displacement mortality for guillemot at Preferred Project 2

Project 2 – Guillemot – Non-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	2	4	10	20	40	60	80	100	120	140	160	180	200
	20	4	8	20	40	80	120	160	200	239	279	319	359	399
	30	6	12	30	60	120	180	239	299	359	419	479	539	599
	40	8	16	40	80	160	239	319	399	479	559	638	718	798
	50	10	20	50	100	200	299	399	499	599	698	798	898	998
	60	12	24	60	120	239	359	479	599	718	838	958	1077	1197
	70	14	28	70	140	279	419	559	698	838	978	1117	1257	1397
	80	16	32	80	160	319	479	638	798	958	1117	1277	1437	1596
	90	18	36	90	180	359	539	718	898	1077	1257	1437	1616	1796
	100	20	40	100	200	399	599	798	998	1197	1397	1596	1796	1995

Razorbill

Table 4.17: Breeding season displacement mortality for razorbill at Preferred Project 2

Project 2 – Razorbill – Breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	1	2	3	4	5	5	6	7	8	9
	20	0	0	1	2	4	5	7	9	11	13	15	16	18
	30	0	1	1	3	5	8	11	14	16	19	22	25	27
	40	0	1	2	4	7	11	15	18	22	25	29	33	36
	50	0	1	2	5	9	14	18	23	27	32	36	41	45
	60	1	1	3	5	11	16	22	27	33	38	44	49	55
	70	1	1	3	6	13	19	25	32	38	45	51	57	64
	80	1	1	4	7	15	22	29	36	44	51	58	65	73
	90	1	2	4	8	16	25	33	41	49	57	65	74	82
	100	1	2	5	9	18	27	36	45	55	64	73	82	91

Table 4.18: Post-breeding season displacement mortality for razorbill at Preferred Project 2

Project 2 – Razorbill – Post-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	1	2	4	6	8	9	11	13	15	17	19
	20	0	1	2	4	8	11	15	19	23	27	30	34	38
	30	1	1	3	6	11	17	23	28	34	40	45	51	57
	40	1	2	4	8	15	23	30	38	45	53	61	68	76
	50	1	2	5	9	19	28	38	47	57	66	76	85	95
	60	1	2	6	11	23	34	45	57	68	80	91	102	114
	70	1	3	7	13	27	40	53	66	80	93	106	119	133
	80	2	3	8	15	30	45	61	76	91	106	121	136	152
	90	2	3	9	17	34	51	68	85	102	119	136	154	171
	100	2	4	9	19	38	57	76	95	114	133	152	171	190

Table 4.19: Non-breeding season displacement mortality for razorbill at Preferred Project 2

Project 2 – Razorbill – Non-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	1	1	3	5	8	10	13	15	18	21	23	26
	20	1	1	3	5	10	15	21	26	31	36	41	46	52
	30	1	2	4	8	15	23	31	39	46	54	62	70	77
	40	1	2	5	10	21	31	41	52	62	72	83	93	103
	50	1	3	6	13	26	39	52	65	77	90	103	116	129
	60	2	3	8	15	31	46	62	77	93	108	124	139	155
	70	2	4	9	18	36	54	72	90	108	126	145	163	181
	80	2	4	10	21	41	62	83	103	124	145	165	186	206
	90	2	5	12	23	46	70	93	116	139	163	186	209	232
	100	3	5	13	26	52	77	103	129	155	181	206	232	258

Table 4.20: Pre-breeding season displacement mortality for razorbill at Preferred Project 2

Project 2 – Razorbill – Pre-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	1	2	3	6	9	12	15	18	21	24	27	30
	20	1	1	3	6	12	18	24	30	36	43	49	55	61
	30	1	2	5	9	18	27	36	46	55	64	73	82	91
	40	1	2	6	12	24	36	49	61	73	85	97	109	122
	50	2	3	8	15	30	46	61	76	91	106	122	137	152
	60	2	4	9	18	36	55	73	91	109	128	146	164	182
	70	2	4	11	21	43	64	85	106	128	149	170	191	213
	80	2	5	12	24	49	73	97	122	146	170	194	219	243
	90	3	5	14	27	55	82	109	137	164	191	219	246	273
	100	3	6	15	30	61	91	122	152	182	213	243	273	304

Puffin

Table 4.21: Breeding season displacement mortality for puffin at Preferred Project 2

Project 2 – Puffin – Breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	1	1	2	3	4	5	6	7	8	9	10
	20	0	0	1	2	4	6	8	10	12	14	16	18	20
	30	0	1	2	3	6	9	12	15	18	21	25	28	31
	40	0	1	2	4	8	12	16	20	25	29	33	37	41
	50	1	1	3	5	10	15	20	26	31	36	41	46	51
	60	1	1	3	6	12	18	25	31	37	43	49	55	61
	70	1	1	4	7	14	21	29	36	43	50	57	64	72
	80	1	2	4	8	16	25	33	41	49	57	65	74	82
	90	1	2	5	9	18	28	37	46	55	64	74	83	92
	100	1	2	5	10	20	31	41	51	61	72	82	92	102

Table 4.22: Non-breeding season displacement mortality for puffin at Preferred Project 2

Project 2 – Puffin – Non-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	1	2	4	5	7	9	11	13	14	16	18
	20	0	1	2	4	7	11	14	18	22	25	29	33	36
	30	1	1	3	5	11	16	22	27	33	38	43	49	54
	40	1	1	4	7	14	22	29	36	43	51	58	65	72
	50	1	2	5	9	18	27	36	45	54	63	72	81	90
	60	1	2	5	11	22	33	43	54	65	76	87	98	108
	70	1	3	6	13	25	38	51	63	76	89	101	114	127
	80	1	3	7	14	29	43	58	72	87	101	116	130	145
	90	2	3	8	16	33	49	65	81	98	114	130	146	163
	100	2	4	9	18	36	54	72	90	108	127	145	163	181

4.4 Preferred Project 3

Gannet

Table 4.23: Breeding season displacement mortality for gannet at Preferred Project 3

Project 3 – Gannet – Breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	1	2	4	6	8	10	12	14	16	18	20
	20	0	1	2	4	8	12	16	20	24	29	33	37	41
	30	1	1	3	6	12	18	24	31	37	43	49	55	61
	40	1	2	4	8	16	24	33	41	49	57	65	73	82
	50	1	2	5	10	20	31	41	51	61	71	82	92	102
	60	1	2	6	12	24	37	49	61	73	86	98	110	122
	70	1	3	7	14	29	43	57	71	86	100	114	129	143
	80	2	3	8	16	33	49	65	82	98	114	131	147	163
	90	2	4	9	18	37	55	73	92	110	129	147	165	184
	100	2	4	10	20	41	61	82	102	122	143	163	184	204

Table 4.24: Post-breeding season displacement mortality for gannet at Preferred Project 3

Project 3 – Gannet – Post-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	1	1	3	4	6	7	8	10	11	13	14
	20	0	1	1	3	6	8	11	14	17	19	22	25	28
	30	0	1	2	4	8	13	17	21	25	29	33	38	42
	40	1	1	3	6	11	17	22	28	33	39	45	50	56
	50	1	1	3	7	14	21	28	35	42	49	56	63	70
	60	1	2	4	8	17	25	33	42	50	58	67	75	83
	70	1	2	5	10	19	29	39	49	58	68	78	88	97
	80	1	2	6	11	22	33	45	56	67	78	89	100	111
	90	1	3	6	13	25	38	50	63	75	88	100	113	125
	100	1	3	7	14	28	42	56	70	83	97	111	125	139

Table 4.25: Pre-breeding season displacement mortality for gannet at Preferred Project 3

Project 3 – Gannet – Pre-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	1	1	2	4	5	6	7	8	9	11	12
	20	0	0	1	2	5	7	9	12	14	16	19	21	23
	30	0	1	2	4	7	11	14	18	21	25	28	32	35
	40	0	1	2	5	9	14	19	23	28	33	37	42	47
	50	1	1	3	6	12	18	23	29	35	41	47	53	59
	60	1	1	4	7	14	21	28	35	42	49	56	63	70
	70	1	2	4	8	16	25	33	41	49	57	66	74	82
	80	1	2	5	9	19	28	37	47	56	66	75	84	94
	90	1	2	5	11	21	32	42	53	63	74	84	95	105
	100	1	2	6	12	23	35	47	59	70	82	94	105	117

Guillemot

Table 4.26: Breeding season displacement mortality for guillemot at Preferred Project 3

Project 3 – Guillemot – Breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	2	3	8	15	31	46	61	76	92	107	122	137	153
	20	3	6	15	31	61	92	122	153	183	214	244	275	305
	30	5	9	23	46	92	137	183	229	275	320	366	412	458
	40	6	12	31	61	122	183	244	305	366	427	488	549	610
	50	8	15	38	76	153	229	305	381	458	534	610	687	763
	60	9	18	46	92	183	275	366	458	549	641	732	824	915
	70	11	21	53	107	214	320	427	534	641	748	854	961	1068
	80	12	24	61	122	244	366	488	610	732	854	977	1099	1221
	90	14	27	69	137	275	412	549	687	824	961	1099	1236	1373
	100	15	31	76	153	305	458	610	763	915	1068	1221	1373	1526

Table 4.27: Non-breeding season displacement mortality for guillemot at Preferred Project 3

Project 3 – Guillemot – Non-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	2	4	10	19	38	57	76	95	114	134	153	172	191
	20	4	8	19	38	76	114	153	191	229	267	305	343	381
	30	6	11	29	57	114	172	229	286	343	401	458	515	572
	40	8	15	38	76	153	229	305	381	458	534	610	687	763
	50	10	19	48	95	191	286	381	477	572	668	763	858	954
	60	11	23	57	114	229	343	458	572	687	801	916	1030	1144
	70	13	27	67	134	267	401	534	668	801	935	1068	1202	1335
	80	15	31	76	153	305	458	610	763	916	1068	1221	1373	1526
	90	17	34	86	172	343	515	687	858	1030	1202	1373	1545	1717
	100	19	38	95	191	381	572	763	954	1144	1335	1526	1717	1907

Razorbill

Table 4.28: Breeding season displacement mortality for razorbill at Preferred Project 3

Project 3 – Razorbill – Breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	1	2	3	3	4	5	6	7	8	9
	20	0	0	1	2	3	5	7	9	10	12	14	16	17
	30	0	1	1	3	5	8	10	13	16	18	21	23	26
	40	0	1	2	3	7	10	14	17	21	24	28	31	34
	50	0	1	2	4	9	13	17	22	26	30	34	39	43
	60	1	1	3	5	10	16	21	26	31	36	41	47	52
	70	1	1	3	6	12	18	24	30	36	42	48	54	60
	80	1	1	3	7	14	21	28	34	41	48	55	62	69
	90	1	2	4	8	16	23	31	39	47	54	62	70	78
	100	1	2	4	9	17	26	34	43	52	60	69	78	86

Table 4.29: Post-breeding season displacement mortality for razorbill at Preferred Project 3

Project 3 – Razorbill – Post-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	1	2	4	6	7	9	11	13	15	17	19
	20	0	1	2	4	7	11	15	19	22	26	30	33	37
	30	1	1	3	6	11	17	22	28	33	39	45	50	56
	40	1	1	4	7	15	22	30	37	45	52	60	67	74
	50	1	2	5	9	19	28	37	47	56	65	74	84	93
	60	1	2	6	11	22	33	45	56	67	78	89	100	112
	70	1	3	7	13	26	39	52	65	78	91	104	117	130
	80	1	3	7	15	30	45	60	74	89	104	119	134	149
	90	2	3	8	17	33	50	67	84	100	117	134	151	167
	100	2	4	9	19	37	56	74	93	112	130	149	167	186

Table 4.30: Non-breeding season displacement mortality for razorbill at Preferred Project 3

Project 3 – Razorbill – Non-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	1	2	5	7	10	12	15	17	19	22	24
	20	0	1	2	5	10	15	19	24	29	34	39	44	49
	30	1	1	4	7	15	22	29	36	44	51	58	66	73
	40	1	2	5	10	19	29	39	49	58	68	78	88	97
	50	1	2	6	12	24	36	49	61	73	85	97	109	122
	60	1	3	7	15	29	44	58	73	88	102	117	131	146
	70	2	3	9	17	34	51	68	85	102	119	136	153	170
	80	2	4	10	19	39	58	78	97	117	136	156	175	195
	90	2	4	11	22	44	66	88	109	131	153	175	197	219
	100	2	5	12	24	49	73	97	122	146	170	195	219	243

Table 4.31: Pre-breeding season displacement mortality for razorbill at Preferred Project 3

Project 3 – Razorbill – Pre-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	1	1	3	6	8	11	14	17	20	22	25	28
	20	1	1	3	6	11	17	22	28	34	39	45	51	56
	30	1	2	4	8	17	25	34	42	51	59	67	76	84
	40	1	2	6	11	22	34	45	56	67	79	90	101	112
	50	1	3	7	14	28	42	56	70	84	98	112	126	140
	60	2	3	8	17	34	51	67	84	101	118	135	152	168
	70	2	4	10	20	39	59	79	98	118	137	157	177	196
	80	2	4	11	22	45	67	90	112	135	157	180	202	224
	90	3	5	13	25	51	76	101	126	152	177	202	227	253
	100	3	6	14	28	56	84	112	140	168	196	224	253	281

Puffin

Table 4.32: Breeding season displacement mortality for puffin at Preferred Project 3

Project 3 – Puffin – Breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	1	1	2	3	4	5	6	7	8	9	10
	20	0	0	1	2	4	6	8	10	13	15	17	19	21
	30	0	1	2	3	6	9	13	16	19	22	25	28	31
	40	0	1	2	4	8	13	17	21	25	29	34	38	42
	50	1	1	3	5	10	16	21	26	31	37	42	47	52
	60	1	1	3	6	13	19	25	31	38	44	50	57	63
	70	1	1	4	7	15	22	29	37	44	51	59	66	73
	80	1	2	4	8	17	25	34	42	50	59	67	76	84
	90	1	2	5	9	19	28	38	47	57	66	76	85	94
	100	1	2	5	10	21	31	42	52	63	73	84	94	105

Table 4.33: Non-breeding season displacement mortality for puffin at Preferred Project 3

Project 3 – Puffin – Non-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	1	2	4	6	7	9	11	13	15	17	18
	20	0	1	2	4	7	11	15	18	22	26	29	33	37
	30	1	1	3	6	11	17	22	28	33	39	44	50	55
	40	1	1	4	7	15	22	29	37	44	51	59	66	74
	50	1	2	5	9	18	28	37	46	55	64	74	83	92
	60	1	2	6	11	22	33	44	55	66	77	88	99	110
	70	1	3	6	13	26	39	51	64	77	90	103	116	129
	80	1	3	7	15	29	44	59	74	88	103	118	132	147
	90	2	3	8	17	33	50	66	83	99	116	132	149	165
	100	2	4	9	18	37	55	74	92	110	129	147	165	184

4.5 Preferred Project 4

Gannet

Table 4.34: Breeding season displacement mortality for gannet at Preferred Project 4

Project 4 – Gannet – Breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	1	2	5	7	9	12	14	16	18	21	23
	20	0	1	2	5	9	14	18	23	28	32	37	41	46
	30	1	1	3	7	14	21	28	35	41	48	55	62	69
	40	1	2	5	9	18	28	37	46	55	64	74	83	92
	50	1	2	6	12	23	35	46	58	69	81	92	104	115
	60	1	3	7	14	28	41	55	69	83	97	111	124	138
	70	2	3	8	16	32	48	64	81	97	113	129	145	161
	80	2	4	9	18	37	55	74	92	111	129	147	166	184
	90	2	4	10	21	41	62	83	104	124	145	166	187	207
	100	2	5	12	23	46	69	92	115	138	161	184	207	230

Table 4.35: Post-breeding season displacement mortality for gannet at Preferred Project 4

Project 4 – Gannet – Post-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	0	0	0	1	1	1	1	1	1	1
	20	0	0	0	0	1	1	1	1	2	2	2	3	3
	30	0	0	0	0	1	1	2	2	3	3	4	4	4
	40	0	0	0	1	1	2	2	3	4	4	5	5	6
	50	0	0	0	1	1	2	3	4	4	5	6	7	7
	60	0	0	0	1	2	3	4	4	5	6	7	8	9
	70	0	0	1	1	2	3	4	5	6	7	8	9	10
	80	0	0	1	1	2	4	5	6	7	8	10	11	12
	90	0	0	1	1	3	4	5	7	8	9	11	12	13
	100	0	0	1	1	3	4	6	7	9	10	12	13	15

Table 4.36: Pre-breeding season displacement mortality for gannet at Preferred Project 4

Project 4 – Gannet – Pre-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	0	0	0	0	1	1	1	1	1	1
	20	0	0	0	0	0	1	1	1	1	2	2	2	2
	30	0	0	0	0	1	1	1	2	2	2	3	3	3
	40	0	0	0	0	1	1	2	2	3	3	4	4	4
	50	0	0	0	1	1	2	2	3	3	4	4	5	6
	60	0	0	0	1	1	2	3	3	4	5	5	6	7
	70	0	0	0	1	2	2	3	4	5	5	6	7	8
	80	0	0	0	1	2	3	4	4	5	6	7	8	9
	90	0	0	0	1	2	3	4	5	6	7	8	9	10
	100	0	0	1	1	2	3	4	6	7	8	9	10	11

Guillemot

Table 4.37: Breeding season displacement mortality for guillemot at Preferred Project 4

Project 4 – Guillemot – Breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	1	1	3	6	11	17	22	28	34	39	45	51	56
	20	1	2	6	11	22	34	45	56	67	79	90	101	112
	30	2	3	8	17	34	51	67	84	101	118	135	152	169
	40	2	4	11	22	45	67	90	112	135	157	180	202	225
	50	3	6	14	28	56	84	112	141	169	197	225	253	281
	60	3	7	17	34	67	101	135	169	202	236	270	303	337
	70	4	8	20	39	79	118	157	197	236	275	315	354	393
	80	4	9	22	45	90	135	180	225	270	315	360	405	450
	90	5	10	25	51	101	152	202	253	303	354	405	455	506
	100	6	11	28	56	112	169	225	281	337	393	450	506	562

Table 4.38: Non-breeding season displacement mortality for guillemot at Preferred Project 4

Project 4 – Guillemot – Non-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	1	1	3	7	13	20	27	34	40	47	54	61	67
	20	1	3	7	13	27	40	54	67	81	94	108	121	135
	30	2	4	10	20	40	61	81	101	121	141	161	182	202
	40	3	5	13	27	54	81	108	135	161	188	215	242	269
	50	3	7	17	34	67	101	135	168	202	235	269	303	336
	60	4	8	20	40	81	121	161	202	242	283	323	363	404
	70	5	9	24	47	94	141	188	235	283	330	377	424	471
	80	5	11	27	54	108	161	215	269	323	377	431	484	538
	90	6	12	30	61	121	182	242	303	363	424	484	545	606
	100	7	13	34	67	135	202	269	336	404	471	538	606	673

Razorbill

Table 4.39: Breeding season displacement mortality for razorbill at Preferred Project 4

Project 4 – Razorbill – Breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	0	1	1	2	2	3	3	4	4	5
	20	0	0	0	1	2	3	4	5	5	6	7	8	9
	30	0	0	1	1	3	4	5	7	8	10	11	12	14
	40	0	0	1	2	4	5	7	9	11	13	15	16	18
	50	0	0	1	2	5	7	9	11	14	16	18	21	23
	60	0	1	1	3	5	8	11	14	16	19	22	25	27
	70	0	1	2	3	6	10	13	16	19	22	26	29	32
	80	0	1	2	4	7	11	15	18	22	26	29	33	37
	90	0	1	2	4	8	12	16	21	25	29	33	37	41
	100	0	1	2	5	9	14	18	23	27	32	37	41	46

Table 4.40: Post-breeding season displacement mortality for razorbill at Preferred Project 4

Project 4 – Razorbill – Post-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	1	2	3	4	5	6	7	8	9	10
	20	0	0	1	2	4	6	8	10	12	13	15	17	19
	30	0	1	1	3	6	9	12	14	17	20	23	26	29
	40	0	1	2	4	8	12	15	19	23	27	31	35	38
	50	0	1	2	5	10	14	19	24	29	34	38	43	48
	60	1	1	3	6	12	17	23	29	35	40	46	52	58
	70	1	1	3	7	13	20	27	34	40	47	54	61	67
	80	1	2	4	8	15	23	31	38	46	54	61	69	77
	90	1	2	4	9	17	26	35	43	52	61	69	78	86
	100	1	2	5	10	19	29	38	48	58	67	77	86	96

Table 4.41: Non-breeding season displacement mortality for razorbill at Preferred Project 4

Project 4 – Razorbill – Non-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	1	1	2	4	5	6	7	8	10	11	12
	20	0	0	1	2	5	7	10	12	15	17	19	22	24
	30	0	1	2	4	7	11	15	18	22	25	29	33	36
	40	0	1	2	5	10	15	19	24	29	34	39	44	48
	50	1	1	3	6	12	18	24	30	36	42	48	55	61
	60	1	1	4	7	15	22	29	36	44	51	58	65	73
	70	1	2	4	8	17	25	34	42	51	59	68	76	85
	80	1	2	5	10	19	29	39	48	58	68	78	87	97
	90	1	2	5	11	22	33	44	55	65	76	87	98	109
	100	1	2	6	12	24	36	48	61	73	85	97	109	121

Table 4.42: Pre-breeding season displacement mortality for razorbill at Preferred Project 4

Project 4 – Razorbill – Pre-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	1	1	3	4	5	7	8	10	11	12	14
	20	0	1	1	3	5	8	11	14	16	19	22	25	27
	30	0	1	2	4	8	12	16	20	25	29	33	37	41
	40	1	1	3	5	11	16	22	27	33	38	44	49	55
	50	1	1	3	7	14	20	27	34	41	48	55	61	68
	60	1	2	4	8	16	25	33	41	49	57	66	74	82
	70	1	2	5	10	19	29	38	48	57	67	76	86	96
	80	1	2	5	11	22	33	44	55	66	76	87	98	109
	90	1	2	6	12	25	37	49	61	74	86	98	111	123
	100	1	3	7	14	27	41	55	68	82	96	109	123	136

Puffin

Table 4.43: Breeding season displacement mortality for puffin at Preferred Project 4

Project 4 – Puffin – Breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	0	0	0	0	0	0	0	0	0	1
	20	0	0	0	0	0	0	0	1	1	1	1	1	1
	30	0	0	0	0	0	0	1	1	1	1	1	1	2
	40	0	0	0	0	0	1	1	1	1	1	2	2	2
	50	0	0	0	0	1	1	1	1	2	2	2	2	3
	60	0	0	0	0	1	1	1	2	2	2	3	3	3
	70	0	0	0	0	1	1	1	2	2	3	3	3	4
	80	0	0	0	0	1	1	2	2	3	3	3	4	4
	90	0	0	0	0	1	1	2	2	3	3	4	4	5
	100	0	0	0	1	1	2	2	3	3	4	4	5	5

Table 4.44: Non-breeding season displacement mortality for puffin at Preferred Project 4

Project 4 – Puffin – Non-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	0	0	0	0	0	0	0	1	1	1
	20	0	0	0	0	0	0	1	1	1	1	1	1	1
	30	0	0	0	0	0	1	1	1	1	1	2	2	2
	40	0	0	0	0	1	1	1	1	2	2	2	2	3
	50	0	0	0	0	1	1	1	2	2	2	3	3	3
	60	0	0	0	0	1	1	2	2	2	3	3	3	4
	70	0	0	0	0	1	1	2	2	3	3	4	4	5
	80	0	0	0	1	1	2	2	3	3	4	4	5	5
	90	0	0	0	1	1	2	2	3	3	4	5	5	6
	100	0	0	0	1	1	2	3	3	4	5	5	6	6

4.6 Preferred Project 5

Gannet

Table 4.45: Breeding season displacement mortality for gannet at Preferred Project 5

Project 5 – Gannet – Breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	1	1	2	3	4	4	5	6	6	7
	20	0	0	1	1	3	4	6	7	9	10	11	13	14
	30	0	0	1	2	4	6	9	11	13	15	17	19	22
	40	0	1	1	3	6	9	11	14	17	20	23	26	29
	50	0	1	2	4	7	11	14	18	22	25	29	32	36
	60	0	1	2	4	9	13	17	22	26	30	34	39	43
	70	1	1	3	5	10	15	20	25	30	35	40	45	50
	80	1	1	3	6	11	17	23	29	34	40	46	52	57
	90	1	1	3	6	13	19	26	32	39	45	52	58	65
	100	1	1	4	7	14	22	29	36	43	50	57	65	72

Table 4.46: Post-breeding season displacement mortality for gannet at Preferred Project 5

Project 5 – Gannet – Post-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	0	0	0	0	0	0	0	0	0	0
	20	0	0	0	0	0	0	0	0	1	1	1	1	1
	30	0	0	0	0	0	0	1	1	1	1	1	1	1
	40	0	0	0	0	0	1	1	1	1	1	1	2	2
	50	0	0	0	0	0	1	1	1	1	2	2	2	2
	60	0	0	0	0	1	1	1	1	2	2	2	2	3
	70	0	0	0	0	1	1	1	2	2	2	3	3	3
	80	0	0	0	0	1	1	1	2	2	3	3	3	4
	90	0	0	0	0	1	1	2	2	2	3	3	4	4
	100	0	0	0	0	1	1	2	2	3	3	4	4	4

Table 4.47: Pre-breeding season displacement mortality for gannet at Preferred Project 5

Project 5 – Gannet – Pre-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	0	0	0	0	0	0	0	0	0	0
	20	0	0	0	0	0	0	0	0	0	0	1	1	1
	30	0	0	0	0	0	0	0	1	1	1	1	1	1
	40	0	0	0	0	0	0	1	1	1	1	1	1	1
	50	0	0	0	0	0	1	1	1	1	1	1	2	2
	60	0	0	0	0	0	1	1	1	1	1	2	2	2
	70	0	0	0	0	0	1	1	1	1	2	2	2	2
	80	0	0	0	0	1	1	1	1	2	2	2	2	3
	90	0	0	0	0	1	1	1	2	2	2	2	3	3
	100	0	0	0	0	1	1	1	2	2	2	3	3	3

Guillemot

Table 4.48: Breeding season displacement mortality for guillemot at Preferred Project 5

Project 5 – Guillemot – Breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	1	2	3	5	7	8	10	12	14	15	17
	20	0	1	2	3	7	10	14	17	20	24	27	30	34
	30	1	1	3	5	10	15	20	25	30	36	41	46	51
	40	1	1	3	7	14	20	27	34	41	47	54	61	68
	50	1	2	4	8	17	25	34	42	51	59	68	76	85
	60	1	2	5	10	20	30	41	51	61	71	81	91	102
	70	1	2	6	12	24	36	47	59	71	83	95	107	118
	80	1	3	7	14	27	41	54	68	81	95	108	122	135
	90	2	3	8	15	30	46	61	76	91	107	122	137	152
	100	2	3	8	17	34	51	68	85	102	118	135	152	169

Table 4.49: Non-breeding season displacement mortality for guillemot at Preferred Project 5

Project 5 – Guillemot – Non-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	1	2	4	6	8	10	12	14	17	19	21
	20	0	1	2	4	8	12	17	21	25	29	33	37	41
	30	1	1	3	6	12	19	25	31	37	43	50	56	62
	40	1	2	4	8	17	25	33	41	50	58	66	74	83
	50	1	2	5	10	21	31	41	52	62	72	83	93	103
	60	1	2	6	12	25	37	50	62	74	87	99	112	124
	70	1	3	7	14	29	43	58	72	87	101	116	130	145
	80	2	3	8	17	33	50	66	83	99	116	132	149	165
	90	2	4	9	19	37	56	74	93	112	130	149	167	186
	100	2	4	10	21	41	62	83	103	124	145	165	186	207

Razorbill

Table 4.50: Breeding season displacement mortality for razorbill at Preferred Project 5

Project 5 – Razorbill – Breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	0	0	0	1	1	1	1	1	1	1
	20	0	0	0	0	1	1	1	1	2	2	2	3	3
	30	0	0	0	0	1	1	2	2	3	3	3	4	4
	40	0	0	0	1	1	2	2	3	3	4	5	5	6
	50	0	0	0	1	1	2	3	4	4	5	6	6	7
	60	0	0	0	1	2	3	3	4	5	6	7	8	8
	70	0	0	0	1	2	3	4	5	6	7	8	9	10
	80	0	0	1	1	2	3	5	6	7	8	9	10	11
	90	0	0	1	1	3	4	5	6	8	9	10	11	13
	100	0	0	1	1	3	4	6	7	8	10	11	13	14

Table 4.51: Post-breeding season displacement mortality for razorbill at Preferred Project 5

Project 5 – Razorbill – Post-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	0	1	1	1	1	2	2	2	2	3
	20	0	0	0	1	1	2	2	3	3	4	4	5	5
	30	0	0	0	1	2	2	3	4	5	6	6	7	8
	40	0	0	1	1	2	3	4	5	6	8	9	10	11
	50	0	0	1	1	3	4	5	7	8	9	11	12	14
	60	0	0	1	2	3	5	6	8	10	11	13	15	16
	70	0	0	1	2	4	6	8	9	11	13	15	17	19
	80	0	0	1	2	4	6	9	11	13	15	17	19	22
	90	0	0	1	2	5	7	10	12	15	17	19	22	24
	100	0	1	1	3	5	8	11	14	16	19	22	24	27

Table 4.52: Non-breeding season displacement mortality for razorbill at Preferred Project 5

Project 5 – Razorbill – Non-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	0	1	1	2	2	2	3	3	3	4
	20	0	0	0	1	2	2	3	4	5	5	6	7	8
	30	0	0	1	1	2	3	5	6	7	8	9	10	12
	40	0	0	1	2	3	5	6	8	9	11	12	14	15
	50	0	0	1	2	4	6	8	10	12	14	15	17	19
	60	0	0	1	2	5	7	9	12	14	16	19	21	23
	70	0	1	1	3	5	8	11	14	16	19	22	24	27
	80	0	1	2	3	6	9	12	15	19	22	25	28	31
	90	0	1	2	3	7	10	14	17	21	24	28	31	35
	100	0	1	2	4	8	12	15	19	23	27	31	35	39

Table 4.53: Pre-breeding season displacement mortality for razorbill at Preferred Project 5

Project 5 – Razorbill – Pre-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	0	1	1	2	2	3	3	4	4	5
	20	0	0	0	1	2	3	4	5	6	7	7	8	9
	30	0	0	1	1	3	4	6	7	8	10	11	13	14
	40	0	0	1	2	4	6	7	9	11	13	15	17	19
	50	0	0	1	2	5	7	9	12	14	16	19	21	23
	60	0	1	1	3	6	8	11	14	17	20	22	25	28
	70	0	1	2	3	7	10	13	16	20	23	26	29	33
	80	0	1	2	4	7	11	15	19	22	26	30	33	37
	90	0	1	2	4	8	13	17	21	25	29	33	38	42
	100	0	1	2	5	9	14	19	23	28	33	37	42	47

Puffin

Table 4.54: Breeding season displacement mortality for puffin at Preferred Project 5

Project 5 – Puffin – Breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	0	0	0	0	0	0	0	0	0	0
	20	0	0	0	0	0	0	0	0	0	0	0	0	0
	30	0	0	0	0	0	0	0	0	0	0	0	0	0
	40	0	0	0	0	0	0	0	0	0	0	0	0	1
	50	0	0	0	0	0	0	0	0	0	0	1	1	1
	60	0	0	0	0	0	0	0	0	0	1	1	1	1
	70	0	0	0	0	0	0	0	0	1	1	1	1	1
	80	0	0	0	0	0	0	0	1	1	1	1	1	1
	90	0	0	0	0	0	0	0	1	1	1	1	1	1
	100	0	0	0	0	0	0	1	1	1	1	1	1	1

Table 4.55: Non-breeding season displacement mortality for puffin at Preferred Project 5

Project 5 – Puffin – Non-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	0	0	0	0	0	0	0	0	0	0
	20	0	0	0	0	0	0	0	0	0	0	0	0	0
	30	0	0	0	0	0	0	0	0	0	0	0	0	0
	40	0	0	0	0	0	0	0	0	0	0	0	1	1
	50	0	0	0	0	0	0	0	0	0	1	1	1	1
	60	0	0	0	0	0	0	0	0	1	1	1	1	1
	70	0	0	0	0	0	0	0	1	1	1	1	1	1
	80	0	0	0	0	0	0	0	1	1	1	1	1	1
	90	0	0	0	0	0	0	1	1	1	1	1	1	1
	100	0	0	0	0	0	0	1	1	1	1	1	1	2

4.7 Preferred Project 6

Gannet

Table 4.56: Breeding season displacement mortality for gannet at Preferred Project 6

Project 6 – Gannet – Breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	1	2	3	5	6	8	9	11	12	14	15
	20	0	1	2	3	6	9	12	15	18	22	25	28	31
	30	0	1	2	5	9	14	18	23	28	32	37	42	46
	40	1	1	3	6	12	18	25	31	37	43	49	55	62
	50	1	2	4	8	15	23	31	38	46	54	62	69	77
	60	1	2	5	9	18	28	37	46	55	65	74	83	92
	70	1	2	5	11	22	32	43	54	65	75	86	97	108
	80	1	2	6	12	25	37	49	62	74	86	98	111	123
	90	1	3	7	14	28	42	55	69	83	97	111	125	138
	100	2	3	8	15	31	46	62	77	92	108	123	138	154

Table 4.57: Post-breeding season displacement mortality for gannet at Preferred Project 6

Project 6 – Gannet – Post-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	0	0	0	0	1	1	1	1	1	1
	20	0	0	0	0	0	1	1	1	1	1	2	2	2
	30	0	0	0	0	1	1	1	2	2	2	2	3	3
	40	0	0	0	0	1	1	2	2	2	3	3	4	4
	50	0	0	0	1	1	2	2	3	3	4	4	5	5
	60	0	0	0	1	1	2	2	3	4	4	5	5	6
	70	0	0	0	1	1	2	3	4	4	5	6	6	7
	80	0	0	0	1	2	2	3	4	5	6	6	7	8
	90	0	0	0	1	2	3	4	5	5	6	7	8	9
	100	0	0	1	1	2	3	4	5	6	7	8	9	10

Table 4.58: Pre-breeding season displacement mortality for gannet at Preferred Project 6

Project 6 – Gannet – Pre-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	0	0	0	0	0	0	1	1	1	1
	20	0	0	0	0	0	0	1	1	1	1	1	1	2
	30	0	0	0	0	0	1	1	1	1	2	2	2	2
	40	0	0	0	0	1	1	1	2	2	2	2	3	3
	50	0	0	0	0	1	1	2	2	2	3	3	3	4
	60	0	0	0	0	1	1	2	2	3	3	4	4	5
	70	0	0	0	1	1	2	2	3	3	4	4	5	5
	80	0	0	0	1	1	2	2	3	4	4	5	5	6
	90	0	0	0	1	1	2	3	3	4	5	5	6	7
	100	0	0	0	1	2	2	3	4	5	5	6	7	8

Guillemot

Table 4.59: Breeding season displacement mortality for guillemot at Preferred Project 6

Project 6 – Guillemot – Breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	1	2	4	7	11	15	18	22	26	29	33	37
	20	1	1	4	7	15	22	29	37	44	51	59	66	73
	30	1	2	6	11	22	33	44	55	66	77	88	99	110
	40	1	3	7	15	29	44	59	73	88	103	117	132	147
	50	2	4	9	18	37	55	73	92	110	128	147	165	183
	60	2	4	11	22	44	66	88	110	132	154	176	198	220
	70	3	5	13	26	51	77	103	128	154	180	205	231	257
	80	3	6	15	29	59	88	117	147	176	205	235	264	293
	90	3	7	17	33	66	99	132	165	198	231	264	297	330
	100	4	7	18	37	73	110	147	183	220	257	293	330	367

Table 4.60: Non-breeding season displacement mortality for guillemot at Preferred Project 6

Project 6 – Guillemot – Non-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	1	2	4	9	13	18	22	27	31	36	40	44
	20	1	2	4	9	18	27	36	44	53	62	71	80	89
	30	1	3	7	13	27	40	53	67	80	93	107	120	133
	40	2	4	9	18	36	53	71	89	107	124	142	160	178
	50	2	4	11	22	44	67	89	111	133	155	178	200	222
	60	3	5	13	27	53	80	107	133	160	186	213	240	266
	70	3	6	16	31	62	93	124	155	186	217	249	280	311
	80	4	7	18	36	71	107	142	178	213	249	284	320	355
	90	4	8	20	40	80	120	160	200	240	280	320	359	399
	100	4	9	22	44	89	133	178	222	266	311	355	399	444

Razorbill

Table 4.61: Breeding season displacement mortality for razorbill at Preferred Project 6

Project 6 – Razorbill – Breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	0	1	1	1	1	2	2	2	3	3
	20	0	0	0	1	1	2	2	3	3	4	4	5	6
	30	0	0	0	1	2	3	3	4	5	6	7	8	8
	40	0	0	1	1	2	3	4	6	7	8	9	10	11
	50	0	0	1	1	3	4	6	7	8	10	11	13	14
	60	0	0	1	2	3	5	7	8	10	12	13	15	17
	70	0	0	1	2	4	6	8	10	12	14	16	18	20
	80	0	0	1	2	4	7	9	11	13	16	18	20	22
	90	0	1	1	3	5	8	10	13	15	18	20	23	25
	100	0	1	1	3	6	8	11	14	17	20	22	25	28

Table 4.62: Post-breeding season displacement mortality for razorbill at Preferred Project 6

Project 6 – Razorbill – Post-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	1	1	2	2	3	3	4	4	5	6
	20	0	0	1	1	2	3	4	6	7	8	9	10	11
	30	0	0	1	2	3	5	7	8	10	12	13	15	17
	40	0	0	1	2	4	7	9	11	13	16	18	20	22
	50	0	1	1	3	6	8	11	14	17	20	22	25	28
	60	0	1	2	3	7	10	13	17	20	24	27	30	34
	70	0	1	2	4	8	12	16	20	24	27	31	35	39
	80	0	1	2	4	9	13	18	22	27	31	36	40	45
	90	1	1	3	5	10	15	20	25	30	35	40	45	50
	100	1	1	3	6	11	17	22	28	34	39	45	50	56

Table 4.63: Non-breeding season displacement mortality for razorbill at Preferred Project 6

Project 6 – Razorbill – Non-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	1	1	2	3	4	4	5	6	6	7
	20	0	0	1	1	3	4	6	7	9	10	12	13	14
	30	0	0	1	2	4	6	9	11	13	15	17	19	22
	40	0	1	1	3	6	9	12	14	17	20	23	26	29
	50	0	1	2	4	7	11	14	18	22	25	29	32	36
	60	0	1	2	4	9	13	17	22	26	30	35	39	43
	70	1	1	3	5	10	15	20	25	30	35	40	45	50
	80	1	1	3	6	12	17	23	29	35	40	46	52	58
	90	1	1	3	6	13	19	26	32	39	45	52	58	65
	100	1	1	4	7	14	22	29	36	43	50	58	65	72

Table 4.64: Pre-breeding season displacement mortality for razorbill at Preferred Project 6

Project 6 – Razorbill – Pre-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	1	2	2	3	4	5	6	7	7	8
	20	0	0	1	2	3	5	7	8	10	11	13	15	16
	30	0	0	1	2	5	7	10	12	15	17	20	22	25
	40	0	1	2	3	7	10	13	16	20	23	26	30	33
	50	0	1	2	4	8	12	16	21	25	29	33	37	41
	60	0	1	2	5	10	15	20	25	30	34	39	44	49
	70	1	1	3	6	11	17	23	29	34	40	46	52	57
	80	1	1	3	7	13	20	26	33	39	46	53	59	66
	90	1	1	4	7	15	22	30	37	44	52	59	66	74
	100	1	2	4	8	16	25	33	41	49	57	66	74	82

Puffin

Table 4.65: Breeding season displacement mortality for puffin at Preferred Project 6

Project 6 – Puffin – Breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	0	0	0	0	0	0	0	0	0	0
	20	0	0	0	0	0	0	0	0	0	0	0	1	1
	30	0	0	0	0	0	0	0	0	1	1	1	1	1
	40	0	0	0	0	0	0	0	1	1	1	1	1	1
	50	0	0	0	0	0	0	1	1	1	1	1	1	1
	60	0	0	0	0	0	1	1	1	1	1	1	2	2
	70	0	0	0	0	0	1	1	1	1	1	2	2	2
	80	0	0	0	0	0	1	1	1	1	2	2	2	2
	90	0	0	0	0	1	1	1	1	2	2	2	2	3
	100	0	0	0	0	1	1	1	1	2	2	2	3	3

Table 4.66: Non-breeding season displacement mortality for puffin at Preferred Project 6

Project 6 – Puffin – Non-breeding season		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	0	0	0	0	0	0	0	0	0	0
	20	0	0	0	0	0	0	0	0	0	0	1	1	1
	30	0	0	0	0	0	0	0	1	1	1	1	1	1
	40	0	0	0	0	0	0	1	1	1	1	1	1	1
	50	0	0	0	0	0	1	1	1	1	1	1	2	2
	60	0	0	0	0	0	1	1	1	1	1	2	2	2
	70	0	0	0	0	0	1	1	1	1	2	2	2	2
	80	0	0	0	0	1	1	1	1	2	2	2	3	3
	90	0	0	0	0	1	1	1	2	2	2	3	3	3
	100	0	0	0	0	1	1	1	2	2	2	3	3	3

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Sub-Annex 1. Comparison between MERP and data from Dogger Bank Creyke Beck A

H.1 Introduction

H.1.1. A comparison between densities obtained from the MERP dataset and those available from Round 3 projects in close proximity to the Preferred Projects has been undertaken in order to provide context to the MERP values. A comparison is presented for all species for which density data from MERP has been extracted.

Projects under consideration

H.1.2. Of the six Preferred Projects, only two are in close proximity to a Round 3 offshore wind project. These are Preferred Project 1 and Preferred Project 2 which are approximately 10km from Dogger Bank Creyke Beck A.

H.2 Methodology

H.1.3. Population estimates for Dogger Bank Creyke Beck A plus a 2km buffer for gannet, guillemot, razorbill and puffin have been obtained from the species-specific sections in Forewind (2013). These estimates have been divided by the area of the Dogger Bank Creyke Beck A area plus a 2km buffer (722.27km^2) to provide densities.

H.1.4. Comparisons are presented in the following sections for all species for which displacement analysis is required (see Section 3.1) and for which data from MERP will be used.

H.3 Comparisons

Gannet

H.1.5. A comparison of densities of gannet recorded at Dogger Bank Creyke Beck A and those extracted from the MERP dataset for Projects 1 and 2 is presented in Figure H.2. 1.

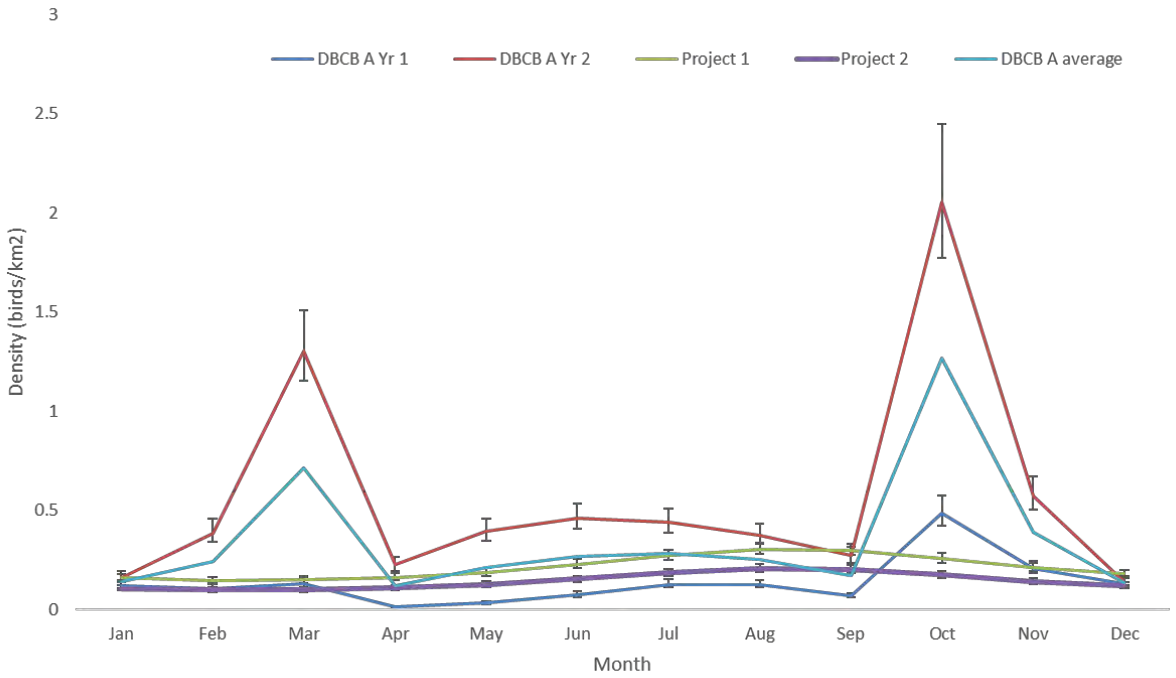


Figure H.2. 1: Comparison of gannet density (all birds) at Dogger Bank Creyke Beck A plus a 2km buffer and for Preferred Projects 1 and 2 plus associated 2km buffers extracted from the MERP dataset

H.1.6. The densities of gannet extracted from the MERP dataset are similar to those recorded at Dogger Bank Creyke Beck A, lying close to the average density observed at Dogger Bank Creyke Beck A in the majority of months, including those months representing the full UK breeding season for gannet as defined by Furness (2015) (March to September), with the exception of March. The most evident differences between the two datasets occur during migration periods, especially in March and October. The implications of this on the displacement mortality estimates calculated for gannet using the densities from the MERP dataset will be considered in the assessments presented in the RIAA.

Guillemot

H.1.7. A comparison of densities of guillemot recorded at Dogger Bank Creyke Beck A and those extracted from the MERP dataset for Projects 1 and 2 is presented in Figure H.2. 2.

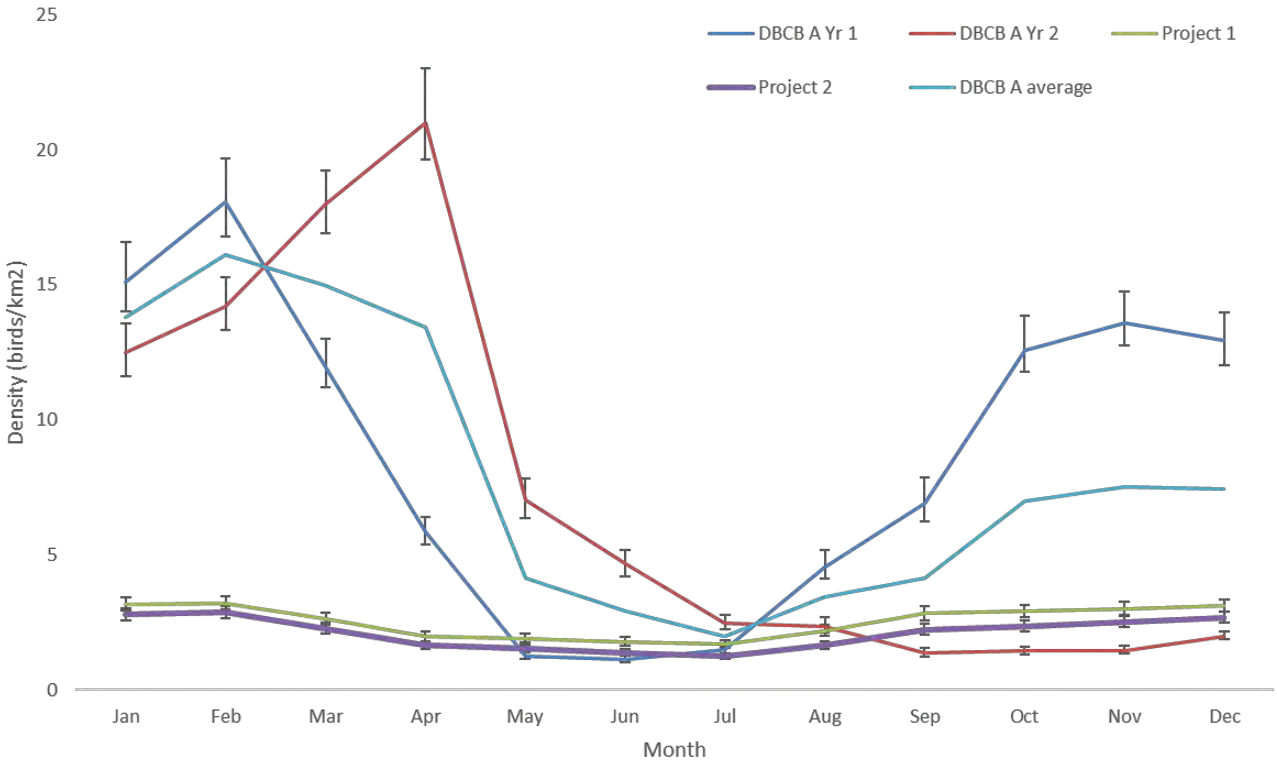


Figure H.2. 2: Comparison of guillemot density (all birds) at Dogger Bank Creyke Beck A plus a 2km buffer and for Preferred Projects 1 and 2 plus associated 2km buffers extracted from the MERP dataset

H.1.8. The densities of guillemot extracted from the MERP dataset are lower than those recorded at Dogger Bank Creyke Beck A in the majority of months, in some cases significantly. There is a degree of overlap between May and July with the largest differences occurring between October and April. The implications of this on the displacement mortality estimates calculated for guillemot using the densities from the MERP dataset will be considered in the assessments presented in the RIAA.

Razorbill

H.1.9. A comparison of densities of razorbill recorded at Dogger Bank Creyke Beck A and those extracted from the MERP dataset for Projects 1 and 2 is presented in Figure H.2. 3.

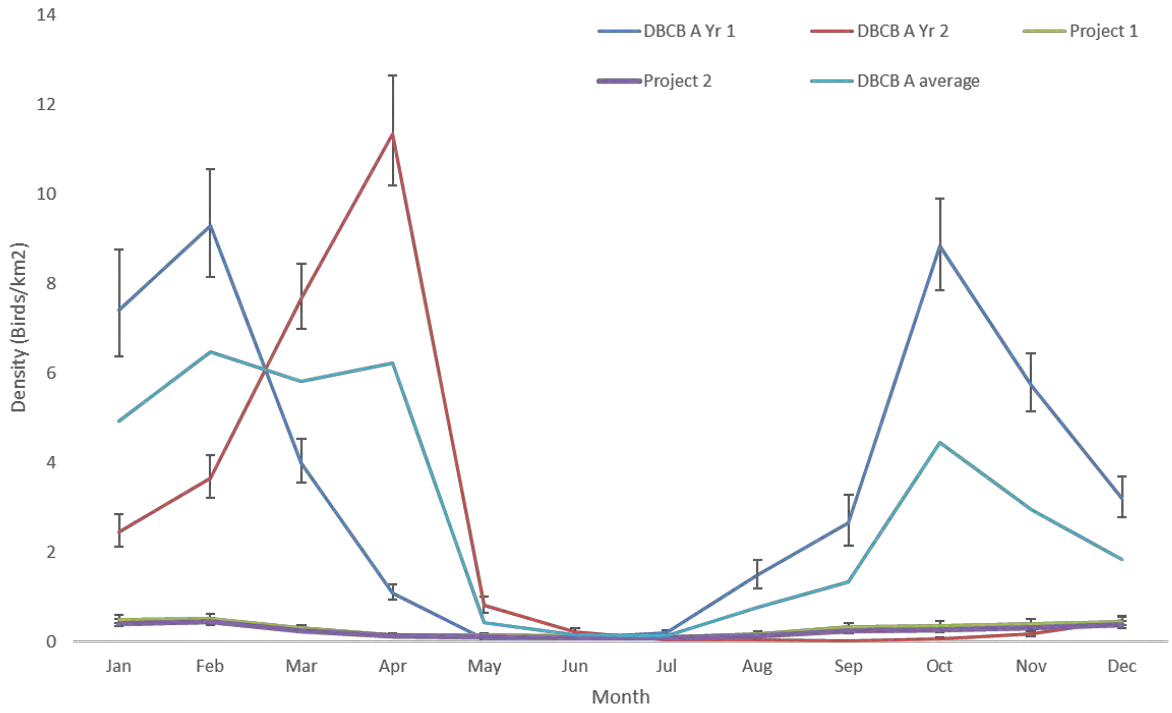


Figure H.2. 3: Comparison of razorbill density (all birds) at Dogger Bank Creyke Beck A plus a 2km buffer and for Preferred Projects 1 and 2 plus associated 2km buffers extracted from the MERP dataset

H.1.10. The densities of razorbill extracted from the MERP dataset are lower than those recorded at Dogger Bank Creyke Beck A in the majority of months, in some cases significantly. There is a degree of overlap between May and July with the largest differences occurring between October and March. The implications of this on the displacement mortality estimates calculated for razorbill using the densities from the MERP dataset will be considered in the assessments presented in the RIAA.

Puffin

H.1.11. A comparison of densities of puffin recorded at Dogger Bank Creyke Beck A and those extracted from the MERP dataset for Projects 1 and 2 is presented in Figure H.2. 4.

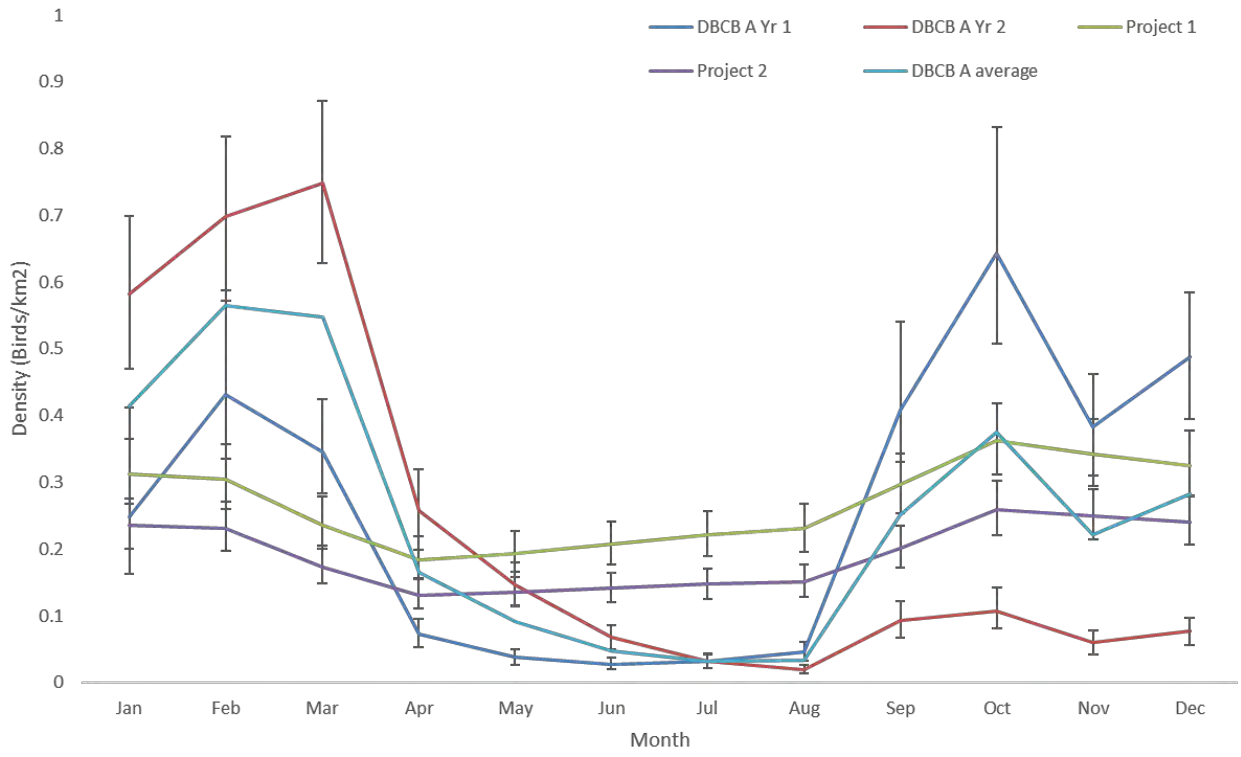


Figure H.2. 4: Comparison of puffin density (all birds) at Dogger Bank Creyke Beck A plus a 2km buffer and for Preferred Projects 1 and 2 plus associated 2km buffers extracted from the MERP dataset

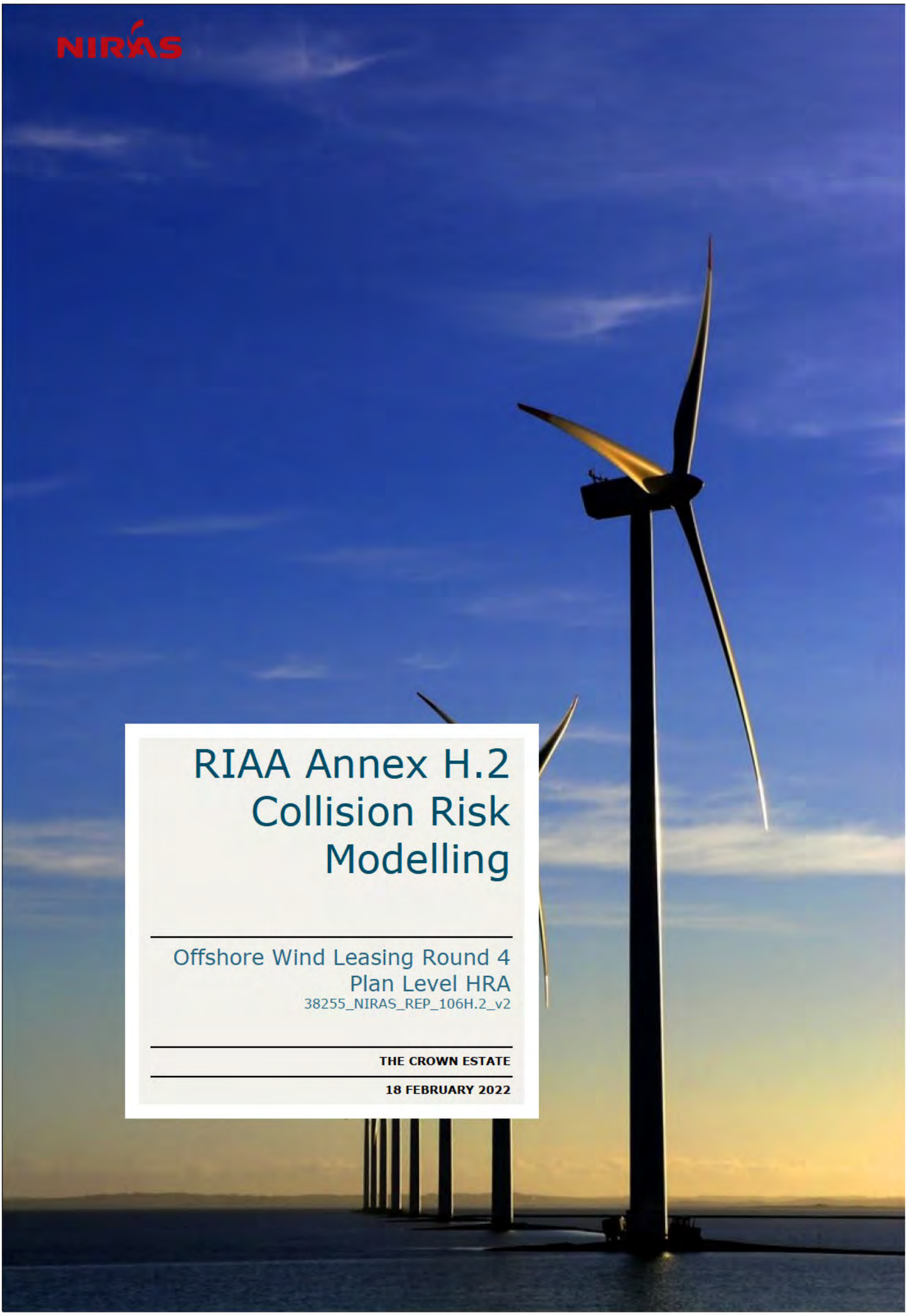
H.1.12. The densities of puffin extracted from the MERP dataset are either higher than or similar to those recorded at Dogger Bank Creyke Beck A in the majority of months. In the majority of the breeding season, densities from the MERP dataset are higher than those recorded at Dogger bank Creyke Beck A. The only months in which the densities from the MERP dataset are lower than those recorded at Dogger Bank Creyke Beck A are February and March. The implications of this on the displacement mortality estimates calculated for puffin using the densities from the MERP dataset will be considered in the assessments presented in the RIAA.

Sub-Annex 2. Monthly MERP population estimates

Table H.1.2- 1: Monthly population estimates extracted from the MERP dataset for relevant species at each of the Preferred Projects

Species	Preferred Project	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Gannet	1	110	102	103	113	130	158	189	211	208	180	147	125
	2	74	69	70	76	88	107	128	144	142	122	99	84
	3	103	95	96	106	122	150	182	204	201	172	139	117
	4	9	8	25	86	108	147	194	230	225	68	15	11
	5	3	2	8	27	33	45	60	72	70	20	4	3
	6	6	5	18	61	75	101	131	154	150	45	10	8
Guillemot	1	2206	2233	1817	1377	1325	1248	1176	1526	1966	2020	2093	2160
	2	1948	1995	1582	1151	1076	969	872	1151	1563	1647	1766	1872
	3	1879	1907	1526	1134	1084	1014	949	1250	1642	1694	1767	1832
	4	473	453	423	413	446	501	562	641	673	622	559	507
	5	169	164	151	142	149	159	169	192	207	198	186	176
	6	314	301	280	271	293	328	367	420	444	411	370	336

Species	Preferred Project	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Razorbill	1	338	354	209	111	100	86	74	124	227	248	281	313
	2	286	304	176	91	79	65	53	89	168	190	223	258
	3	266	281	164	86	77	64	54	91	168	186	215	243
	4	131	136	82	46	41	36	31	50	88	96	109	121
	5	43	47	27	14	12	10	8	13	24	27	33	39
	6	78	82	50	28	25	22	19	29	51	56	64	72
Puffin	1	216	211	163	128	134	144	153	160	205	251	237	225
	2	163	161	121	91	94	98	102	105	140	181	174	168
	3	163	159	119	90	94	99	105	109	145	184	175	168
	4	2	1	2	2	3	4	5	6	5	4	3	2
	5	1	1	1	1	1	1	1	2	1	1	1	1
	6	1	1	1	1	2	2	3	3	3	2	2	1



RIAA Annex H.2 Collision Risk Modelling

Offshore Wind Leasing Round 4 Plan Level HRA

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1. Introduction

1.1.1 This Annex presents the bird collision risk modelling methodology and results used to inform the Plan alone Array Assessment (Part 2) in the RIAA.

2. Background

2.1 Overview

2.1.1 Birds can collide with turbine rotor blades, which is almost certain to result in direct mortality. Most studies have found evidence of only low levels of bird mortality associated with operational onshore wind farms, as birds are able to take avoiding action (Drewitt and Langston, 2006). Similar findings have been found in the marine environment (e.g. Skov *et al.,* 2018) although the evidence base is more limited. The actual risk of collision depends on a number of factors including the location of a wind farm, the bird species using the area, weather and visibility conditions, and the size and design of the wind farm, including the number and size of turbines and the use, or otherwise, of lighting (e.g. Kerlinger and Curry, 2002).

2.1.2 The effect of collision rates on a population is influenced by various characteristics, notably its size, density, recruitment rate (additions to the population through reproduction and immigration) and mortality rate (the natural rate of losses due to death and emigration). In general, the effect of an individual lost from the population will be greater for species that occur at low density, are relatively long-lived and reproduce at a low rate with most seabird species falling into this category. Conversely, the effect will often be reduced for shorter-lived species with higher reproductive rates found at high densities, including some smaller gull species. Species that habitually fly at night or during low light conditions at dawn and dusk may also be at increased risk from collisions.

2.1.3 In general, the effects of increased mortality on populations due to collisions with turbines are considered to be long-term (i.e. throughout the operational wind farm's lifespan) and it is assumed that in the model, collision rate does not decrease in response to losses in the population. In reality, effects may change over time, as birds, particularly those resident near the wind farm, may become habituated to the presence of turbines, or external factors such as changes in fishing activities, may alter the attractiveness of the wind farm area to birds, thereby changing activity levels within it.

2.2 Collision risk modelling

2.2.1 The most frequently used collision risk model in the UK is commonly referred to as 'the Band model'. This model was originally devised in 1995 and has since been subject to a number of iterations, to facilitate application in the offshore environment (Band, 2011) and to allow for the use of flight height distribution data and to include a methodology for considering birds on migration (Band, 2012). Several newer iterations now exist, and these are described in detail, along with the various options available within the model in Sections 3.4 and 3.5.

2.2.2 Figure 2.1 provides an overview of the information required for Band (2012) and the key outputs from the modelling process. The key elements of the process to calculate the collision risk for a given species is a six-stage process described as follows:

- Stage A: assemble data on the number of flights which, in the absence of birds being displaced or taking other avoiding action, or being attracted to the wind farm, are potentially at risk from wind farm turbines;
- Stage B: use that flight activity data to estimate the potential number of bird transits through rotors of the wind farm;
- Stage C: calculate the probability of collision during a single bird transit;
- Stage D: multiply these to yield the potential collision mortality rate for the bird species under consideration, allowing for the proportion of time the turbines are not operational, assuming current bird use of the site and that no avoiding action is taken;
- Stage E: allow for the proportion of birds likely to avoid the wind farm or its turbines, either because they have been displaced from the site or because they take evasive action; and allow for any attraction by birds to the wind farm; and
- Stage F: express the uncertainty surrounding such a collision risk estimate.

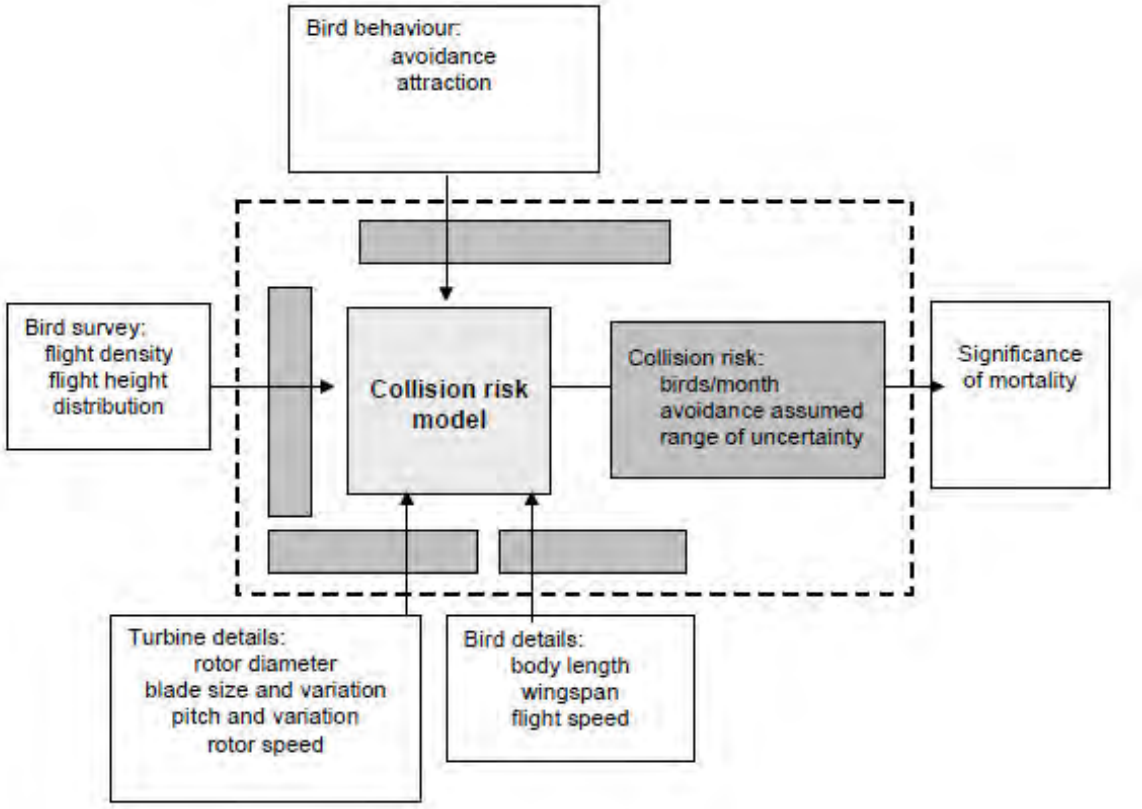


Figure 2.1: Band (2012) collision risk model overview.

3. Methodology

3.1 Species for consideration

3.1.1 Following the results of the Screening Report (NIRAS, 2021) and the Array Assessment (Part 1), collision risk modelling has been undertaken for the following species:

- Kittiwake
- Little gull
- Herring gull
- Lesser black-backed gull
- Sandwich tern

- Arctic tern
- Gannet

3.1.2 It should be noted that in addition to the species above, common tern, cormorant, red-breasted merganser, common scoter and red-throated diver were also screened in in relation to P4. However, collision risk modelling has not been carried out for these species in view of either an overlap with foraging areas associated with the relevant SPAs (common tern only) or a low risk of collision due to the low vulnerability of these species to collision (Wade *et al*., 2016) (all other species), therefore a qualitative assessment of collision risk on these species has been provided in the results (excluding common tern).

3.1.3 The list of Preferred Projects for which collision risk modelling was required (Table 3-1) was identified in view of connectivity to the above species, and the location of those species as features of the Protected Sites 'screened in' (i.e. the Protected Sites for which a risk of a likely significant effect ("LSE") was established) in the Screening Report. For breeding birds, all Preferred Projects within foraging range of the screened in Protected Sites have been subject to collision risk modelling. For non-breeding birds, an overlap with a BDMPS population has been used to establish connectivity. The foraging ranges and BDMPS populations used matched those presented in the Screening Report. This is an additional step to that presented in the Screening Report, which only identified the risk of LSE occurring with the Round 4 Plan, but not specific Preferred Projects.

Table 3-1: Species considered for collision risk modelling at each of the Preferred Projects

Feature	Season as used in Round 4 Plan Level HRA screening exercise	Preferred Project					
		1	2	3	4	5	6
Kittiwake	Breeding	✓	✓	✓	✓	✓	✓
	Non-breeding (BDMPS)	✓	✓	✓	✓	✓	✓
Little gull	Non-breeding (coastal)					✓	
Herring gull	Breeding				✓	✓	✓
	Non-breeding (BDMPS)	✓	✓	✓	✓	✓	✓
Lesser black-backed gull	Breeding	✓	✓	✓	✓	✓	✓
	Non-breeding (BDMPS)	✓	✓	✓	✓	✓	✓
Sandwich tern	Breeding			✓	✓	✓	✓
Arctic tern	Breeding				✓		
Gannet	Breeding	✓	✓	✓	✓	✓	✓
	Non-breeding (BDMPS)	✓	✓	✓	✓	✓	✓

3.2 Species parameters

Bird biometric and behavioural data

3.2.1 Table 3-2 presents the species-specific parameters required for collision risk modelling.

Avoidance rates

3.2.2 The avoidance rates presented in Table 3-3Error! Reference source not found. are taken from Bowgen and Cook (2018) and JNCC *et al.* (2014). JNCC *et al.* (2014) presents recommendations from UK SNCBs in relation to the conclusions reached in Cook *et al.* (2014). JNCC *et al.* (2014) recommends that the conclusions reached in Cook *et al.* (2014) are followed with the exception of kittiwake for which a different avoidance rate is proposed. Bowgen and Cook (2018) presents avoidance rates calculated from data collected as part of the Offshore Renewables Joint Industry Programme (ORJIP) Bird Collision Avoidance (BCA) study (Skov *et al.,* 2018). The ORJIP BCA study has generated the most extensive dataset of observations of seabird behaviour in and around an operational offshore wind farm (Thanet offshore wind farm) that is currently available and, through Bowgen and Cook (2018), allows for the estimation of avoidance rates from empirical data at an operational wind farm.

Nocturnal activity factors

3.2.3 Nocturnal activity factors have been categorised based on information presented in Garthe and Hüppop (2004) and, in some cases where information is available, in line with SNCB advice. This follows the Band (2012) guidance which suggests that the subjectively-defined nocturnal activity factors presented in Garthe and Hüppop (2004) and King *et al*. (2009) should be used to populate the CRM by translating the rankings presented (1-5) into activity factors of 0, 25, 50, 75 and 100%. There is however, a body of evidence (e.g. Hamer *et al*., 1993; Daunt *et al*., 2002; Kotzerka *et al*., 2010; Orben *et al*., 2015; Garthe *et al*., 1999; Hamer *et al*., 2000; Hamer *et al*., 2007; Garthe *et al*., 2012) that suggests this approach may over-estimate the nocturnal activity for some species. This has been discussed further in the assessments presented in the results, where relevant.

Flight speed

3.2.4 Flight speeds for all species will be sourced from Alerstam *et al.* (2007) and Pennycuick (1987). In addition, for gannet, kittiwake, herring gull and lesser black-backed gull flight speed information is available from Skov *et al.* (2018). The latter, more recent study used laser rangefinder tracking data to estimate flight speed from sample sizes much larger than those reported in Alerstam *et al.* (2007) and Pennycuick (1987). As such, these are considered to be more accurate, and will be used alongside those from Alerstam *et al.* (2007) and Pennycuick (1987) (Table 3-2).

Table 3-2: Species-specific mean flight speeds (m/s) often used in collision risk modelling, and those measured from single rangefinder segments recorded at Thanet

Species	Flight speed from Alerstam *et al.* (2007)/Pennycuick (1987) (no. of tracks)	Flight speed from Skov *et al.* (2018) (m/s) (SD) [no. of fixes]
Gannet	14.9 (n=32)	13.33 (4.24) [n=683)
Kittiwake	13.1 (n=2)	8.71 (3.16) [n=287]
Lesser black-backed gull	13.1 (n=11)	9.80 (3.63) [n=790]
Herring gull	12.8 (n=4)	9.80 (3.63) [n=790]

3.2.5 In relation to the values provided in Table 3-2 it should be noted that:

- The flight speed for gannet calculated in Pennycuick (1987) is based on a small sample size with these data having been collected from birds flying at a breeding colony (Foula, Shetland). It is therefore possible that the flight speeds recorded are not representative of the flight speeds of birds foraging offshore. This is therefore likely to over-estimate collision risk estimates and increase the uncertainty associated with these estimates.
- The birds observed by Alerstam *et al.* (2007) were located either in southern Sweden or within the Arctic circle and no differentiation is provided between migratory or foraging birds from colonies. Indeed, the large range of species included in Alerstam *et al.* (2007) suggests that non-breeding and/or migratory flights comprised a significant component of the data set. This is therefore likely to over-estimate collision risk estimates and increase the uncertainty associated with these estimates.

Table 3-3: Seabird parameters used for collision risk modelling.

Parameter	Source	Kittiwake	Little gull	Herring gull	Lesser black-backed gull	Arctic tern	Sandwich tern	Gannet
Bird length (m)	Robinson (2017)	0.39	0.26	0.60	0.58	0.34	0.38	0.94
Wingspan (m)	Robinson (2017)	1.08	0.78	1.44	1.42	0.80	1.00	1.72
Flight speed (m/s)	Alerstam *et al.* (2007) / Pennycuick (1987)	13.1	11.5	12.8	13.1	10.9	-	14.9
	Hendestron and Akesson (2016)	-	-	-	-	-	12.6	-
	Skov *et al.* (2018)	8.71	-	9.8	9.8	-	-	13.33
Nocturnal activity factor	Garthe and Hüppop (2004) / SNCB advice	2-3	2	2-3	2-3	1	1	1-2
Flight type	-	Flapping	Flapping	Flapping	Flapping	Flapping	Flapping	Flapping
Proportion of flights upwind	-	50	50	50	50	50	50	50

Parameter	Source	Kittiwake	Little gull	Herring gull	Lesser black-backed gull	Arctic tern	Sandwich tern	Gannet
Avoidance rate (Basic model) (%)	Cook *et al.* (2014) / JNCC *et al.* (2014)	98.9 (± 0.2)	*99.2 (± 0.2)*[1]	99.5 (± 0.1)	99.5 (± 0.1)	98	98	98.9 (± 0.2)
	Bowgen and Cook (2018)	99.0	-	99.5	99.5	-	-	99.5
Avoidance rate (Extended model) (%)	Cook *et al.* (2014) / JNCC *et al.* (2014)	-	-	99.0 (± 0.2)	98.9 (± 0.2)	-	-	-
	Bowgen and Cook (2018)	98.0	-	99.3	99.3	-	-	-

[1] An avoidance rates for little gull is not provided in Cook *et al.* (2014) however, the avoidance rate estimate for small gull sp. is considered appropriate

Density data

3.2.6 The Band (2012) collision risk model requires monthly density data to estimate collision risk estimates which would generally be collected as part of site-specific baseline characterisation surveys. However, it is not practicable to undertake data collection to this extent at the plan level. Instead, abundance data have been sourced in line with the recommendations presented in Johnston *et al.* (2020) – a report produced as part of The Crown Estate's series of HRA Front Loading projects:

- *"…density data collected as part of individual survey programs, such as the strategic aerial surveys for Rounds 1 and 2, should be used in the plan-level HRA for wintering red-throated divers and common scoters."*
- *"…where a project boundary is within, or close to, an area covered as part of baseline surveys for Round 3, density estimates from these surveys (where available) should be used within the plan-level HRA in relation to that project."*
- *"Where data from appropriate individual surveys are not available, for the species covered (Atlantic Puffin, Black-legged Kittiwake, Common Guillemot, European Shag, European Storm Petrel, Great Skua, Herring Gull, Lesser Black-backed Gull, Manx Shearwater, Northern Fulmar, Northern Gannet and Razorbill) density estimates from the MERP dataset should be used for the Round 4 plan-level HRA."*
- *"For species not covered by MERP in areas for which data from individual surveys are not available, density estimates from the SeaMAST dataset should be used for the Round 4 plan-level HRA."*

3.2.7 Table 3-4identifies the availability of potential data sources at each of the Preferred Projects for each of the species for which displacement analysis is required. The density data that has been used for each species are presented in Sub-Annex 1.

Table 3-4: Sources of abundance data for each species at each Preferred Project

Preferred Project	Species	Strategic data	Round 3 project	MERP	SEAMAST
1	Kittiwake	No	Dogger Bank Creyke Beck A located approximately 7.5 km to the north	Yes	Yes
	Herring gull	No		Yes	Yes
	Lesser black-backed gull	No		Yes	Yes
	Gannet	No		Yes	Yes
2	Kittiwake	No	Dogger Bank Creyke Beck A located approximately 7.5 km to the north	Yes	Yes
	Herring gull	No		Yes	Yes
	Lesser black-backed gull	No		Yes	Yes

Preferred Project	Species	Strategic data	Round 3 project	MERP	SEAMAST
	Gannet	No		Yes	Yes
3	Kittiwake	No	No	Yes	Yes
	Herring gull	No	No	Yes	Yes
	Lesser black-backed gull	No	No	Yes	Yes
	Sandwich tern	No	No	No	Yes
	Gannet	No	No	Yes	Yes
4	Kittiwake	No	No	Yes	Yes
	Herring gull	No	No	Yes	Yes
	Lesser black-backed gull	No	No	Yes	Yes
	Arctic tern	No	No	No	Yes
	Sandwich tern	No	No	No	Yes
	Gannet	No	No	Yes	Yes
5	Kittiwake	No	No	Yes	Yes
	Little gull	Yes	No	No	Yes
	Herring gull	No	No	Yes	Yes
	Lesser black-backed gull	No	No	Yes	Yes
	Sandwich tern	No	No	No	Yes
	Gannet	No	No	Yes	Yes
6	Kittiwake	No	No	Yes	Yes
	Herring gull	No	No	Yes	Yes

Preferred Project	Species	Strategic data	Round 3 project	MERP	SEAMAST
	Lesser black-backed gull	No	No	Yes	Yes
	Sandwich tern	No	No	No	Yes
	Gannet	No	No	Yes	Yes

MERP

3.2.8 Table 3-4**Error! Reference source not found.** identifies that the use of abundance data from MERP is required for kittiwake, herring gull, lesser black-backed gull and gannet at all of the Preferred Projects. Densities for these species have therefore been estimated from the MERP dataset across the three Round 4 Bidding Areas in which Preferred Projects have been proposed. Where a Preferred Project footprint lies across more than one MERP 10x10 km square then a weighted density estimate is derived based on the densities in each square and the proportion of the Preferred Project footprint overlapping with each. Densities for each of the Preferred Projects are presented in Sub-Annex 1. Data from Round 3 projects are also available for Preferred Projects 1 and 2, so a comparison between the data derived from MERP and data from Dogger Bank Creyke A has been conducted (see Sub-Annex 2) to determine how representative the densities derived from MERP are for each species.

SEAMAST

3.2.9 Table 3-4 identifies that the only dataset that contains data for Sandwich tern and Arctic tern is the SEAMAST dataset. However, it has not been possible to utilise the SEAMAST dataset to obtain density data for Sandwich tern and Arctic tern due to the necessity to scale density data from the SEAMAST dataset to known density data, which in the case of the relevant Preferred Projects are not available. Where necessary assessments required for Sandwich tern and Arctic tern will be undertaken on a qualitative basis.

Little gull

3.2.10 For little gull, the density data presented in Lawson *et al.* (2016) has been used to identify the worst case scenario in relation to the density of little gull present at Preferred Project 5. A value of 0.4 birds/km^2 was estimated with this applied in all months between October and March.

3.3 Wind farm design and turbine parameters

3.3.1 Details of the likely wind farm and turbine scenarios to be developed at each of the Preferred Projects have been provided by each Bidder as part of the Bidding process for the Round 4 Plan. The parameters provided for each Preferred Project are provided in Table 3-5.

3.3.2 The Band (2012) CRM also requires information relating to the monthly proportion of time turbines will be operational taking into account maintenance activities and

wind availability. Table 3-5 presents the information which has been provided by the Preferred Project Bidders in terms of the anticipated parameters.

Table 3-5: Wind farm and turbine parameters used for collision risk modelling.

Parameter	Preferred Project					
	1	2	3	4	5	6
Wind farm						
Latitude (degrees)	54.62	54.52	53.57	53.73	53.79	53.99
No. of turbines	150	150	107	107	40	107
Tidal offset (m)	-	-	-	-	-	-
Turbine						
No. of blades	3	3	3	3	3	3
Average rotation speed (rpm)	13.9	13.9	9.4	7.8	10.2	7.8
Rotor radius (m)	82	82	110	110	110	110
Hub height (m)	106	106	150	140	137	140
Max blade width (m)	5.5	5.5	7.7	5.5	7	5.5
Average pitch (°)	3	3	3	3	10	3
Monthly proportion of time operational (all months) (%)	92	92	91.9	91.2	88	91.2

3.4 Band model version

3.4.1 The Band (2012) CRM was originally created as an Excel workbook. In 2018, a version of the Band (2012) CRM written in R was published (McGregor *et al.*, 2018). This version of the model was created to allow for better consideration of variability in parameters used to estimate collision risk. It allows for calculation of collision risk using a deterministic approach (similar to that undertaken in the Excel version of the model) or a stochastic approach. It is understood that Natural England currently do not recommend the use of the stochastic version of the McGregor *et al.* (2018) version of Band (2012). The modelling presented in this Annex and therefore used in the RIAA has utilised the Excel version of the Band (2012) CRM.

3.5 Band model options

3.5.1 The Band (2012) model incorporates two approaches to calculating the risk of collision referred to as the 'Basic' and 'Extended' versions of the model. A key difference between these versions is the extent to which they account for the flight height patterns of seabirds (Band, 2012). The distribution of seabird flights across the sea is generally skewed towards lower altitudes. As stated by Band (2012) there are three consequences of a skewed flight height distribution:

- "the proportion of birds flying at risk height decreases as the height of the rotor is increased;
- more birds miss the rotor, where flights lie close to the bottom of the circle presented by the rotor; and
- the collision risk, for birds passing through the lower parts of a rotor, is less than the average collision risk for the whole rotor."

3.5.2 The Basic model assumes a uniform distribution of flights across the rotor with a consistent risk of collision across the whole rotor swept area. The Extended model of Band (2012) takes into account the distribution of birds in addition to the differential risk across the rotor swept area. It should be noted that the use of the basic model is precautionary as it does not take into account the variability in risk of collision that occurs across a rotor swept area, with the risk of collision decreasing as the distance from the hub of the turbine increases. If this were to be taken into account it is likely that collision risk estimates would be lower as the vertical distribution of birds flying across water is skewed towards lower heights (i.e. those associated with a lower risk of collision within a rotor swept area).

3.5.3 Both the Basic and Extended models of Band (2012) allow for the use of two 'Options' termed Options 1-4. Options 1 and 2 use the Basic model with Options 3 and 4 utilising the Extended model. The difference between the two Options under each model is linked to the use of flight height data. Options 2 and 3 use generic data from Johnston *et al.* (2014) whereas Options 1 and 4 use site-specific data derived from site-specific surveys. Site-specific flight height information is not available for the Preferred Projects and therefore only Options 2 and 3, which use generic flight height data, are available for use. Generic flight height data has been sourced from Johnston *et al.* (2014).

3.5.4 It is standard practice to present collision risk estimates calculated using all possible Options in Band (2012) (in this case Options 2 and 3) and, where the availability of other parameters allows (e.g. avoidance rate), this has been followed throughout this Annex and associated assessments.

3.6 Expressing variability

3.6.1 There are a number of parameters for which measures of variability exist. This includes species density, flight height and avoidance rate. In order to account for this variability modelling has been conducted using the confidence metrics (upper and lower 95% confidence intervals or standard deviations) associated with these parameters. See Sub-Annex 1 for variability in monthly species density data and Sub-Annex 3 for variability in monthly collision risk estimates.

4. Results

4.1 Gannet

4.1.1 The annual collision risk estimates (Option 2 only) calculated for gannet using the Band (2012) CRM are presented in Table 4-1Error! Reference source not found.. Collision risk estimates calculated using confidence metrics associated with relevant input parameters are presented in Sub-Annex 3.

Table 4-1: Collision risk estimates for gannet calculated using Option 2 of the Band (2012) CRM taking into account uncertainty associated with flight speed and nocturnal activity factor

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Annual collision risk estimates (no. of birds)					
				Project 1	Project 2	Project 3	Project 4	Project 5	Project 6
Option 2	1	14.9	98.9	21	12	3	6	3	6
			99.5	9	5	1	3	2	3
		13.33	98.9	20	11	2	5	3	5
			99.5	9	5	1	2	1	2
	2	14.9	98.9	25	15	3	7	4	7
			99.5	11	7	1	3	2	3
		13.33	98.9	24	14	3	6	4	6
			99.5	11	6	1	3	2	3

4.2 Kittiwake

4.2.1 The annual collision risk estimates (Options 2 and 3) calculated for kittiwake using the Band (2012) CRM are presented in Table 4-2. Collision risk estimates calculated using confidence metrics associated with relevant input parameters are presented in Sub-Annex 3.

Table 4-2: Collision risk estimates for kittiwake calculated using Options 2 and 3 of the Band (2012) CRM taking into account uncertainty associated with flight speed and nocturnal activity factor

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Annual collision risk estimates (no. of birds)					
				Project 1	Project 2	Project 3	Project 4	Project 5	Project 6
Option 2	2	13.1	98.9	123	88	19	5	3	5
			99	112	80	17	5	3	5
		8.71	98.9	94	67	14	4	3	4
			99	86	61	13	4	3	3
	3	13.1	98.9	147	105	23	6	4	6
			99	134	96	21	6	4	5
		8.71	98.9	113	81	17	5	3	4
			99	103	73	15	4	3	4
Option 3	2	13.1	98	58	42	6	2	1	2
		8.71	98	51	36	5	2	1	1
	3	13.1	98	70	50	7	2	1	2
		8.71	98	61	44	6	2	1	2

4.3 Lesser black-backed gull

4.3.1 The annual collision risk estimates (Options 2 only) calculated for lesser black-backed gull using the Band (2012) CRM are presented in Table 4-3. Collision risk estimates calculated using confidence metrics associated with relevant input parameters are presented in Sub-Annex 3.

Table 4-3: Collision risk estimates for lesser black-backed gull calculated using Options 2 and 3 of the Band (2012) CRM taking into account uncertainty associated with flight speed and nocturnal activity factor

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Annual collision risk estimates (no. of birds)					
				Project 1	Project 2	Project 3	Project 4	Project 5	Project 6
Option 2	2	13.1	99.5	11	15	4	6	7	5
		9.8		9	12	3	5	6	4
	3	13.1		13	17	5	6	8	6
		9.8		11	15	4	5	7	5
Option 3	2	13.1	98.9	10	13	2	4	5	3
			99.3	6	8	2	2	3	2
		9.8	98.9	9	12	2	3	5	3
			99.3	6	8	1	2	3	2
	3	13.1	98.9	11	15	3	4	5	4
			99.3	7	10	2	3	4	2
		9.8	98.9	10	14	2	4	5	3
			99.3	7	9	2	2	4	2

4.4 Herring gull

4.4.1 The annual collision risk estimates (Options 2 and 3) calculated for herring gull using the Band (2012) CRM are presented in Table 4-4. Collision risk estimates calculated using confidence metrics associated with relevant input parameters are presented in Sub-Annex 3.

Table 4-4: Collision risk estimates for herring gull calculated using Options 2 and 3 of the Band (2012) CRM taking into account uncertainty associated with flight speed and nocturnal activity factor

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Annual collision risk estimates (no. of birds)					
				Project 1	Project 2	Project 3	Project 4	Project 5	Project 6
Option 2	2	12.8	99.5	23	27	8	6	4	6
		9.8		20	24	7	5	3	5
	3	12.8		29	34	10	7	4	7
		9.8		25	29	9	6	4	6
Option 3	2	12.8	99.0	20	24	5	4	3	4
			99.3	14	17	4	3	2	3
		9.8	99.0	19	22	5	3	3	4
			99.3	13	15	3	2	2	2
	3	12.8	99.0	26	30	6	4	3	5
			99.3	18	21	4	3	2	3
		9.8	99.0	23	27	6	4	3	4
			99.3	16	19	4	3	2	3

4.5 Little gull

4.5.1 The annual collision risk estimates (Option 2 only) calculated for little gull using the Band (2012) CRM are presented in Table 4-5Error! Reference source not found.. Collision risk estimates calculated using confidence metrics associated with relevant input parameters are presented in Sub-Annex 3Monthly collision risk estimates incorporating variability.

Table 4-5: Collision risk estimates for little gull calculated using Option 2 of the Band (2012) CRM

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Annual collision risk estimates (no. of birds)
				Project 5
Option 2	2	11.5	99.2	0.78

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Sub-Annex 1. Monthly MERP density estimates

Table H.2.1- 1: monthly density estimates for all species at each Preferred Project

Species	Preferred Project	Estimate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Kittiwake	1	LCI	0.42	0.45	0.48	0.46	0.40	0.32	0.25	0.21	0.21	0.24	0.31	0.37
	1	mean	0.48	0.52	0.54	0.53	0.45	0.36	0.28	0.24	0.23	0.27	0.34	0.42
	1	UCI	0.54	0.59	0.61	0.60	0.51	0.40	0.31	0.27	0.26	0.30	0.38	0.47
	2	LCI	0.30	0.32	0.34	0.33	0.29	0.23	0.18	0.15	0.15	0.17	0.22	0.26
	2	mean	0.34	0.37	0.39	0.38	0.32	0.26	0.20	0.17	0.17	0.19	0.24	0.29
	2	UCI	0.38	0.42	0.44	0.43	0.36	0.29	0.23	0.20	0.19	0.22	0.27	0.33
	3	LCI	0.33	0.36	0.37	0.37	0.32	0.26	0.21	0.19	0.18	0.20	0.25	0.30
	3	mean	0.38	0.40	0.42	0.41	0.37	0.30	0.24	0.21	0.21	0.23	0.28	0.34
	3	UCI	0.42	0.46	0.48	0.47	0.41	0.33	0.27	0.24	0.23	0.26	0.32	0.38
	4	LCI	0.03	0.03	0.03	0.03	0.03	0.04	0.05	0.05	0.05	0.04	0.04	0.03
	4	mean	0.04	0.03	0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.05	0.05	0.04
	4	UCI	0.04	0.04	0.04	0.04	0.05	0.06	0.07	0.07	0.07	0.07	0.06	0.05
	5	LCI	0.03	0.02	0.02	0.02	0.03	0.04	0.04	0.05	0.05	0.04	0.04	0.03

Species	Preferred Project	Estimate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	5	mean	0.03	0.03	0.03	0.03	0.04	0.04	0.05	0.06	0.06	0.06	0.05	0.04
	5	UCI	0.04	0.04	0.04	0.04	0.05	0.05	0.07	0.08	0.08	0.07	0.06	0.05
	6	LCI	0.03	0.03	0.02	0.03	0.03	0.03	0.04	0.05	0.05	0.04	0.04	0.03
	6	mean	0.03	0.03	0.03	0.03	0.04	0.04	0.05	0.05	0.05	0.05	0.04	0.04
	6	UCI	0.04	0.04	0.04	0.04	0.04	0.05	0.06	0.07	0.07	0.06	0.05	0.05
Herring gull	1	LCI	0.10	0.12	0.07	0.03	0.02	0.01	0.01	0.01	0.03	0.04	0.06	0.08
	1	mean	0.13	0.15	0.09	0.04	0.03	0.02	0.01	0.02	0.03	0.05	0.07	0.10
	1	UCI	0.17	0.19	0.11	0.05	0.04	0.02	0.01	0.02	0.04	0.06	0.09	0.13
	2	LCI	0.12	0.14	0.08	0.03	0.02	0.02	0.01	0.02	0.03	0.05	0.07	0.10
	2	mean	0.15	0.17	0.10	0.04	0.03	0.02	0.01	0.02	0.04	0.06	0.09	0.12
	2	UCI	0.19	0.22	0.13	0.06	0.04	0.03	0.02	0.03	0.06	0.07	0.11	0.15
	3	LCI	0.11	0.12	0.07	0.03	0.02	0.01	0.01	0.01	0.03	0.04	0.06	0.08
	3	mean	0.14	0.16	0.09	0.04	0.03	0.02	0.01	0.02	0.04	0.05	0.08	0.11
	3	UCI	0.17	0.20	0.12	0.06	0.04	0.03	0.02	0.02	0.05	0.06	0.10	0.14
	4	LCI	0.03	0.04	0.03	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.03	0.03
	4	mean	0.04	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.03	0.03	0.03	0.04

Species	Preferred Project	Estimate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	4	UCI	0.05	0.06	0.05	0.04	0.03	0.03	0.02	0.03	0.03	0.04	0.04	0.05
	5	LCI	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.04
	5	mean	0.05	0.05	0.04	0.03	0.03	0.03	0.02	0.02	0.03	0.03	0.04	0.04
	5	UCI	0.06	0.07	0.06	0.05	0.04	0.03	0.03	0.03	0.04	0.04	0.05	0.06
	6	LCI	0.04	0.04	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03
	6	mean	0.05	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.03	0.03	0.04	0.04
	6	UCI	0.06	0.06	0.05	0.04	0.04	0.03	0.03	0.03	0.03	0.04	0.05	0.05
Lesser black-backed gull	1	LCI	0.01	0.01	0.02	0.03	0.03	0.03	0.03	0.02	0.01	0.01	0.01	0.01
	1	mean	0.02	0.02	0.03	0.05	0.04	0.04	0.04	0.03	0.02	0.02	0.02	0.02
	1	UCI	0.02	0.03	0.04	0.06	0.06	0.06	0.06	0.04	0.02	0.02	0.02	0.02
	2	LCI	0.02	0.02	0.03	0.04	0.05	0.05	0.04	0.03	0.02	0.02	0.02	0.02
	2	mean	0.02	0.02	0.04	0.06	0.06	0.06	0.06	0.04	0.02	0.02	0.02	0.02
	2	UCI	0.03	0.03	0.06	0.09	0.08	0.07	0.08	0.05	0.03	0.03	0.03	0.03
	3	LCI	0.01	0.01	0.02	0.03	0.04	0.04	0.04	0.03	0.02	0.02	0.02	0.01
	3	mean	0.02	0.02	0.03	0.05	0.05	0.05	0.06	0.04	0.02	0.02	0.02	0.02
	3	UCI	0.02	0.02	0.04	0.06	0.06	0.07	0.08	0.05	0.03	0.03	0.03	0.02

Species	Preferred Project	Estimate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	4	LCI	0.01	0.01	0.02	0.03	0.04	0.04	0.05	0.03	0.02	0.01	0.01	0.01
	4	mean	0.01	0.01	0.02	0.04	0.05	0.06	0.07	0.04	0.02	0.02	0.02	0.02
	4	UCI	0.02	0.02	0.03	0.06	0.07	0.08	0.09	0.06	0.03	0.03	0.02	0.02
	5	LCI	0.02	0.02	0.04	0.08	0.09	0.10	0.11	0.07	0.04	0.03	0.03	0.03
	5	mean	0.03	0.03	0.06	0.11	0.12	0.13	0.15	0.09	0.05	0.05	0.04	0.04
	5	UCI	0.05	0.04	0.08	0.14	0.15	0.17	0.19	0.13	0.07	0.06	0.06	0.05
	6	LCI	0.01	0.01	0.02	0.03	0.03	0.04	0.04	0.03	0.01	0.01	0.01	0.01
	6	mean	0.01	0.01	0.02	0.04	0.05	0.05	0.06	0.04	0.02	0.02	0.02	0.01
	6	UCI	0.02	0.02	0.03	0.06	0.06	0.07	0.08	0.05	0.03	0.02	0.02	0.02
Gannet	1	LCI	0.03	0.03	0.04	0.04	0.05	0.06	0.07	0.08	0.08	0.06	0.04	0.04
	1	mean	0.04	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.09	0.07	0.05	0.04
	1	UCI	0.04	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.10	0.08	0.06	0.05
	2	LCI	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.05	0.03	0.02	0.02
	2	mean	0.02	0.02	0.02	0.03	0.03	0.04	0.05	0.05	0.05	0.04	0.03	0.02
	2	UCI	0.03	0.02	0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.04	0.03	0.03
	3	LCI	0.03	0.03	0.03	0.04	0.04	0.05	0.06	0.07	0.07	0.05	0.03	0.03

Species	Preferred Project	Estimate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	3	mean	0.03	0.03	0.03	0.04	0.05	0.06	0.07	0.07	0.07	0.06	0.04	0.03
	3	UCI	0.04	0.03	0.04	0.05	0.05	0.06	0.08	0.08	0.08	0.06	0.05	0.04
	4	LCI	0.00	0.00	0.01	0.04	0.04	0.06	0.07	0.08	0.08	0.02	0.01	0.00
	4	mean	0.01	0.01	0.02	0.05	0.06	0.07	0.08	0.10	0.09	0.03	0.01	0.01
	4	UCI	0.01	0.01	0.02	0.06	0.07	0.08	0.10	0.12	0.12	0.04	0.01	0.01
	5	LCI	0.00	0.00	0.01	0.03	0.04	0.05	0.07	0.08	0.08	0.02	0.01	0.00
	5	mean	0.00	0.00	0.01	0.04	0.05	0.06	0.08	0.10	0.10	0.03	0.01	0.01
	5	UCI	0.01	0.01	0.02	0.05	0.06	0.08	0.10	0.12	0.12	0.04	0.01	0.01
	6	LCI	0.00	0.00	0.01	0.04	0.04	0.06	0.07	0.08	0.08	0.02	0.01	0.00
	6	mean	0.01	0.01	0.02	0.05	0.06	0.07	0.09	0.10	0.10	0.03	0.01	0.01
	6	UCI	0.01	0.01	0.02	0.06	0.07	0.09	0.11	0.12	0.12	0.04	0.01	0.01

Sub-Annex 2. Comparison between MERP and data from Dogger Bank Creyke A

H.1 Introduction

H.1.1. A comparison between densities obtained from the MERP dataset and those available from Round 3 projects in close proximity to the Preferred Projects has been undertaken in order to provide context to the MERP values. A comparison is presented for all species for which density data from MERP has been extracted.

H.2 Projects under consideration

H.1.2. Of the six Preferred Projects, only two are in close proximity to a Round 3 offshore wind project. These are Project 1 and Project 2 which are approximately 10 km from Dogger Bank Creyke Beck A.

H.3 Methodology

H.1.3. In flight densities recorded at Dogger Bank Creyke Beck A for gannet, kittiwake and lesser black-backed gull have been obtained from Tables 4.14a and 4.14 in Forewind (2013) for the Dogger Bank Creyke Beck A Project area only.

H.1.4. For herring gull, in flight densities at Dogger Bank Creyke Beck A are not presented in Forewind (2013) and therefore population estimates for the species presented in Section 3.2 of Forewind (2013) have been used. These population estimates have been divided by the area of the Dogger Bank Creyke Beck A project which as calculated in GIS. The population estimates presented in Section 3.2 of Forewind (2013) represent all birds and therefore densities representing all birds at Projects 1 and 2 have been extracted from the MERP dataset for herring gull. For all other species densities of birds in flight in the relevant Preferred Project area have been extracted.

H.1.5. Comparisons are presented for all species for which collision risk modelling is required (see Section Species for consideration) and for which data from MERP will be used.

H.4 Comparisons

Gannet

H.1.6. A comparison of densities of gannet recorded at Dogger Bank Creyke Beck A and those extracted from the MERP dataset for Projects 1 and 2 is presented in Figure H.2. 1.

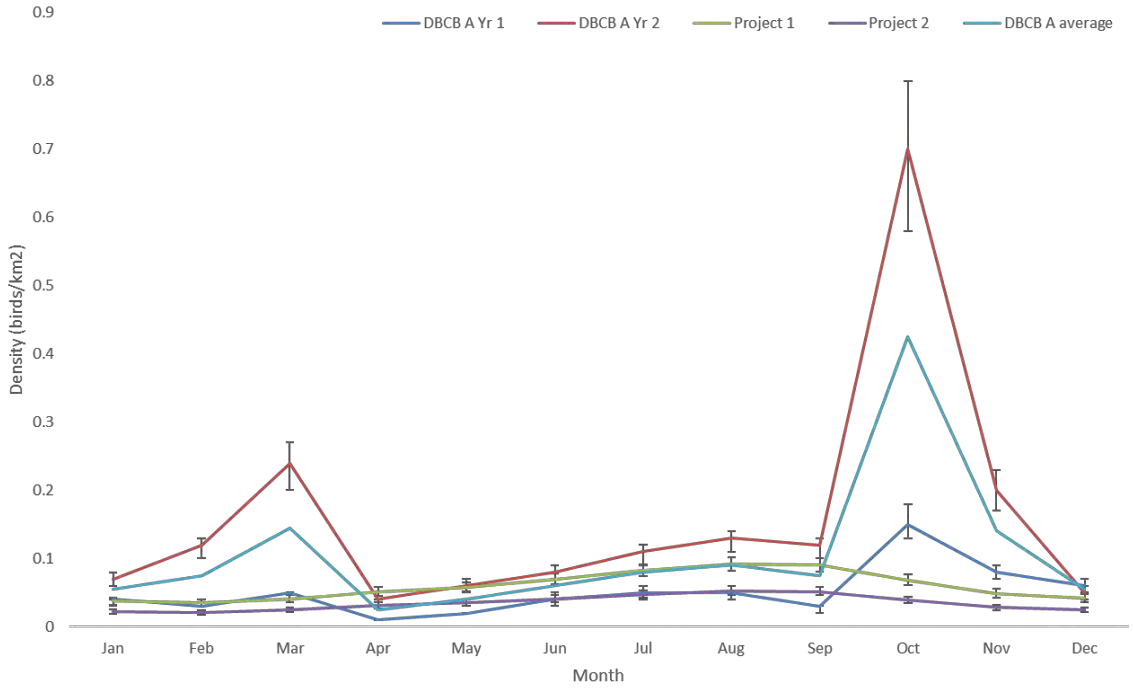


Figure H.2. 1: Comparison of gannet density (all birds) at Dogger Bank Creyke Beck A and for Preferred Projects 1 and 2 extracted from the MERP dataset

H.1.7. The densities of gannet extracted from the MERP dataset are similar to those recorded at Dogger Bank Creyke Beck A, lying close to the average density observed at Dogger Bank Creyke Beck A in the majority of months, including those months representing the full UK breeding season for gannet as defined by Furness (2015) (March to September), with the exception of March. The most evident differences between the two datasets occur during migration periods, especially in March and October. The implications of this on the collision risk estimates calculated for kittiwake using the densities from the MERP dataset will be considered in the assessments presented in the RIAA.

Kittiwake

H.1.8. A comparison of densities of kittiwake recorded at Dogger Bank Creyke Beck A and those extracted from the MERP dataset for Projects 1 and 2 is presented in Figure H.2. 2.

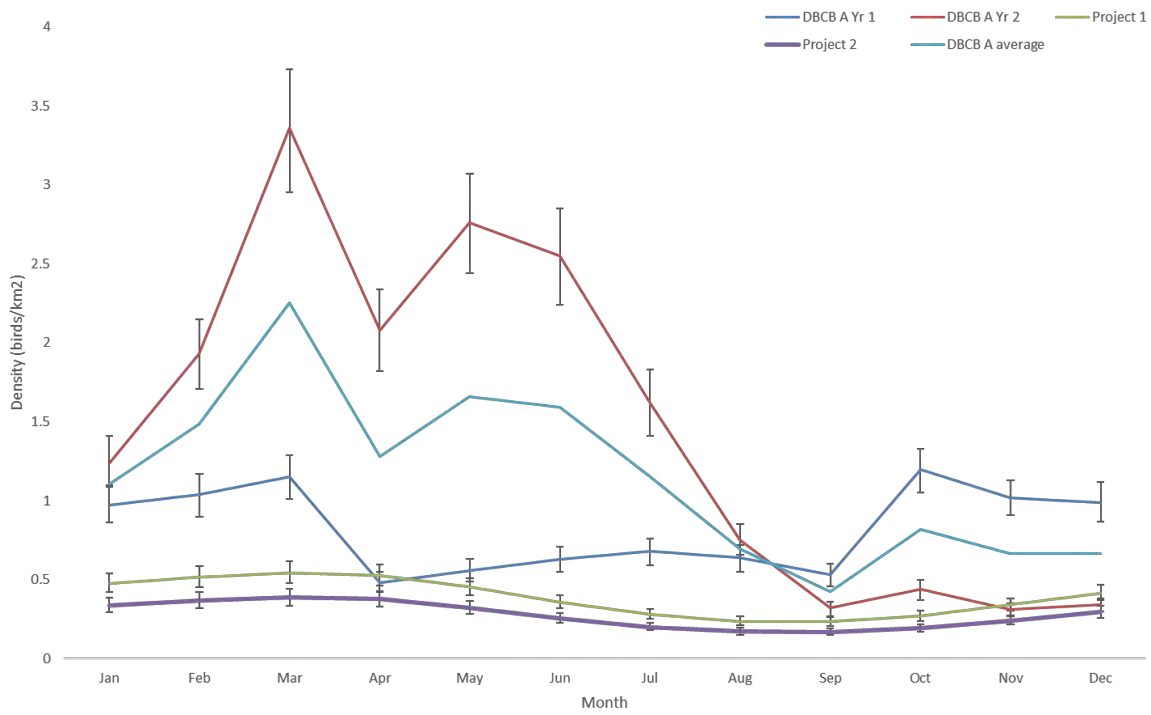


Figure H.2. 2: Comparison of kittiwake density (all birds) at Dogger Bank Creyke Beck A and for Preferred Projects 1 and 2 extracted from the MERP dataset

H.1.9. The densities extracted from the MERP dataset for kittiwake at Project 1 and 2 are lower than the average density of kittiwake recorded at Dogger Bank Creyke Beck A in all months. The implications of this on the collision risk estimates calculated for kittiwake using the densities from the MERP dataset will be considered in the assessments presented in the RIAA.

Lesser black-backed gull

H.1.10. A comparison of densities of lesser black-backed gull recorded at Dogger Bank Creyke Beck A and those extracted from the MERP dataset for Projects 1 and 2 is presented in Figure H.2. 3.

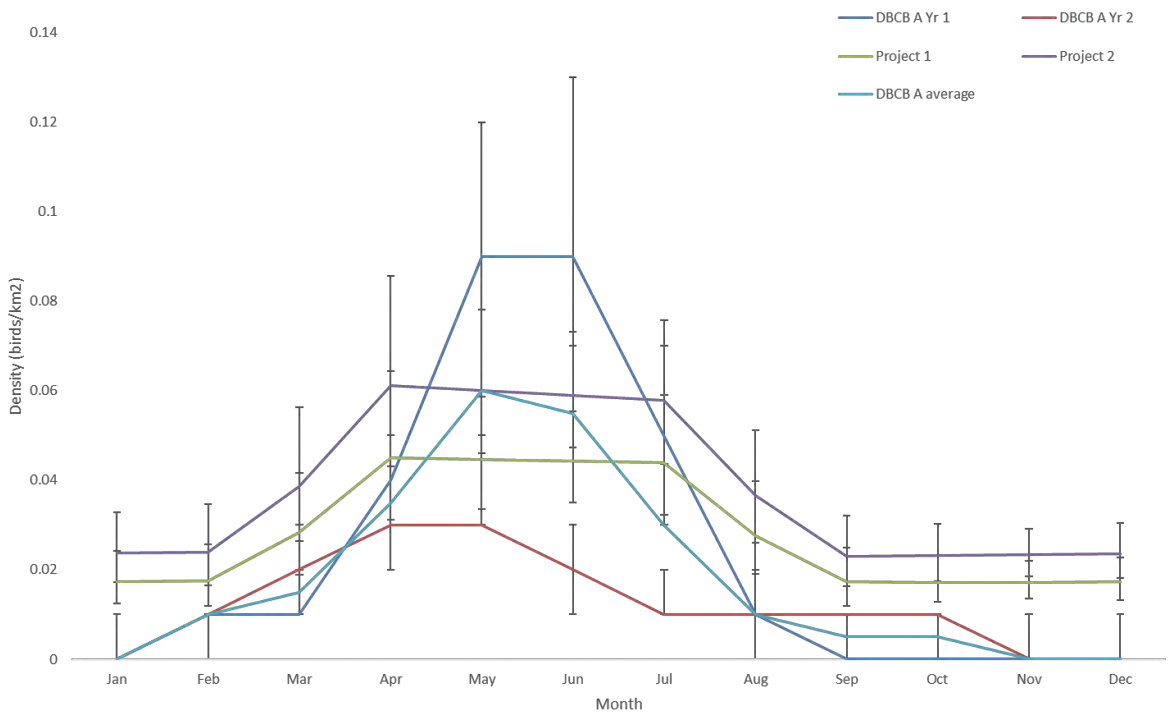


Figure H.2. 3: Comparison of lesser black-backed gull density (all birds) at Dogger Bank Creyke Beck A and for Preferred Projects 1 and 2 extracted from the MERP dataset

H.1.11. The densities of lesser black-backed gull extracted from the MERP dataset are above the average density of the species recorded at Dogger Bank Creyke Beck A in the majority of months. Lesser black-backed gulls were often absent from Dogger Bank Creyke Beck A in non-breeding season months but this is not reflected in the MERP dataset. The densities of lesser black-backed gull in the area occupied by both Dogger Bank Creyke Beck A and the two Preferred Projects is very low (all densities were below 0.1 birds/km^2) and therefore any differences are unlikely to have implications for the collision risk estimates calculated to support the assessments in the RIAA.

Herring gull

H.1.12. A comparison of densities of herring gull recorded at Dogger Bank Creyke Beck A and those extracted from the MERP dataset for Projects 1 and 2 is presented in Figure H.2. 4.

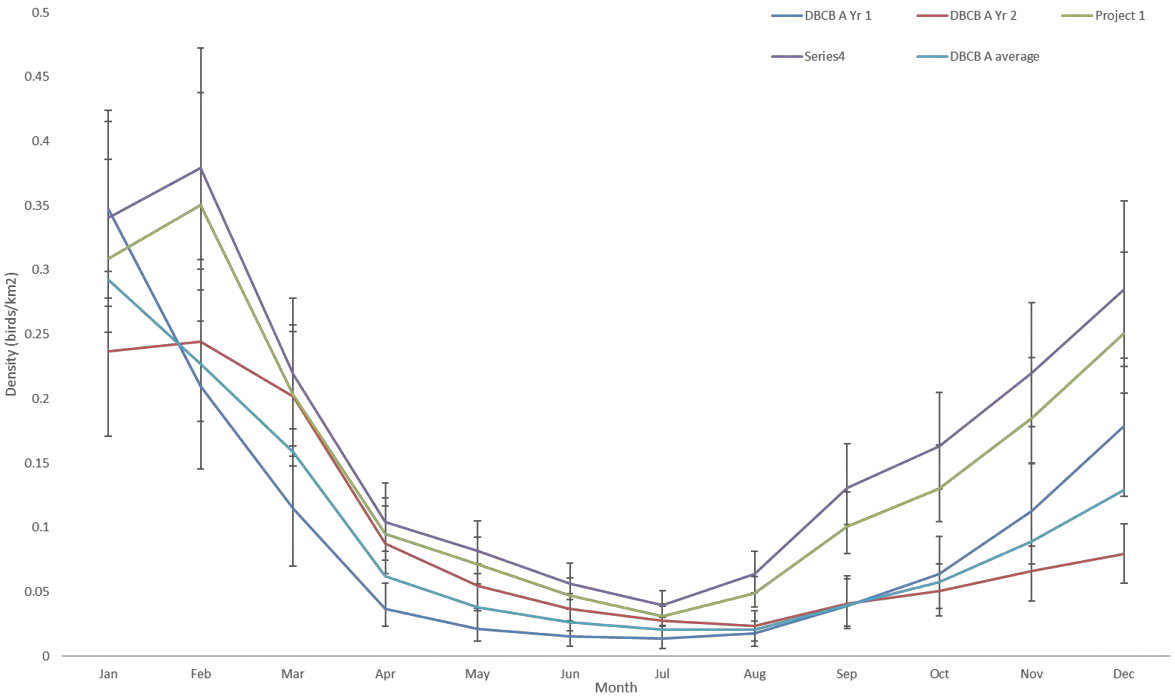


Figure H.2. 4: Comparison of herring gull density (all birds) at Dogger Bank Creyke Beck A and for Preferred Projects 1 and 2 extracted from the MERP dataset

H.1.13. The densities of herring gull extracted from the MERP dataset are higher than the average density of herring gull observed at Dogger Bank Creyke Beck A in all months. The implications of this on the collision risk estimates calculated for herring gull using the densities from the MERP dataset will be considered in the assessments presented in the RIAA.

Sub-Annex 3. Monthly collision risk estimates incorporating variability

H.5 Preferred Project 1

Gannet

Table H.2.1- 2: Collision risk estimates for gannet at Preferred Project 1 incorporating variability associated with density, flight height distribution and avoidance rate

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Option 2	Mean	Maximum likelihood	1	14.9	98.7	0.79	0.81	1.29	1.86	2.49	3.08	3.67	3.65	2.98	1.93	1.07	0.82
					98.9	0.67	0.68	1.09	1.58	2.11	2.61	3.10	3.09	2.52	1.63	0.91	0.70
					99.1	0.55	0.56	0.89	1.29	1.72	2.13	2.54	2.53	2.06	1.33	0.74	0.57
					99.5	0.30	0.31	0.50	0.72	0.96	1.19	1.41	1.40	1.15	0.74	0.41	0.32
				13.33	98.7	0.74	0.77	1.22	1.76	2.35	2.91	3.47	3.45	2.82	1.82	1.01	0.78
					98.9	0.63	0.65	1.03	1.49	1.99	2.47	2.93	2.92	2.38	1.54	0.86	0.66
					99.1	0.52	0.53	0.84	1.22	1.63	2.02	2.40	2.39	1.95	1.26	0.70	0.54
					99.5	0.29	0.29	0.47	0.68	0.90	1.12	1.33	1.33	1.08	0.70	0.39	0.30
			2	14.9	98.7	1.19	1.11	1.62	2.19	2.80	3.39	4.07	4.21	3.63	2.54	1.56	1.28
					98.9	1.01	0.94	1.37	1.86	2.37	2.87	3.44	3.56	3.07	2.15	1.32	1.09
					99.1	0.82	0.77	1.12	1.52	1.94	2.35	2.82	2.91	2.52	1.76	1.08	0.89

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.5	0.46	0.43	0.62	0.84	1.08	1.30	1.57	1.62	1.40	0.98	0.60	0.49
				13.33	98.7	1.12	1.05	1.53	2.07	2.64	3.20	3.85	3.97	3.43	2.40	1.47	1.21
					98.9	0.95	0.89	1.30	1.75	2.24	2.71	3.26	3.36	2.91	2.03	1.25	1.03
					99.1	0.78	0.73	1.06	1.43	1.83	2.22	2.66	2.75	2.38	1.66	1.02	0.84
					99.5	0.43	0.40	0.59	0.80	1.02	1.23	1.48	1.53	1.32	0.92	0.57	0.47
	UCL		1	14.9	98.9	0.76	0.78	1.24	1.79	2.37	2.92	3.47	3.45	2.82	1.83	1.03	0.79
					99.5	0.34	0.36	0.56	0.81	1.08	1.33	1.58	1.57	1.28	0.83	0.47	0.36
				13.33	98.9	0.72	0.74	1.17	1.69	2.24	2.76	3.28	3.26	2.66	1.73	0.97	0.75
					99.5	0.33	0.34	0.53	0.77	1.02	1.25	1.49	1.48	1.21	0.79	0.44	0.34
			2	14.9	98.9	1.14	1.07	1.55	2.11	2.67	3.21	3.85	3.98	3.44	2.41	1.50	1.23
					99.5	0.52	0.49	0.71	0.96	1.21	1.46	1.75	1.81	1.56	1.10	0.68	0.56
				13.33	98.9	1.08	1.01	1.47	1.99	2.52	3.03	3.63	3.76	3.25	2.28	1.42	1.17
					99.5	0.49	0.46	0.67	0.91	1.15	1.38	1.65	1.71	1.48	1.04	0.64	0.53
	LCL		1	14.9	98.9	0.58	0.60	0.95	1.37	1.86	2.33	2.77	2.76	2.25	1.44	0.79	0.61
					99.5	0.26	0.27	0.43	0.62	0.84	1.06	1.26	1.25	1.02	0.66	0.36	0.28
				13.33	98.9	0.55	0.56	0.90	1.30	1.75	2.20	2.62	2.61	2.13	1.37	0.75	0.57
					99.5	0.25	0.26	0.41	0.59	0.80	1.00	1.19	1.19	0.97	0.62	0.34	0.26
			2	14.9	98.9	0.88	0.82	1.20	1.62	2.09	2.56	3.08	3.18	2.75	1.90	1.15	0.95

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.5	0.40	0.37	0.54	0.73	0.95	1.16	1.40	1.44	1.25	0.87	0.52	0.43
				13.33	98.9	0.83	0.77	1.13	1.53	1.97	2.42	2.91	3.00	2.60	1.80	1.09	0.90
					99.5	0.38	0.35	0.51	0.69	0.90	1.10	1.32	1.37	1.18	0.82	0.49	0.41
	Mean	UCL	1	14.9	98.9	1.19	1.22	1.94	2.81	3.75	4.65	5.53	5.51	4.49	2.90	1.62	1.24
					99.5	0.54	0.55	0.88	1.28	1.70	2.11	2.51	2.50	2.04	1.32	0.74	0.56
				13.33	98.9	1.12	1.15	1.84	2.65	3.55	4.39	5.23	5.20	4.25	2.74	1.53	1.17
					99.5	0.51	0.52	0.83	1.21	1.61	2.00	2.38	2.37	1.93	1.25	0.70	0.53
			2	14.9	98.9	1.79	1.67	2.44	3.31	4.22	5.11	6.14	6.34	5.48	3.83	2.35	1.94
					99.5	0.81	0.76	1.11	1.50	1.92	2.32	2.79	2.88	2.49	1.74	1.07	0.88
				13.33	98.9	1.69	1.58	2.31	3.12	3.98	4.83	5.80	5.99	5.18	3.62	2.22	1.83
					99.5	0.77	0.72	1.05	1.42	1.81	2.19	2.64	2.72	2.35	1.64	1.01	0.83
		LCL	1	14.9	98.9	0.28	0.29	0.46	0.67	0.89	1.10	1.31	1.31	1.07	0.69	0.38	0.29
					99.5	0.13	0.13	0.21	0.30	0.40	0.50	0.60	0.59	0.48	0.31	0.17	0.13
				13.33	98.9	0.27	0.27	0.44	0.63	0.84	1.04	1.24	1.23	1.01	0.65	0.36	0.28
					99.5	0.12	0.12	0.20	0.29	0.38	0.47	0.56	0.56	0.46	0.30	0.16	0.13
			2	14.9	98.9	0.43	0.40	0.58	0.78	1.00	1.21	1.46	1.50	1.30	0.91	0.56	0.46
					99.5	0.19	0.18	0.26	0.36	0.45	0.55	0.66	0.68	0.59	0.41	0.25	0.21
				13.33	98.9	0.40	0.38	0.55	0.74	0.95	1.15	1.38	1.42	1.23	0.86	0.53	0.43

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.5	0.18	0.17	0.25	0.34	0.43	0.52	0.63	0.65	0.56	0.39	0.24	0.20

Kittiwake

Table H.2.1- 3: Collision risk estimates for kittiwake at Preferred Project 1 incorporating variability associated with density, flight height distribution and avoidance rate

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Option 2	Mean	Maximum likelihood	2	13.1	98.7	12.06	13.10	17.05	17.83	17.37	13.88	10.99	8.63	7.48	7.95	8.67	10.16
					98.9	10.20	11.08	14.43	15.09	14.69	11.75	9.30	7.30	6.33	6.72	7.34	8.60
					99.0	9.27	10.08	13.11	13.72	13.36	10.68	8.45	6.64	5.75	6.11	6.67	7.82
					99.1	8.35	9.07	11.80	12.34	12.02	9.61	7.61	5.98	5.18	5.50	6.01	7.03
				8.71	98.7	9.25	10.05	13.08	13.68	13.33	10.65	8.43	6.62	5.74	6.10	6.66	7.80
					98.9	7.83	8.50	11.07	11.58	11.28	9.01	7.13	5.60	4.86	5.16	5.63	6.60
					99.0	7.12	7.73	10.06	10.52	10.25	8.19	6.49	5.09	4.41	4.69	5.12	6.00
					99.1	6.40	6.96	9.06	9.47	9.23	7.37	5.84	4.59	3.97	4.22	4.61	5.40
			3	13.1	98.7	16.12	16.64	20.55	20.51	19.28	15.14	12.07	9.77	8.82	9.86	11.38	13.82
					98.9	13.64	14.08	17.39	17.36	16.31	12.81	10.22	8.26	7.47	8.35	9.63	11.70
					99.0	12.40	12.80	15.81	15.78	14.83	11.64	9.29	7.51	6.79	7.59	8.75	10.63
					99.1	11.16	11.52	14.23	14.20	13.35	10.48	8.36	6.76	6.11	6.83	7.88	9.57
				8.71	98.7	12.37	12.77	15.77	15.74	14.80	11.61	9.26	7.50	6.77	7.57	8.73	10.61
					98.9	10.47	10.80	13.34	13.32	12.52	9.83	7.84	6.34	5.73	6.40	7.39	8.98
					99.0	9.51	9.82	12.13	12.11	11.38	8.93	7.13	5.77	5.21	5.82	6.72	8.16

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.1	8.56	8.84	10.92	10.90	10.24	8.04	6.41	5.19	4.69	5.24	6.05	7.34
	UCL		2	13.1	98.9	11.52	12.57	16.36	17.08	16.48	13.09	10.41	8.26	7.12	7.55	8.21	9.66
					99.0	10.48	11.43	14.88	15.53	14.98	11.90	9.46	7.51	6.48	6.87	7.46	8.78
				8.71	98.9	8.84	9.65	12.56	13.10	12.64	10.04	7.99	6.34	5.47	5.80	6.30	7.41
					99.0	8.04	8.77	11.42	11.91	11.49	9.13	7.26	5.76	4.97	5.27	5.73	6.74
			3	13.1	98.9	15.41	15.97	19.72	19.65	18.29	14.27	11.44	9.35	8.41	9.38	10.77	13.15
					99.0	14.01	14.52	17.93	17.86	16.63	12.97	10.40	8.50	7.64	8.52	9.79	11.95
				8.71	98.9	11.82	12.26	15.13	15.08	14.04	10.95	8.77	7.17	6.45	7.19	8.26	10.09
					99.0	10.75	11.14	13.76	13.71	12.76	9.95	7.98	6.52	5.86	6.54	7.51	9.17
	LCL		2	13.1	98.9	9.02	9.74	12.68	13.28	13.05	10.52	8.33	6.48	5.61	5.98	6.57	7.65
					99.0	8.20	8.85	11.53	12.07	11.86	9.56	7.57	5.89	5.10	5.43	5.97	6.95
				8.71	98.9	6.92	7.47	9.73	10.19	10.01	8.07	6.39	4.97	4.31	4.59	5.04	5.87
					99.0	6.29	6.79	8.85	9.26	9.10	7.34	5.81	4.52	3.92	4.17	4.58	5.34
			3	13.1	98.9	12.06	12.37	15.28	15.28	14.49	11.47	9.15	7.34	6.62	7.42	8.61	10.41
					99.0	10.96	11.24	13.89	13.89	13.17	10.43	8.32	6.67	6.02	6.75	7.83	9.46
				8.71	98.9	9.25	9.49	11.73	11.72	11.12	8.80	7.02	5.63	5.08	5.69	6.61	7.99
					99.0	8.41	8.63	10.66	10.66	10.11	8.00	6.38	5.12	4.62	5.18	6.01	7.26
	Mean	UCL	2	13.1	98.9	12.38	13.45	17.50	18.30	17.83	14.25	11.28	8.86	7.68	8.16	8.91	10.43

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.0	11.25	12.22	15.91	16.64	16.21	12.95	10.25	8.06	6.98	7.42	8.10	9.48
				8.71	98.9	9.50	10.32	13.43	14.05	13.68	10.93	8.66	6.80	5.89	6.26	6.83	8.00
					99.0	8.63	9.38	12.21	12.77	12.44	9.94	7.87	6.18	5.36	5.69	6.21	7.28
			3	13.1	98.9	16.55	17.08	21.09	21.06	19.79	15.54	12.39	10.03	9.06	10.12	11.68	14.19
					99.0	15.04	15.53	19.18	19.15	17.99	14.13	11.27	9.12	8.23	9.20	10.62	12.90
				8.71	98.9	12.70	13.11	16.19	16.16	15.19	11.92	9.51	7.69	6.95	7.77	8.96	10.89
					99.0	11.54	11.92	14.72	14.69	13.81	10.84	8.65	7.00	6.32	7.06	8.15	9.90
		LCL	2	13.1	98.9	7.49	8.14	10.59	11.07	10.79	8.62	6.82	5.36	4.65	4.94	5.39	6.31
					99.0	6.81	7.40	9.63	10.07	9.81	7.84	6.20	4.87	4.22	4.49	4.90	5.74
				8.71	98.9	5.75	6.24	8.13	8.50	8.28	6.62	5.24	4.11	3.56	3.79	4.13	4.84
					99.0	5.22	5.68	7.39	7.73	7.52	6.01	4.76	3.74	3.24	3.44	3.76	4.40
			3	13.1	98.9	10.01	10.34	12.76	12.74	11.98	9.40	7.50	6.07	5.48	6.13	7.07	8.59
					99.0	9.10	9.40	11.60	11.58	10.89	8.55	6.82	5.52	4.98	5.57	6.43	7.81
				8.71	98.9	7.68	7.93	9.79	9.78	9.19	7.21	5.75	4.66	4.21	4.70	5.42	6.59
					99.0	6.98	7.21	8.90	8.89	8.35	6.56	5.23	4.23	3.82	4.27	4.93	5.99
Option 3	Mean	Maximum likelihood	2	13.1	98.0	4.84	5.26	6.85	7.16	6.98	5.58	4.41	3.47	3.00	3.19	3.49	4.08
				8.71	98.0	4.24	4.60	5.99	6.27	6.11	4.88	3.86	3.03	2.63	2.79	3.05	3.57
			3	13.1	98.0	6.48	6.69	8.26	8.24	7.75	6.08	4.85	3.92	3.55	3.96	4.57	5.55

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				8.71	98.0	5.67	5.85	7.22	7.21	6.78	5.32	4.24	3.43	3.10	3.47	4.00	4.86
	UCL		2	13.1	98.0	5.47	5.97	7.77	8.11	7.82	6.21	4.94	3.92	3.38	3.59	3.90	4.59
				8.71	98.0	4.79	5.22	6.80	7.10	6.85	5.44	4.32	3.43	2.96	3.14	3.41	4.01
			3	13.1	98.0	7.32	7.58	9.37	9.33	8.69	6.78	5.43	4.44	3.99	4.45	5.11	6.24
				8.71	98.0	6.40	6.64	8.19	8.16	7.60	5.93	4.75	3.88	3.49	3.90	4.47	5.46
	LCL		2	13.1	98.0	4.28	4.62	6.02	6.31	6.20	4.99	3.95	3.08	2.67	2.84	3.12	3.63
				8.71	98.0	3.75	4.04	5.27	5.52	5.42	4.37	3.46	2.69	2.33	2.48	2.73	3.18
			3	13.1	98.0	5.72	5.87	7.26	7.26	6.88	5.45	4.34	3.48	3.15	3.52	4.09	4.94
				8.71	98.0	5.01	5.14	6.35	6.35	6.02	4.76	3.80	3.05	2.75	3.08	3.58	4.33
	Mean	UCL	2	13.1	98.0	6.34	6.89	8.97	9.38	9.14	7.30	5.78	4.54	3.93	4.18	4.56	5.34
				8.71	98.0	5.51	5.99	7.80	8.15	7.94	6.35	5.03	3.95	3.42	3.63	3.97	4.65
			3	13.1	98.0	8.48	8.75	10.81	10.79	10.14	7.96	6.35	5.14	4.64	5.19	5.99	7.27
				8.71	98.0	7.37	7.61	9.40	9.38	8.82	6.92	5.52	4.47	4.04	4.51	5.20	6.32
		LCL	2	13.1	98.0	3.21	3.49	4.54	4.75	4.63	3.70	2.93	2.30	1.99	2.12	2.31	2.71
				8.71	98.0	2.83	3.08	4.01	4.19	4.08	3.26	2.58	2.03	1.76	1.87	2.04	2.39
			3	13.1	98.0	4.29	4.43	5.48	5.47	5.14	4.03	3.22	2.60	2.35	2.63	3.03	3.68
				8.71	98.0	3.79	3.91	4.83	4.82	4.53	3.56	2.84	2.30	2.07	2.32	2.67	3.25

Lesser black-backed gull

Table H.2.1- 4: Collision risk estimates for lesser black-backed gull at Preferred Project 1 incorporating variability associated with density, flight height distribution and avoidance rate

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Option 2	Mean	Maximum likelihood	2	13.1	99.4	0.51	0.51	1.03	1.77	1.98	1.98	2.00	1.17	0.64	0.59	0.51	0.49
					99.5	0.42	0.43	0.86	1.48	1.65	1.65	1.66	0.97	0.53	0.49	0.42	0.41
					99.6	0.34	0.34	0.69	1.18	1.32	1.32	1.33	0.78	0.43	0.39	0.34	0.33
				8.71	99.4	0.43	0.43	0.87	1.50	1.67	1.68	1.69	0.99	0.54	0.50	0.43	0.42
					99.5	0.36	0.36	0.73	1.25	1.40	1.40	1.41	0.82	0.45	0.42	0.36	0.35
					99.6	0.29	0.29	0.58	1.00	1.12	1.12	1.13	0.66	0.36	0.33	0.29	0.28
			3	13.1	99.4	0.68	0.65	1.24	2.04	2.19	2.16	2.19	1.32	0.75	0.73	0.67	0.67
					99.5	0.57	0.54	1.04	1.70	1.83	1.80	1.83	1.10	0.63	0.61	0.55	0.56
					99.6	0.45	0.43	0.83	1.36	1.46	1.44	1.46	0.88	0.50	0.49	0.44	0.45
				8.71	99.4	0.58	0.55	1.05	1.73	1.86	1.83	1.86	1.12	0.64	0.62	0.56	0.57
					99.5	0.48	0.46	0.88	1.44	1.55	1.53	1.55	0.93	0.53	0.52	0.47	0.47
					99.6	0.39	0.37	0.70	1.15	1.24	1.22	1.24	0.75	0.43	0.41	0.38	0.38
	UCL		2	13.1	99.5	0.59	0.63	1.27	2.11	2.17	2.07	2.23	1.40	0.77	0.66	0.54	0.54
				8.71	99.5	0.50	0.53	1.07	1.79	1.84	1.75	1.89	1.19	0.65	0.56	0.46	0.45
			3	13.1	99.5	0.79	0.80	1.53	2.43	2.41	2.26	2.45	1.59	0.91	0.82	0.71	0.73

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				8.71	99.5	0.67	0.68	1.29	2.06	2.04	1.91	2.08	1.35	0.77	0.69	0.60	0.62
	LCL		2	13.1	99.5	0.30	0.29	0.58	1.02	1.24	1.31	1.22	0.67	0.37	0.36	0.33	0.31
				8.71	99.5	0.26	0.25	0.49	0.87	1.05	1.11	1.03	0.57	0.31	0.31	0.28	0.26
			3	13.1	99.5	0.41	0.37	0.69	1.18	1.38	1.42	1.34	0.76	0.44	0.45	0.43	0.42
				8.71	99.5	0.34	0.31	0.59	1.00	1.17	1.21	1.14	0.65	0.37	0.38	0.37	0.36
	Mean	UCL	2	13.1	99.5	0.74	0.74	1.49	2.55	2.85	2.86	2.88	1.68	0.92	0.85	0.73	0.71
				8.71	99.5	0.62	0.63	1.26	2.16	2.41	2.42	2.44	1.43	0.78	0.72	0.62	0.60
			3	13.1	99.5	0.98	0.94	1.79	2.94	3.16	3.12	3.16	1.91	1.09	1.05	0.96	0.96
				8.71	99.5	0.83	0.79	1.52	2.49	2.68	2.64	2.68	1.62	0.92	0.89	0.81	0.82
		LCL	2	13.1	99.5	0.28	0.28	0.57	0.98	1.09	1.10	1.10	0.65	0.35	0.33	0.28	0.27
				8.71	99.5	0.24	0.24	0.48	0.83	0.93	0.93	0.94	0.55	0.30	0.28	0.24	0.23
			3	13.1	99.5	0.38	0.36	0.69	1.13	1.21	1.20	1.21	0.73	0.42	0.40	0.37	0.37
				8.71	99.5	0.32	0.30	0.58	0.95	1.03	1.01	1.03	0.62	0.35	0.34	0.31	0.31
Option 3	Mean	Maximum likelihood	2	13.1	98.7	0.44	0.44	0.90	1.54	1.72	1.72	1.74	1.02	0.56	0.51	0.44	0.43
					98.9	0.38	0.38	0.76	1.30	1.45	1.46	1.47	0.86	0.47	0.43	0.37	0.36
					99.1	0.31	0.31	0.62	1.07	1.19	1.19	1.20	0.70	0.38	0.35	0.31	0.30
					99.3	0.24	0.24	0.48	0.83	0.93	0.93	0.93	0.55	0.30	0.28	0.24	0.23
				8.71	98.7	0.40	0.40	0.81	1.40	1.56	1.57	1.58	0.92	0.51	0.47	0.40	0.39

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					98.9	0.34	0.34	0.69	1.18	1.32	1.33	1.34	0.78	0.43	0.39	0.34	0.33
					99.1	0.28	0.28	0.56	0.97	1.08	1.08	1.09	0.64	0.35	0.32	0.28	0.27
					99.3	0.22	0.22	0.44	0.75	0.84	0.84	0.85	0.50	0.27	0.25	0.22	0.21
			3	13.1	98.7	0.59	0.57	1.08	1.77	1.91	1.88	1.91	1.15	0.66	0.64	0.58	0.58
					98.9	0.50	0.48	0.91	1.50	1.61	1.59	1.61	0.97	0.56	0.54	0.49	0.49
					99.1	0.41	0.39	0.75	1.23	1.32	1.30	1.32	0.80	0.45	0.44	0.40	0.40
					99.3	0.32	0.30	0.58	0.95	1.03	1.01	1.03	0.62	0.35	0.34	0.31	0.31
				8.71	98.7	0.54	0.51	0.98	1.61	1.73	1.71	1.73	1.04	0.60	0.58	0.53	0.53
					98.9	0.46	0.43	0.83	1.36	1.47	1.45	1.47	0.88	0.50	0.49	0.44	0.45
					99.1	0.37	0.36	0.68	1.11	1.20	1.18	1.20	0.72	0.41	0.40	0.36	0.37
					99.3	0.29	0.28	0.53	0.87	0.93	0.92	0.93	0.56	0.32	0.31	0.28	0.28
	UCL		2	13.1	98.9	0.52	0.55	1.12	1.86	1.91	1.83	1.97	1.24	0.68	0.58	0.48	0.47
					99.3	0.33	0.35	0.71	1.18	1.22	1.16	1.25	0.79	0.43	0.37	0.30	0.30
				8.71	98.9	0.48	0.50	1.02	1.69	1.74	1.66	1.79	1.13	0.62	0.53	0.43	0.43
					99.3	0.30	0.32	0.65	1.08	1.11	1.06	1.14	0.72	0.39	0.34	0.27	0.27
			3	13.1	98.9	0.70	0.70	1.35	2.14	2.12	1.99	2.17	1.40	0.80	0.72	0.62	0.64
					99.3	0.44	0.45	0.86	1.36	1.35	1.27	1.38	0.89	0.51	0.46	0.40	0.41
				8.71	98.9	0.64	0.64	1.23	1.95	1.93	1.81	1.97	1.27	0.73	0.66	0.57	0.58

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.3	0.40	0.41	0.78	1.24	1.23	1.15	1.25	0.81	0.46	0.42	0.36	0.37
	LCL		2	13.1	98.9	0.27	0.26	0.51	0.90	1.10	1.15	1.08	0.59	0.33	0.32	0.29	0.27
					99.3	0.17	0.16	0.32	0.57	0.70	0.73	0.69	0.38	0.21	0.20	0.19	0.17
				8.71	98.9	0.24	0.23	0.46	0.82	1.00	1.05	0.98	0.54	0.30	0.29	0.27	0.25
					99.3	0.15	0.15	0.29	0.52	0.63	0.67	0.62	0.34	0.19	0.19	0.17	0.16
			3	13.1	98.9	0.36	0.33	0.61	1.04	1.22	1.26	1.18	0.67	0.38	0.40	0.38	0.37
					99.3	0.23	0.21	0.39	0.66	0.77	0.80	0.75	0.43	0.24	0.25	0.24	0.24
				8.71	98.9	0.33	0.30	0.56	0.94	1.11	1.14	1.08	0.61	0.35	0.36	0.35	0.34
					99.3	0.21	0.19	0.35	0.60	0.70	0.73	0.68	0.39	0.22	0.23	0.22	0.22
	Mean	UCL	2	13.1	98.9	0.88	0.89	1.79	3.07	3.42	3.44	3.46	2.02	1.11	1.02	0.88	0.85
					99.3	0.56	0.56	1.14	1.95	2.18	2.19	2.20	1.29	0.71	0.65	0.56	0.54
				8.71	98.9	0.78	0.79	1.58	2.72	3.04	3.05	3.07	1.80	0.98	0.91	0.78	0.75
					99.3	0.50	0.50	1.01	1.73	1.93	1.94	1.95	1.14	0.63	0.58	0.50	0.48
			3	13.1	98.9	1.18	1.13	2.15	3.53	3.80	3.75	3.80	2.29	1.31	1.27	1.15	1.16
					99.3	0.75	0.72	1.37	2.25	2.42	2.38	2.42	1.46	0.83	0.81	0.73	0.74
				8.71	98.9	1.05	1.00	1.91	3.13	3.37	3.32	3.37	2.03	1.16	1.12	1.02	1.03
					99.3	0.67	0.64	1.22	1.99	2.15	2.12	2.15	1.29	0.74	0.72	0.65	0.65
		LCL	2	13.1	98.9	0.21	0.21	0.42	0.72	0.80	0.81	0.81	0.48	0.26	0.24	0.21	0.20

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.3	0.13	0.13	0.27	0.46	0.51	0.51	0.52	0.30	0.17	0.15	0.13	0.13
				8.71	98.9	0.19	0.19	0.39	0.66	0.74	0.74	0.75	0.44	0.24	0.22	0.19	0.18
					99.3	0.12	0.12	0.25	0.42	0.47	0.47	0.48	0.28	0.15	0.14	0.12	0.12
			3	13.1	98.9	0.28	0.26	0.51	0.83	0.89	0.88	0.89	0.54	0.31	0.30	0.27	0.27
					99.3	0.18	0.17	0.32	0.53	0.57	0.56	0.57	0.34	0.20	0.19	0.17	0.17
				8.71	98.9	0.26	0.24	0.47	0.76	0.82	0.81	0.82	0.50	0.28	0.27	0.25	0.25
					99.3	0.16	0.15	0.30	0.49	0.52	0.52	0.52	0.32	0.18	0.17	0.16	0.16

Herring gull

Table H.2.1- 5: Collision risk estimates for herring gull at Preferred Project 1 incorporating variability associated with density, flight height distribution and avoidance rate

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Option 2	Mean	Maximum likelihood	2	12.8	99.4	4.48	5.21	3.65	1.75	1.42	0.87	0.54	0.78	1.47	1.85	2.43	3.36
					99.5	3.73	4.34	3.04	1.46	1.18	0.73	0.45	0.65	1.22	1.54	2.03	2.80
					99.6	2.99	3.48	2.43	1.17	0.94	0.58	0.36	0.52	0.98	1.23	1.62	2.24
				9.8	99.4	3.86	4.49	3.14	1.51	1.22	0.75	0.47	0.67	1.26	1.59	2.10	2.90
					99.5	3.22	3.74	2.62	1.26	1.02	0.63	0.39	0.56	1.05	1.33	1.75	2.42
					99.6	2.57	2.99	2.10	1.01	0.81	0.50	0.31	0.45	0.84	1.06	1.40	1.93
			3	12.8	99.4	5.99	6.62	4.40	2.01	1.57	0.95	0.60	0.88	1.73	2.29	3.19	4.58
					99.5	4.99	5.52	3.67	1.68	1.31	0.79	0.50	0.73	1.44	1.91	2.66	3.82
					99.6	3.99	4.42	2.93	1.34	1.05	0.63	0.40	0.58	1.15	1.53	2.13	3.05
				9.8	99.4	5.16	5.71	3.79	1.73	1.35	0.82	0.52	0.76	1.49	1.97	2.75	3.94
					99.5	4.30	4.76	3.16	1.45	1.13	0.68	0.43	0.63	1.24	1.64	2.29	3.29
					99.6	3.44	3.80	2.53	1.16	0.90	0.55	0.34	0.50	0.99	1.32	1.83	2.63
	UCL		2	12.8	99.5	4.71	5.50	3.91	1.94	1.57	0.96	0.60	0.83	1.55	1.94	2.55	3.52
				9.8	99.5	4.06	4.74	3.37	1.67	1.35	0.82	0.52	0.72	1.33	1.67	2.20	3.03
			3	12.8	99.5	6.30	6.98	4.71	2.23	1.74	1.04	0.66	0.94	1.83	2.40	3.34	4.79

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				9.8	99.5	5.43	6.02	4.06	1.92	1.50	0.90	0.57	0.81	1.57	2.07	2.88	4.13
	LCL		2	12.8	99.5	2.95	3.43	2.37	1.09	0.89	0.55	0.34	0.50	0.94	1.20	1.60	2.22
				9.8	99.5	2.54	2.95	2.04	0.94	0.76	0.47	0.29	0.43	0.81	1.03	1.38	1.91
			3	12.8	99.5	3.95	4.36	2.85	1.26	0.98	0.60	0.37	0.56	1.11	1.49	2.10	3.02
				9.8	99.5	3.40	3.75	2.46	1.08	0.85	0.51	0.32	0.48	0.96	1.28	1.81	2.60
	Mean	UCL	2	12.8	99.5	5.40	6.28	4.40	2.11	1.71	1.05	0.66	0.93	1.77	2.22	2.93	4.05
				9.8	99.5	4.65	5.41	3.79	1.82	1.47	0.91	0.57	0.80	1.52	1.92	2.53	3.49
			3	12.8	99.5	7.22	7.98	5.30	2.43	1.89	1.15	0.72	1.06	2.09	2.76	3.85	5.52
				9.8	99.5	6.22	6.88	4.57	2.09	1.63	0.99	0.62	0.91	1.80	2.38	3.31	4.75
		LCL	2	12.8	99.5	2.76	3.21	2.25	1.08	0.87	0.54	0.34	0.48	0.90	1.14	1.50	2.07
				9.8	99.5	2.38	2.77	1.94	0.93	0.75	0.46	0.29	0.41	0.78	0.98	1.29	1.78
			3	12.8	99.5	3.69	4.08	2.71	1.24	0.97	0.59	0.37	0.54	1.07	1.41	1.97	2.82
				9.8	99.5	3.18	3.51	2.33	1.07	0.83	0.50	0.32	0.47	0.92	1.22	1.69	2.43
Option 3	Mean	Maximum likelihood	2	12.8	98.8	3.94	4.58	3.21	1.54	1.24	0.77	0.48	0.68	1.29	1.62	2.14	2.96
					99.0	3.28	3.82	2.67	1.28	1.04	0.64	0.40	0.57	1.07	1.35	1.78	2.47
					99.2	2.63	3.06	2.14	1.03	0.83	0.51	0.32	0.45	0.86	1.08	1.43	1.97
					99.3	2.30	2.67	1.87	0.90	0.73	0.45	0.28	0.40	0.75	0.95	1.25	1.73
				9.8	98.8	3.60	4.19	2.93	1.41	1.14	0.70	0.44	0.62	1.18	1.48	1.95	2.70

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.0	3.00	3.49	2.44	1.17	0.95	0.58	0.36	0.52	0.98	1.24	1.63	2.25
					99.2	2.40	2.79	1.95	0.94	0.76	0.47	0.29	0.42	0.79	0.99	1.30	1.80
					99.3	2.10	2.44	1.71	0.82	0.66	0.41	0.26	0.36	0.69	0.86	1.14	1.58
			3	12.8	98.8	5.27	5.82	3.87	1.77	1.38	0.84	0.53	0.77	1.52	2.01	2.81	4.03
					99.0	4.39	4.85	3.22	1.48	1.15	0.70	0.44	0.64	1.27	1.68	2.34	3.35
					99.2	3.51	3.88	2.58	1.18	0.92	0.56	0.35	0.51	1.01	1.34	1.87	2.68
					99.3	3.07	3.40	2.26	1.03	0.81	0.49	0.31	0.45	0.89	1.17	1.64	2.35
				9.8	98.8	4.81	5.32	3.53	1.62	1.26	0.76	0.48	0.70	1.39	1.84	2.56	3.68
					99.0	4.01	4.43	2.94	1.35	1.05	0.64	0.40	0.59	1.16	1.53	2.14	3.06
					99.2	3.21	3.55	2.36	1.08	0.84	0.51	0.32	0.47	0.93	1.23	1.71	2.45
					99.3	2.81	3.10	2.06	0.94	0.74	0.45	0.28	0.41	0.81	1.07	1.50	2.14
	UCL		2	12.8	99.0	4.14	4.83	3.44	1.71	1.38	0.84	0.53	0.73	1.36	1.70	2.24	3.10
					99.3	2.90	3.38	2.41	1.19	0.96	0.59	0.37	0.51	0.95	1.19	1.57	2.17
				9.8	99.0	3.78	4.41	3.14	1.56	1.26	0.77	0.49	0.67	1.24	1.56	2.05	2.83
					99.3	2.65	3.09	2.20	1.09	0.88	0.54	0.34	0.47	0.87	1.09	1.43	1.98
			3	12.8	99.0	5.54	6.14	4.14	1.96	1.53	0.92	0.58	0.83	1.61	2.11	2.94	4.21
					99.3	3.88	4.30	2.90	1.37	1.07	0.64	0.41	0.58	1.13	1.48	2.06	2.95
				9.8	99.0	5.06	5.61	3.79	1.79	1.40	0.84	0.53	0.76	1.47	1.93	2.69	3.85

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.3	3.54	3.93	2.65	1.26	0.98	0.59	0.37	0.53	1.03	1.35	1.88	2.69
	LCL		2	12.8	99.0	2.60	3.02	2.08	0.96	0.78	0.48	0.30	0.44	0.83	1.06	1.41	1.95
					99.3	1.82	2.11	1.46	0.67	0.55	0.34	0.21	0.31	0.58	0.74	0.98	1.37
				9.8	99.0	2.37	2.75	1.90	0.88	0.71	0.44	0.27	0.40	0.76	0.96	1.28	1.78
					99.3	1.66	1.93	1.33	0.61	0.50	0.31	0.19	0.28	0.53	0.68	0.90	1.25
			3	12.8	99.0	3.47	3.83	2.51	1.10	0.86	0.52	0.33	0.49	0.98	1.31	1.84	2.66
					99.3	2.43	2.68	1.76	0.77	0.61	0.37	0.23	0.35	0.68	0.92	1.29	1.86
				9.8	99.0	3.17	3.50	2.29	1.01	0.79	0.48	0.30	0.45	0.89	1.20	1.68	2.43
					99.3	2.22	2.45	1.60	0.71	0.55	0.33	0.21	0.32	0.62	0.84	1.18	1.70
	Mean	UCL	2	12.8	99.0	6.04	7.03	4.92	2.36	1.91	1.18	0.73	1.05	1.98	2.49	3.28	4.54
					99.3	4.23	4.92	3.44	1.65	1.34	0.82	0.51	0.73	1.38	1.74	2.30	3.17
				9.8	99.0	5.41	6.30	4.41	2.12	1.71	1.05	0.66	0.94	1.77	2.23	2.94	4.07
					99.3	3.79	4.41	3.09	1.48	1.20	0.74	0.46	0.66	1.24	1.56	2.06	2.85
			3	12.8	99.0	8.07	8.93	5.93	2.71	2.12	1.28	0.81	1.18	2.33	3.09	4.30	6.17
					99.3	5.65	6.25	4.15	1.90	1.48	0.90	0.56	0.83	1.63	2.16	3.01	4.32
				9.8	99.0	7.24	8.00	5.32	2.43	1.90	1.15	0.72	1.06	2.09	2.77	3.86	5.53
					99.3	5.07	5.60	3.72	1.70	1.33	0.80	0.51	0.74	1.46	1.94	2.70	3.87
		LCL	2	12.8	99.0	2.14	2.49	1.74	0.83	0.67	0.42	0.26	0.37	0.70	0.88	1.16	1.60

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.3	1.49	1.74	1.22	0.58	0.47	0.29	0.18	0.26	0.49	0.62	0.81	1.12
				9.8	99.0	1.97	2.29	1.60	0.77	0.62	0.38	0.24	0.34	0.64	0.81	1.07	1.48
					99.3	1.38	1.60	1.12	0.54	0.44	0.27	0.17	0.24	0.45	0.57	0.75	1.03
			3	12.8	99.0	2.86	3.16	2.10	0.96	0.75	0.45	0.29	0.42	0.82	1.09	1.52	2.18
					99.3	2.00	2.21	1.47	0.67	0.52	0.32	0.20	0.29	0.58	0.76	1.07	1.53
				9.8	99.0	2.63	2.91	1.93	0.88	0.69	0.42	0.26	0.39	0.76	1.01	1.40	2.01
					99.3	1.84	2.04	1.35	0.62	0.48	0.29	0.18	0.27	0.53	0.70	0.98	1.41

H.6 Preferred Project 2

Gannet

Table H.2.1- 6: Collision risk estimates for gannet at Preferred Project 2 incorporating variability associated with density, flight height distribution and avoidance rate

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Option 2	Mean	Maximum likelihood	1	14.9	98.7	0.47	0.49	0.78	1.12	1.48	1.81	2.12	2.09	1.71	1.10	0.62	0.48
					98.9	0.40	0.41	0.66	0.95	1.26	1.53	1.79	1.77	1.45	0.93	0.53	0.41
					99.1	0.33	0.34	0.54	0.78	1.03	1.25	1.47	1.45	1.18	0.76	0.43	0.34
					99.5	0.18	0.19	0.30	0.43	0.57	0.69	0.81	0.80	0.66	0.42	0.24	0.19
				13.33	98.7	0.44	0.46	0.74	1.06	1.40	1.71	2.00	1.98	1.62	1.04	0.59	0.46
					98.9	0.38	0.39	0.62	0.90	1.19	1.44	1.69	1.67	1.37	0.88	0.50	0.39
					99.1	0.31	0.32	0.51	0.74	0.97	1.18	1.39	1.37	1.12	0.72	0.41	0.32
					99.5	0.17	0.18	0.28	0.41	0.54	0.66	0.77	0.76	0.62	0.40	0.23	0.18
			2	14.9	98.7	0.71	0.67	0.98	1.32	1.67	1.99	2.35	2.41	2.08	1.45	0.90	0.76
					98.9	0.60	0.57	0.83	1.12	1.41	1.68	1.99	2.04	1.76	1.23	0.76	0.64
					99.1	0.49	0.46	0.68	0.92	1.15	1.37	1.63	1.67	1.44	1.01	0.63	0.52
					99.5	0.27	0.26	0.38	0.51	0.64	0.76	0.90	0.93	0.80	0.56	0.35	0.29
				13.33	98.7	0.67	0.63	0.93	1.25	1.58	1.88	2.22	2.28	1.97	1.38	0.85	0.72
					98.9	0.57	0.53	0.79	1.06	1.33	1.59	1.88	1.93	1.67	1.16	0.72	0.61

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.1	0.46	0.44	0.64	0.87	1.09	1.30	1.54	1.58	1.36	0.95	0.59	0.50
					99.5	0.26	0.24	0.36	0.48	0.61	0.72	0.85	0.88	0.76	0.53	0.33	0.28
	UCL		1	14.9	98.9	0.46	0.47	0.75	1.09	1.43	1.73	2.02	1.99	1.63	1.06	0.60	0.47
					99.5	0.21	0.21	0.34	0.50	0.65	0.78	0.92	0.91	0.74	0.48	0.27	0.21
				13.33	98.9	0.43	0.45	0.71	1.03	1.35	1.63	1.91	1.88	1.54	1.00	0.57	0.44
					99.5	0.20	0.20	0.32	0.47	0.61	0.74	0.87	0.86	0.70	0.45	0.26	0.20
			2	14.9	98.9	0.69	0.65	0.95	1.28	1.60	1.90	2.24	2.30	1.99	1.40	0.87	0.73
					99.5	0.31	0.29	0.43	0.58	0.73	0.86	1.02	1.04	0.90	0.63	0.40	0.33
				13.33	98.9	0.65	0.61	0.89	1.21	1.52	1.79	2.12	2.17	1.88	1.32	0.83	0.69
					99.5	0.29	0.28	0.41	0.55	0.69	0.82	0.96	0.99	0.85	0.60	0.38	0.31
	LCL		1	14.9	98.9	0.34	0.36	0.57	0.83	1.10	1.35	1.59	1.57	1.28	0.82	0.46	0.36
					99.5	0.16	0.16	0.26	0.38	0.50	0.62	0.72	0.71	0.58	0.37	0.21	0.16
				13.33	98.9	0.33	0.34	0.54	0.78	1.04	1.28	1.50	1.48	1.21	0.78	0.43	0.34
					99.5	0.15	0.15	0.25	0.36	0.47	0.58	0.68	0.67	0.55	0.35	0.20	0.15
			2	14.9	98.9	0.52	0.49	0.72	0.97	1.24	1.49	1.77	1.81	1.57	1.08	0.66	0.56
					99.5	0.24	0.22	0.33	0.44	0.56	0.68	0.80	0.82	0.71	0.49	0.30	0.25
				13.33	98.9	0.49	0.46	0.68	0.92	1.17	1.41	1.67	1.71	1.48	1.03	0.63	0.53
					99.5	0.22	0.21	0.31	0.42	0.53	0.64	0.76	0.78	0.67	0.47	0.28	0.24

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Mean	UCL	1	14.9	98.9	0.71	0.73	1.18	1.70	2.24	2.72	3.19	3.15	2.58	1.66	0.94	0.73
					99.5	0.32	0.33	0.53	0.77	1.02	1.24	1.45	1.43	1.17	0.76	0.43	0.33
				13.33	98.9	0.67	0.69	1.11	1.60	2.11	2.57	3.02	2.98	2.44	1.57	0.89	0.69
					99.5	0.30	0.32	0.51	0.73	0.96	1.17	1.37	1.35	1.11	0.72	0.40	0.31
			2	14.9	98.9	1.07	1.01	1.48	2.00	2.51	2.99	3.54	3.63	3.14	2.19	1.36	1.14
					99.5	0.49	0.46	0.67	0.91	1.14	1.36	1.61	1.65	1.43	1.00	0.62	0.52
				13.33	98.9	1.01	0.95	1.40	1.89	2.38	2.83	3.35	3.43	2.97	2.07	1.29	1.08
					99.5	0.46	0.43	0.64	0.86	1.08	1.29	1.52	1.56	1.35	0.94	0.58	0.49
		LCL	1	14.9	98.9	0.17	0.17	0.28	0.40	0.53	0.65	0.76	0.75	0.61	0.40	0.22	0.17
					99.5	0.08	0.08	0.13	0.18	0.24	0.29	0.34	0.34	0.28	0.18	0.10	0.08
				13.33	98.9	0.16	0.16	0.26	0.38	0.50	0.61	0.72	0.71	0.58	0.37	0.21	0.16
					99.5	0.07	0.07	0.12	0.17	0.23	0.28	0.33	0.32	0.26	0.17	0.10	0.07
			2	14.9	98.9	0.25	0.24	0.35	0.47	0.60	0.71	0.84	0.86	0.75	0.52	0.32	0.27
					99.5	0.12	0.11	0.16	0.22	0.27	0.32	0.38	0.39	0.34	0.24	0.15	0.12
				13.33	98.9	0.24	0.23	0.33	0.45	0.56	0.67	0.79	0.81	0.70	0.49	0.31	0.26
					99.5	0.11	0.10	0.15	0.20	0.26	0.31	0.36	0.37	0.32	0.22	0.14	0.12

Kittiwake

Table H.2.1- 7: Collision risk estimates for kittiwake at Preferred Project 2 incorporating variability associated with density, flight height distribution and avoidance rate

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Option 2	Mean	Maximum likelihood	2	13.1	98.7	8.55	9.31	12.19	12.76	12.35	9.87	7.89	6.27	5.42	5.68	6.15	7.19
					98.9	7.23	7.88	10.31	10.79	10.45	8.35	6.68	5.30	4.59	4.81	5.20	6.09
					99.0	6.58	7.16	9.37	9.81	9.50	7.59	6.07	4.82	4.17	4.37	4.73	5.53
					99.1	5.92	6.44	8.44	8.83	8.55	6.83	5.46	4.34	3.75	3.94	4.26	4.98
				8.71	98.7	6.56	7.14	9.35	9.79	9.48	7.57	6.05	4.81	4.16	4.36	4.72	5.52
					98.9	5.55	6.04	7.91	8.28	8.02	6.41	5.12	4.07	3.52	3.69	3.99	4.67
					99.0	5.05	5.49	7.19	7.53	7.29	5.83	4.66	3.70	3.20	3.36	3.63	4.24
					99.1	4.54	4.94	6.47	6.78	6.56	5.24	4.19	3.33	2.88	3.02	3.27	3.82
			3	13.1	98.7	11.42	11.82	14.69	14.68	13.72	10.77	8.67	7.10	6.40	7.05	8.06	9.78
					98.9	9.67	10.00	12.43	12.42	11.61	9.11	7.34	6.00	5.41	5.97	6.82	8.28
					99.0	8.79	9.09	11.30	11.29	10.55	8.28	6.67	5.46	4.92	5.43	6.20	7.52
					99.1	7.91	8.18	10.17	10.16	9.50	7.45	6.00	4.91	4.43	4.88	5.58	6.77
				8.71	98.7	8.76	9.07	11.27	11.26	10.53	8.26	6.65	5.45	4.91	5.41	6.19	7.50
					98.9	7.42	7.68	9.54	9.53	8.91	6.99	5.63	4.61	4.15	4.58	5.23	6.35
					99.0	6.74	6.98	8.67	8.66	8.10	6.35	5.12	4.19	3.78	4.16	4.76	5.77

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.1	6.07	6.28	7.80	7.80	7.29	5.72	4.61	3.77	3.40	3.75	4.28	5.20
	UCL		2	13.1	98.9	8.23	9.01	11.77	12.27	11.78	9.36	7.53	6.05	5.20	5.44	5.86	6.89
					99.0	7.48	8.19	10.70	11.15	10.71	8.51	6.85	5.50	4.73	4.95	5.33	6.26
				8.71	98.9	6.32	6.92	9.03	9.41	9.04	7.19	5.78	4.64	3.99	4.18	4.50	5.28
					99.0	5.74	6.29	8.21	8.56	8.22	6.53	5.25	4.22	3.63	3.80	4.09	4.80
			3	13.1	98.9	11.00	11.45	14.19	14.12	13.09	10.21	8.28	6.84	6.14	6.75	7.68	9.36
					99.0	10.00	10.41	12.90	12.83	11.90	9.29	7.53	6.22	5.58	6.14	6.98	8.51
				8.71	98.9	8.44	8.79	10.89	10.83	10.04	7.84	6.35	5.25	4.71	5.18	5.89	7.19
					99.0	7.67	7.99	9.90	9.85	9.13	7.13	5.77	4.77	4.28	4.71	5.36	6.53
	LCL		2	13.1	98.9	6.34	6.85	8.93	9.41	9.21	7.45	5.94	4.66	4.03	4.25	4.63	5.38
					99.0	5.77	6.23	8.12	8.55	8.37	6.77	5.40	4.24	3.66	3.86	4.21	4.89
				8.71	98.9	4.87	5.25	6.86	7.22	7.07	5.72	4.56	3.58	3.09	3.26	3.56	4.13
					99.0	4.42	4.78	6.23	6.56	6.42	5.20	4.14	3.25	2.81	2.96	3.23	3.76
			3	13.1	98.9	8.48	8.70	10.77	10.83	10.23	8.13	6.53	5.28	4.75	5.27	6.08	7.32
					99.0	7.70	7.91	9.79	9.84	9.30	7.39	5.94	4.80	4.32	4.79	5.52	6.66
				8.71	98.9	6.50	6.67	8.26	8.31	7.85	6.24	5.01	4.05	3.65	4.05	4.66	5.62
					99.0	5.91	6.07	7.51	7.55	7.13	5.67	4.55	3.68	3.32	3.68	4.24	5.11
	Mean	UCL	2	13.1	98.9	8.78	9.55	12.51	13.10	12.68	10.13	8.10	6.44	5.57	5.84	6.31	7.38

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.0	7.98	8.69	11.37	11.90	11.53	9.21	7.36	5.85	5.06	5.31	5.74	6.71
				8.71	98.9	6.73	7.33	9.60	10.05	9.73	7.78	6.21	4.94	4.27	4.48	4.84	5.67
					99.0	6.12	6.67	8.73	9.13	8.85	7.07	5.65	4.49	3.88	4.07	4.40	5.15
			3	13.1	98.9	11.73	12.14	15.08	15.07	14.08	11.05	8.90	7.28	6.57	7.24	8.28	10.04
					99.0	10.66	11.03	13.71	13.70	12.80	10.05	8.09	6.62	5.97	6.58	7.52	9.13
				8.71	98.9	9.00	9.31	11.57	11.56	10.81	8.48	6.83	5.59	5.04	5.56	6.35	7.70
					99.0	8.18	8.47	10.52	10.51	9.82	7.71	6.21	5.08	4.58	5.05	5.77	7.00
		LCL	2	13.1	98.9	5.31	5.78	7.57	7.92	7.67	6.13	4.90	3.89	3.37	3.53	3.82	4.47
					99.0	4.83	5.26	6.88	7.20	6.97	5.57	4.45	3.54	3.06	3.21	3.47	4.06
				8.71	98.9	4.07	4.44	5.81	6.08	5.89	4.70	3.76	2.99	2.58	2.71	2.93	3.43
					99.0	3.70	4.03	5.28	5.53	5.35	4.28	3.42	2.72	2.35	2.46	2.66	3.12
			3	13.1	98.9	7.09	7.34	9.12	9.12	8.52	6.69	5.39	4.41	3.97	4.38	5.01	6.07
					99.0	6.45	6.68	8.29	8.29	7.75	6.08	4.90	4.01	3.61	3.98	4.55	5.52
				8.71	98.9	5.44	5.63	7.00	7.00	6.54	5.13	4.13	3.38	3.05	3.36	3.84	4.66
					99.0	4.95	5.12	6.36	6.36	5.94	4.66	3.76	3.07	2.77	3.06	3.49	4.24
Option 3	Mean	Maximum likelihood	2	13.1	98.0	3.43	3.74	4.90	5.13	4.96	3.97	3.17	2.52	2.18	2.28	2.47	2.89
				8.71	98.0	3.01	3.27	4.28	4.48	4.34	3.47	2.77	2.20	1.91	2.00	2.16	2.53
			3	13.1	98.0	4.59	4.75	5.90	5.90	5.51	4.33	3.48	2.85	2.57	2.83	3.24	3.93

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				8.71	98.0	4.02	4.16	5.16	5.16	4.82	3.78	3.05	2.49	2.25	2.48	2.83	3.44
	UCL		2	13.1	98.0	3.91	4.28	5.59	5.83	5.60	4.45	3.58	2.87	2.47	2.58	2.78	3.27
				8.71	98.0	3.42	3.75	4.89	5.10	4.90	3.89	3.13	2.51	2.16	2.26	2.43	2.86
			3	13.1	98.0	5.22	5.44	6.74	6.70	6.21	4.85	3.93	3.25	2.92	3.21	3.65	4.45
				8.71	98.0	4.57	4.76	5.90	5.87	5.44	4.24	3.44	2.84	2.55	2.81	3.19	3.89
	LCL		2	13.1	98.0	3.01	3.25	4.24	4.47	4.37	3.54	2.82	2.21	1.91	2.02	2.20	2.56
				8.71	98.0	2.64	2.85	3.71	3.91	3.83	3.10	2.47	1.94	1.67	1.77	1.93	2.24
			3	13.1	98.0	4.02	4.13	5.11	5.14	4.86	3.86	3.10	2.51	2.26	2.50	2.89	3.48
				8.71	98.0	3.52	3.61	4.47	4.50	4.25	3.38	2.71	2.19	1.97	2.19	2.52	3.04
	Mean	UCL	2	13.1	98.0	4.50	4.90	6.41	6.71	6.50	5.19	4.15	3.30	2.85	2.99	3.23	3.78
				8.71	98.0	3.91	4.26	5.57	5.83	5.65	4.51	3.61	2.87	2.48	2.60	2.81	3.29
			3	13.1	98.0	6.01	6.22	7.73	7.72	7.22	5.66	4.56	3.73	3.37	3.71	4.24	5.14
				8.71	98.0	5.22	5.41	6.72	6.71	6.27	4.92	3.97	3.25	2.93	3.23	3.69	4.47
		LCL	2	13.1	98.0	2.28	2.48	3.25	3.40	3.29	2.63	2.10	1.67	1.44	1.51	1.64	1.92
				8.71	98.0	2.01	2.19	2.86	3.00	2.90	2.32	1.85	1.47	1.27	1.34	1.44	1.69
			3	13.1	98.0	3.04	3.15	3.91	3.91	3.66	2.87	2.31	1.89	1.70	1.88	2.15	2.61
				8.71	98.0	2.68	2.78	3.45	3.45	3.22	2.53	2.04	1.67	1.50	1.66	1.89	2.30

Lesser black-backed gull

Table H.2.1- 8: Collision risk estimates for lesser black-backed gull at Preferred Project 2 incorporating variability associated with density, flight height distribution and avoidance rate

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Option 2	Mean	Maximum likelihood	2	13.1	99.4	0.70	0.70	1.41	2.40	2.66	2.64	2.63	1.54	0.85	0.79	0.69	0.67
					99.5	0.58	0.59	1.17	2.00	2.21	2.20	2.19	1.28	0.71	0.66	0.57	0.56
					99.6	0.47	0.47	0.94	1.60	1.77	1.76	1.75	1.03	0.57	0.53	0.46	0.45
				8.71	99.4	0.59	0.60	1.19	2.03	2.25	2.24	2.23	1.31	0.72	0.67	0.58	0.57
					99.5	0.49	0.50	0.99	1.69	1.88	1.87	1.86	1.09	0.60	0.56	0.49	0.47
					99.6	0.39	0.40	0.79	1.35	1.50	1.49	1.49	0.87	0.48	0.45	0.39	0.38
			3	13.1	99.4	0.93	0.89	1.69	2.76	2.95	2.88	2.89	1.74	1.00	0.98	0.90	0.91
					99.5	0.78	0.74	1.41	2.30	2.46	2.40	2.41	1.45	0.84	0.82	0.75	0.76
					99.6	0.62	0.60	1.13	1.84	1.97	1.92	1.93	1.16	0.67	0.65	0.60	0.61
				8.71	99.4	0.79	0.76	1.44	2.34	2.50	2.44	2.45	1.48	0.85	0.83	0.76	0.77
					99.5	0.66	0.63	1.20	1.95	2.08	2.03	2.04	1.23	0.71	0.69	0.64	0.64
					99.6	0.53	0.50	0.96	1.56	1.67	1.63	1.63	0.99	0.57	0.55	0.51	0.51
	UCL		2	13.1	99.5	0.80	0.85	1.71	2.80	2.88	2.73	2.87	1.80	0.99	0.86	0.72	0.72
				8.71	99.5	0.68	0.72	1.45	2.38	2.44	2.31	2.43	1.52	0.84	0.73	0.61	0.61
			3	13.1	99.5	1.07	1.08	2.06	3.23	3.20	2.98	3.15	2.04	1.17	1.07	0.94	0.98

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				8.71	99.5	0.91	0.91	1.74	2.73	2.71	2.52	2.67	1.73	0.99	0.91	0.80	0.83
	LCL		2	13.1	99.5	0.42	0.40	0.80	1.41	1.70	1.77	1.65	0.91	0.50	0.50	0.45	0.43
				8.71	99.5	0.36	0.34	0.68	1.19	1.44	1.50	1.40	0.77	0.43	0.42	0.38	0.36
			3	13.1	99.5	0.56	0.51	0.96	1.62	1.89	1.93	1.82	1.03	0.59	0.62	0.60	0.58
				8.71	99.5	0.47	0.43	0.82	1.37	1.60	1.64	1.54	0.88	0.50	0.52	0.50	0.49
	Mean	UCL	2	13.1	99.5	1.01	1.01	2.03	3.46	3.83	3.81	3.79	2.22	1.22	1.14	0.99	0.96
				8.71	99.5	0.85	0.86	1.72	2.93	3.25	3.23	3.22	1.88	1.04	0.97	0.84	0.82
			3	13.1	99.5	1.34	1.29	2.44	3.98	4.25	4.16	4.17	2.51	1.45	1.41	1.30	1.31
				8.71	99.5	1.14	1.09	2.07	3.37	3.60	3.52	3.53	2.13	1.22	1.20	1.10	1.11
		LCL	2	13.1	99.5	0.39	0.39	0.78	1.33	1.47	1.46	1.46	0.85	0.47	0.44	0.38	0.37
				8.71	99.5	0.33	0.33	0.66	1.12	1.24	1.24	1.23	0.72	0.40	0.37	0.32	0.31
			3	13.1	99.5	0.52	0.49	0.94	1.53	1.63	1.59	1.60	0.96	0.55	0.54	0.50	0.50
				8.71	99.5	0.44	0.42	0.79	1.29	1.38	1.35	1.35	0.82	0.47	0.46	0.42	0.43
Option 3	Mean	Maximum likelihood	2	13.1	98.7	0.61	0.61	1.22	2.08	2.31	2.30	2.29	1.34	0.74	0.69	0.60	0.58
					98.9	0.51	0.52	1.03	1.76	1.95	1.94	1.94	1.13	0.62	0.58	0.51	0.49
					99.1	0.42	0.42	0.85	1.44	1.60	1.59	1.58	0.93	0.51	0.48	0.41	0.40
					99.3	0.33	0.33	0.66	1.12	1.24	1.24	1.23	0.72	0.40	0.37	0.32	0.31
				8.71	98.7	0.55	0.56	1.11	1.89	2.10	2.09	2.08	1.22	0.67	0.62	0.54	0.53

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					98.9	0.47	0.47	0.94	1.60	1.78	1.77	1.76	1.03	0.57	0.53	0.46	0.45
					99.1	0.38	0.38	0.77	1.31	1.45	1.45	1.44	0.84	0.46	0.43	0.38	0.37
					99.3	0.30	0.30	0.60	1.02	1.13	1.12	1.12	0.66	0.36	0.34	0.29	0.28
			3	13.1	98.7	0.81	0.78	1.47	2.40	2.56	2.50	2.51	1.52	0.87	0.85	0.78	0.79
					98.9	0.69	0.66	1.25	2.03	2.17	2.12	2.13	1.28	0.74	0.72	0.66	0.67
					99.1	0.56	0.54	1.02	1.66	1.78	1.73	1.74	1.05	0.60	0.59	0.54	0.55
					99.3	0.44	0.42	0.79	1.29	1.38	1.35	1.35	0.82	0.47	0.46	0.42	0.43
				8.71	98.7	0.74	0.71	1.34	2.18	2.33	2.28	2.29	1.38	0.79	0.77	0.71	0.72
					98.9	0.62	0.60	1.13	1.85	1.97	1.93	1.93	1.17	0.67	0.66	0.60	0.61
					99.1	0.51	0.49	0.93	1.51	1.61	1.58	1.58	0.95	0.55	0.54	0.49	0.50
					99.3	0.40	0.38	0.72	1.17	1.26	1.23	1.23	0.74	0.43	0.42	0.38	0.39
	UCL		2	13.1	98.9	0.71	0.75	1.51	2.47	2.54	2.41	2.53	1.59	0.88	0.76	0.63	0.64
					99.3	0.45	0.48	0.96	1.57	1.62	1.53	1.61	1.01	0.56	0.48	0.40	0.40
				8.71	98.9	0.64	0.68	1.37	2.25	2.31	2.19	2.30	1.44	0.80	0.69	0.58	0.58
					99.3	0.41	0.43	0.87	1.43	1.47	1.39	1.46	0.92	0.51	0.44	0.37	0.37
			3	13.1	98.9	0.95	0.95	1.82	2.85	2.82	2.63	2.78	1.80	1.03	0.94	0.83	0.86
					99.3	0.60	0.61	1.16	1.81	1.80	1.67	1.77	1.14	0.66	0.60	0.53	0.55
				8.71	98.9	0.86	0.86	1.65	2.59	2.57	2.39	2.53	1.63	0.94	0.86	0.76	0.79

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.3	0.55	0.55	1.05	1.65	1.63	1.52	1.61	1.04	0.60	0.55	0.48	0.50
	LCL		2	13.1	98.9	0.37	0.36	0.71	1.24	1.50	1.56	1.46	0.81	0.44	0.44	0.40	0.38
					99.3	0.24	0.23	0.45	0.79	0.95	0.99	0.93	0.51	0.28	0.28	0.26	0.24
				8.71	98.9	0.34	0.32	0.64	1.13	1.36	1.42	1.33	0.73	0.40	0.40	0.36	0.34
					99.3	0.21	0.21	0.41	0.72	0.87	0.90	0.84	0.47	0.26	0.25	0.23	0.22
			3	13.1	98.9	0.49	0.45	0.85	1.43	1.66	1.70	1.60	0.91	0.52	0.54	0.53	0.51
					99.3	0.31	0.29	0.54	0.91	1.06	1.08	1.02	0.58	0.33	0.35	0.33	0.33
				8.71	98.9	0.45	0.41	0.77	1.30	1.51	1.55	1.46	0.83	0.48	0.50	0.48	0.47
					99.3	0.29	0.26	0.49	0.83	0.96	0.99	0.93	0.53	0.30	0.32	0.30	0.30
	Mean	UCL	2	13.1	98.9	1.21	1.22	2.44	4.16	4.60	4.58	4.56	2.67	1.47	1.37	1.19	1.16
					99.3	0.77	0.77	1.55	2.64	2.93	2.91	2.90	1.70	0.94	0.87	0.76	0.74
				8.71	98.9	1.07	1.08	2.16	3.69	4.08	4.06	4.05	2.37	1.31	1.21	1.06	1.03
					99.3	0.68	0.69	1.38	2.35	2.60	2.58	2.57	1.51	0.83	0.77	0.67	0.65
			3	13.1	98.9	1.62	1.55	2.94	4.78	5.11	4.99	5.01	3.02	1.74	1.70	1.56	1.58
					99.3	1.03	0.98	1.87	3.04	3.25	3.18	3.19	1.92	1.11	1.08	0.99	1.00
				8.71	98.9	1.43	1.37	2.60	4.24	4.54	4.43	4.45	2.68	1.54	1.51	1.39	1.40
					99.3	0.91	0.87	1.66	2.70	2.89	2.82	2.83	1.71	0.98	0.96	0.88	0.89
		LCL	2	13.1	98.9	0.28	0.29	0.57	0.98	1.08	1.07	1.07	0.63	0.35	0.32	0.28	0.27

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.3	0.18	0.18	0.36	0.62	0.69	0.68	0.68	0.40	0.22	0.20	0.18	0.17
				8.71	98.9	0.26	0.26	0.53	0.90	0.99	0.99	0.99	0.58	0.32	0.30	0.26	0.25
					99.3	0.17	0.17	0.33	0.57	0.63	0.63	0.63	0.37	0.20	0.19	0.16	0.16
			3	13.1	98.9	0.38	0.36	0.69	1.12	1.20	1.17	1.18	0.71	0.41	0.40	0.37	0.37
					99.3	0.24	0.23	0.44	0.71	0.76	0.75	0.75	0.45	0.26	0.25	0.23	0.24
				8.71	98.9	0.35	0.33	0.63	1.03	1.10	1.08	1.08	0.65	0.38	0.37	0.34	0.34
					99.3	0.22	0.21	0.40	0.66	0.70	0.69	0.69	0.42	0.24	0.23	0.21	0.22

Herring gull

Table H.2.1- 9: Collision risk estimates for herring gull at Preferred Project 2 incorporating variability associated with density, flight height distribution and avoidance rate

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Option 2	Mean	Maximum likelihood	2	12.8	99.4	5.14	5.88	4.16	2.02	1.68	1.07	0.70	1.02	1.91	2.34	2.97	3.96
					99.5	4.28	4.90	3.46	1.68	1.40	0.89	0.58	0.85	1.59	1.95	2.47	3.30
					99.6	3.43	3.92	2.77	1.35	1.12	0.72	0.46	0.68	1.27	1.56	1.98	2.64
				9.8	99.4	4.43	5.07	3.58	1.74	1.44	0.92	0.60	0.87	1.65	2.01	2.56	3.41
					99.5	3.69	4.22	2.98	1.45	1.20	0.77	0.50	0.73	1.37	1.68	2.13	2.85
					99.6	2.95	3.38	2.39	1.16	0.96	0.62	0.40	0.58	1.10	1.34	1.70	2.28
			3	12.8	99.4	6.87	7.47	5.01	2.32	1.86	1.17	0.77	1.15	2.26	2.90	3.89	5.39
					99.5	5.72	6.22	4.18	1.94	1.55	0.97	0.64	0.96	1.88	2.42	3.24	4.49
					99.6	4.58	4.98	3.34	1.55	1.24	0.78	0.51	0.77	1.50	1.93	2.59	3.59
				9.8	99.4	5.92	6.43	4.32	2.00	1.60	1.01	0.66	0.99	1.94	2.50	3.35	4.64
					99.5	4.93	5.36	3.60	1.67	1.34	0.84	0.55	0.82	1.62	2.08	2.79	3.87
					99.6	3.94	4.29	2.88	1.34	1.07	0.67	0.44	0.66	1.30	1.67	2.24	3.10
	UCL		2	12.8	99.5	5.38	6.17	4.46	2.25	1.86	1.18	0.78	1.11	2.05	2.47	3.11	4.13
				9.8	99.5	4.63	5.32	3.84	1.94	1.60	1.02	0.67	0.96	1.76	2.13	2.68	3.56
			3	12.8	99.5	7.19	7.84	5.37	2.59	2.06	1.29	0.86	1.26	2.41	3.06	4.08	5.62

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				9.8	99.5	6.19	6.76	4.63	2.23	1.77	1.11	0.74	1.08	2.08	2.64	3.51	4.84
	LCL		2	12.8	99.5	3.40	3.88	2.69	1.26	1.05	0.67	0.43	0.64	1.22	1.53	1.96	2.63
				9.8	99.5	2.93	3.34	2.32	1.08	0.91	0.58	0.37	0.55	1.05	1.32	1.69	2.27
			3	12.8	99.5	4.55	4.93	3.24	1.45	1.17	0.73	0.47	0.73	1.44	1.89	2.58	3.58
				9.8	99.5	3.92	4.25	2.79	1.25	1.01	0.63	0.41	0.63	1.24	1.63	2.22	3.09
	Mean	UCL	2	12.8	99.5	6.19	7.08	5.01	2.43	2.02	1.29	0.84	1.22	2.30	2.82	3.58	4.78
				9.8	99.5	5.33	6.10	4.32	2.10	1.74	1.11	0.72	1.05	1.98	2.43	3.08	4.11
			3	12.8	99.5	8.27	9.00	6.04	2.80	2.24	1.41	0.92	1.38	2.72	3.50	4.69	6.49
				9.8	99.5	7.13	7.75	5.20	2.41	1.93	1.21	0.80	1.19	2.34	3.01	4.04	5.59
		LCL	2	12.8	99.5	3.16	3.62	2.56	1.24	1.03	0.66	0.43	0.62	1.18	1.44	1.83	2.44
				9.8	99.5	2.73	3.12	2.20	1.07	0.89	0.57	0.37	0.54	1.01	1.24	1.57	2.10
			3	12.8	99.5	4.23	4.60	3.08	1.43	1.15	0.72	0.47	0.71	1.39	1.79	2.40	3.32
				9.8	99.5	3.64	3.96	2.66	1.23	0.99	0.62	0.41	0.61	1.20	1.54	2.06	2.86
Option 3	Mean	Maximum likelihood	2	12.8	98.8	4.52	5.17	3.66	1.78	1.47	0.94	0.61	0.89	1.68	2.06	2.61	3.48
					99.0	3.77	4.31	3.05	1.48	1.23	0.79	0.51	0.74	1.40	1.71	2.17	2.90
					99.2	3.01	3.45	2.44	1.18	0.98	0.63	0.41	0.59	1.12	1.37	1.74	2.32
					99.3	2.64	3.02	2.13	1.04	0.86	0.55	0.36	0.52	0.98	1.20	1.52	2.03
				9.8	98.8	4.13	4.72	3.34	1.62	1.35	0.86	0.56	0.82	1.54	1.88	2.38	3.18

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.0	3.44	3.93	2.78	1.35	1.12	0.72	0.47	0.68	1.28	1.57	1.99	2.65
					99.2	2.75	3.15	2.23	1.08	0.90	0.57	0.37	0.54	1.02	1.25	1.59	2.12
					99.3	2.41	2.75	1.95	0.95	0.79	0.50	0.33	0.48	0.90	1.10	1.39	1.86
			3	12.8	98.8	6.04	6.57	4.41	2.04	1.64	1.03	0.67	1.01	1.98	2.55	3.42	4.74
					99.0	5.03	5.47	3.67	1.70	1.36	0.86	0.56	0.84	1.65	2.13	2.85	3.95
					99.2	4.02	4.38	2.94	1.36	1.09	0.69	0.45	0.67	1.32	1.70	2.28	3.16
					99.3	3.52	3.83	2.57	1.19	0.96	0.60	0.39	0.59	1.16	1.49	2.00	2.76
				9.8	98.8	5.51	6.00	4.02	1.87	1.50	0.94	0.62	0.92	1.81	2.33	3.13	4.33
					99.0	4.60	5.00	3.35	1.56	1.25	0.78	0.51	0.77	1.51	1.94	2.60	3.61
					99.2	3.68	4.00	2.68	1.24	1.00	0.63	0.41	0.62	1.21	1.55	2.08	2.89
					99.3	3.22	3.50	2.35	1.09	0.87	0.55	0.36	0.54	1.06	1.36	1.82	2.52
	UCL		2	12.8	99.0	4.73	5.43	3.92	1.98	1.63	1.04	0.68	0.98	1.80	2.17	2.73	3.63
					99.3	3.31	3.80	2.74	1.38	1.14	0.73	0.48	0.68	1.26	1.52	1.91	2.54
				9.8	99.0	4.32	4.96	3.58	1.81	1.49	0.95	0.63	0.89	1.64	1.98	2.50	3.32
					99.3	3.02	3.47	2.51	1.26	1.04	0.66	0.44	0.62	1.15	1.39	1.75	2.32
			3	12.8	99.0	6.32	6.89	4.72	2.27	1.81	1.13	0.75	1.10	2.12	2.69	3.58	4.94
					99.3	4.42	4.83	3.31	1.59	1.27	0.79	0.53	0.77	1.49	1.88	2.51	3.46
				9.8	99.0	5.77	6.30	4.31	2.08	1.65	1.03	0.69	1.01	1.94	2.46	3.27	4.51

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.3	4.04	4.41	3.02	1.45	1.16	0.72	0.48	0.71	1.36	1.72	2.29	3.16
	LCL		2	12.8	99.0	2.99	3.41	2.36	1.11	0.92	0.59	0.38	0.56	1.07	1.34	1.73	2.32
					99.3	2.09	2.39	1.65	0.77	0.65	0.41	0.27	0.40	0.75	0.94	1.21	1.62
				9.8	99.0	2.73	3.12	2.16	1.01	0.84	0.54	0.35	0.52	0.98	1.23	1.58	2.12
					99.3	1.91	2.18	1.51	0.71	0.59	0.38	0.24	0.36	0.69	0.86	1.10	1.48
			3	12.8	99.0	4.00	4.33	2.85	1.27	1.03	0.64	0.42	0.64	1.27	1.67	2.27	3.15
					99.3	2.80	3.03	1.99	0.89	0.72	0.45	0.29	0.45	0.89	1.17	1.59	2.20
				9.8	99.0	3.65	3.96	2.60	1.16	0.94	0.59	0.38	0.58	1.16	1.52	2.07	2.88
					99.3	2.56	2.77	1.82	0.81	0.66	0.41	0.27	0.41	0.81	1.06	1.45	2.01
	Mean	UCL	2	12.8	99.0	6.93	7.93	5.60	2.72	2.26	1.45	0.94	1.37	2.58	3.15	4.00	5.34
					99.3	4.85	5.55	3.92	1.91	1.58	1.01	0.66	0.96	1.80	2.21	2.80	3.74
				9.8	99.0	1.88	2.15	1.52	0.74	0.61	0.39	0.25	0.37	0.70	0.85	1.08	1.45
					99.3	1.31	1.50	1.06	0.52	0.43	0.27	0.18	0.26	0.49	0.60	0.76	1.01
			3	12.8	99.0	9.26	10.07	6.75	3.13	2.51	1.58	1.03	1.55	3.04	3.91	5.25	7.26
					99.3	6.48	7.05	4.73	2.19	1.76	1.10	0.72	1.08	2.13	2.74	3.67	5.09
				9.8	99.0	2.51	2.73	1.83	0.85	0.68	0.43	0.28	0.42	0.82	1.06	1.42	1.97
					99.3	1.75	1.91	1.28	0.59	0.48	0.30	0.20	0.29	0.58	0.74	0.99	1.38
		LCL	2	12.8	99.0	2.45	2.80	1.98	0.96	0.80	0.51	0.33	0.48	0.91	1.11	1.41	1.89

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.3	1.71	1.96	1.39	0.67	0.56	0.36	0.23	0.34	0.64	0.78	0.99	1.32
				9.8	99.0	2.26	2.58	1.83	0.89	0.74	0.47	0.31	0.45	0.84	1.03	1.30	1.74
					99.3	1.58	1.81	1.28	0.62	0.52	0.33	0.21	0.31	0.59	0.72	0.91	1.22
			3	12.8	99.0	3.27	3.56	2.39	1.11	0.89	0.56	0.37	0.55	1.08	1.38	1.86	2.57
					99.3	2.29	2.49	1.67	0.78	0.62	0.39	0.26	0.38	0.75	0.97	1.30	1.80
				9.8	99.0	3.02	3.28	2.20	1.02	0.82	0.51	0.34	0.50	0.99	1.27	1.71	2.37
					99.3	2.11	2.30	1.54	0.71	0.57	0.36	0.24	0.35	0.69	0.89	1.20	1.66

H.7 Preferred Project 3

Gannet

Table H.2.1- 10: Collision risk estimates for gannet at Preferred Project 3 incorporating variability associated with density, flight height distribution and avoidance rate

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Option 2	Mean	Maximum likelihood	1	14.9	98.7	0.10	0.11	0.17	0.24	0.32	0.39	0.46	0.46	0.37	0.24	0.14	0.11
					98.9	0.09	0.09	0.14	0.20	0.27	0.33	0.39	0.39	0.32	0.21	0.12	0.09
					99.1	0.07	0.07	0.12	0.17	0.22	0.27	0.32	0.32	0.26	0.17	0.10	0.07
					99.5	0.04	0.04	0.06	0.09	0.12	0.15	0.18	0.18	0.14	0.09	0.05	0.04
				13.33	98.7	0.10	0.10	0.16	0.23	0.30	0.36	0.43	0.43	0.35	0.23	0.13	0.10
					98.9	0.08	0.08	0.13	0.19	0.25	0.31	0.36	0.36	0.30	0.19	0.11	0.09
					99.1	0.07	0.07	0.11	0.16	0.21	0.25	0.30	0.30	0.24	0.16	0.09	0.07
					99.5	0.04	0.04	0.06	0.09	0.11	0.14	0.16	0.16	0.13	0.09	0.05	0.04
			2	14.9	98.7	0.15	0.14	0.21	0.28	0.36	0.43	0.51	0.53	0.46	0.32	0.20	0.17
					98.9	0.13	0.12	0.18	0.24	0.30	0.36	0.43	0.45	0.39	0.27	0.17	0.14
					99.1	0.11	0.10	0.15	0.20	0.25	0.30	0.35	0.36	0.32	0.22	0.14	0.12
					99.5	0.06	0.06	0.08	0.11	0.14	0.17	0.20	0.20	0.18	0.12	0.08	0.06
				13.33	98.7	0.14	0.13	0.20	0.27	0.34	0.40	0.48	0.49	0.43	0.30	0.19	0.16
					98.9	0.12	0.11	0.17	0.22	0.28	0.34	0.40	0.42	0.36	0.25	0.16	0.13

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.1	0.10	0.09	0.14	0.18	0.23	0.28	0.33	0.34	0.30	0.21	0.13	0.11
					99.5	0.06	0.05	0.08	0.10	0.13	0.15	0.18	0.19	0.16	0.12	0.07	0.06
	UCL		1	14.9	98.9	0.10	0.10	0.16	0.23	0.31	0.37	0.43	0.43	0.36	0.23	0.13	0.10
					99.5	0.05	0.05	0.07	0.11	0.14	0.17	0.20	0.20	0.16	0.11	0.06	0.05
				13.33	98.9	0.09	0.10	0.15	0.22	0.29	0.35	0.41	0.40	0.33	0.22	0.13	0.10
					99.5	0.04	0.04	0.07	0.10	0.13	0.16	0.18	0.18	0.15	0.10	0.06	0.04
			2	14.9	98.9	0.15	0.14	0.20	0.28	0.34	0.41	0.48	0.50	0.43	0.31	0.19	0.16
					99.5	0.07	0.06	0.09	0.13	0.16	0.19	0.22	0.23	0.20	0.14	0.09	0.07
				13.33	98.9	0.14	0.13	0.19	0.26	0.32	0.38	0.45	0.47	0.41	0.29	0.18	0.15
					99.5	0.06	0.06	0.09	0.12	0.15	0.17	0.21	0.21	0.18	0.13	0.08	0.07
	LCL		1	14.9	98.9	0.08	0.08	0.12	0.18	0.24	0.29	0.35	0.34	0.28	0.18	0.10	0.08
					99.5	0.03	0.04	0.06	0.08	0.11	0.13	0.16	0.16	0.13	0.08	0.05	0.04
				13.33	98.9	0.07	0.07	0.12	0.17	0.22	0.27	0.32	0.32	0.26	0.17	0.10	0.07
					99.5	0.03	0.03	0.05	0.08	0.10	0.12	0.15	0.15	0.12	0.08	0.04	0.03
			2	14.9	98.9	0.11	0.11	0.16	0.21	0.27	0.32	0.39	0.40	0.35	0.24	0.15	0.12
					99.5	0.05	0.05	0.07	0.09	0.12	0.15	0.18	0.18	0.16	0.11	0.07	0.06
				13.33	98.9	0.11	0.10	0.14	0.19	0.25	0.30	0.36	0.37	0.32	0.23	0.14	0.11
					99.5	0.05	0.05	0.07	0.09	0.11	0.14	0.16	0.17	0.15	0.10	0.06	0.05

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Mean	UCL	1	14.9	98.9	0.23	0.23	0.37	0.53	0.70	0.86	1.01	1.01	0.83	0.54	0.31	0.24
					99.5	0.10	0.11	0.17	0.24	0.32	0.39	0.46	0.46	0.38	0.25	0.14	0.11
				13.33	98.9	0.21	0.22	0.35	0.50	0.66	0.80	0.95	0.94	0.77	0.50	0.29	0.22
					99.5	0.10	0.10	0.16	0.23	0.30	0.37	0.43	0.43	0.35	0.23	0.13	0.10
			2	14.9	98.9	0.34	0.32	0.47	0.63	0.79	0.95	1.13	1.16	1.01	0.71	0.44	0.37
					99.5	0.16	0.15	0.21	0.29	0.36	0.43	0.51	0.53	0.46	0.32	0.20	0.17
				13.33	98.9	0.32	0.30	0.43	0.59	0.74	0.89	1.06	1.09	0.95	0.66	0.41	0.34
					99.5	0.15	0.14	0.20	0.27	0.34	0.40	0.48	0.49	0.43	0.30	0.19	0.16
		LCL	1	14.9	98.9	0.02	0.02	0.03	0.05	0.06	0.08	0.09	0.09	0.08	0.05	0.03	0.02
					99.5	0.01	0.01	0.02	0.02	0.03	0.04	0.04	0.04	0.03	0.02	0.01	0.01
				13.33	98.9	0.02	0.02	0.03	0.05	0.06	0.07	0.09	0.09	0.07	0.05	0.03	0.02
					99.5	0.01	0.01	0.01	0.02	0.03	0.03	0.04	0.04	0.03	0.02	0.01	0.01
			2	14.9	98.9	0.03	0.03	0.04	0.06	0.07	0.09	0.10	0.11	0.09	0.07	0.04	0.03
					99.5	0.01	0.01	0.02	0.03	0.03	0.04	0.05	0.05	0.04	0.03	0.02	0.02
				13.33	98.9	0.03	0.03	0.04	0.05	0.07	0.08	0.10	0.10	0.09	0.06	0.04	0.03
					99.5	0.01	0.01	0.02	0.02	0.03	0.04	0.04	0.05	0.04	0.03	0.02	0.01

Kittiwake

Table H.2.1- 11: Collision risk estimates for kittiwake at Preferred Project 3 incorporating variability associated with density, flight height distribution and avoidance rate

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Option 2	Mean	Maximum likelihood	2	13.1	98.7	1.84	1.97	2.55	2.67	2.64	2.18	1.80	1.45	1.26	1.31	1.38	1.58
					98.9	1.56	1.66	2.15	2.26	2.24	1.85	1.52	1.23	1.07	1.11	1.17	1.34
					99.0	1.41	1.51	1.96	2.06	2.03	1.68	1.38	1.12	0.97	1.01	1.06	1.22
					99.1	1.27	1.36	1.76	1.85	1.83	1.51	1.24	1.01	0.87	0.90	0.96	1.10
				8.71	98.7	1.36	1.45	1.88	1.98	1.96	1.61	1.33	1.07	0.93	0.97	1.02	1.17
					98.9	1.15	1.23	1.59	1.67	1.65	1.36	1.12	0.91	0.79	0.82	0.87	0.99
					99.0	1.05	1.12	1.45	1.52	1.50	1.24	1.02	0.83	0.72	0.74	0.79	0.90
					99.1	0.94	1.01	1.30	1.37	1.35	1.12	0.92	0.74	0.64	0.67	0.71	0.81
			3	13.1	98.7	2.44	2.49	3.07	3.08	2.94	2.39	1.98	1.65	1.49	1.62	1.81	2.14
					98.9	2.07	2.11	2.59	2.61	2.49	2.02	1.67	1.40	1.26	1.37	1.53	1.81
					99.0	1.88	1.92	2.36	2.37	2.26	1.84	1.52	1.27	1.14	1.25	1.39	1.65
					99.1	1.69	1.72	2.12	2.13	2.04	1.65	1.37	1.14	1.03	1.12	1.25	1.48
				8.71	98.7	1.81	1.84	2.27	2.28	2.18	1.76	1.46	1.22	1.10	1.20	1.34	1.58
					98.9	1.53	1.56	1.92	1.93	1.84	1.49	1.24	1.03	0.93	1.01	1.13	1.34
					99.0	1.39	1.42	1.74	1.75	1.67	1.36	1.13	0.94	0.85	0.92	1.03	1.22

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.1	1.25	1.28	1.57	1.58	1.51	1.22	1.01	0.84	0.76	0.83	0.93	1.10
	UCL		2	13.1	98.9	1.75	1.87	2.42	2.54	2.50	2.06	1.71	1.39	1.20	1.25	1.31	1.50
					99.0	1.59	1.70	2.20	2.31	2.27	1.87	1.55	1.27	1.09	1.13	1.19	1.36
				8.71	98.9	1.29	1.39	1.79	1.88	1.85	1.52	1.26	1.03	0.89	0.92	0.97	1.11
					99.0	1.18	1.26	1.63	1.71	1.68	1.38	1.15	0.94	0.81	0.84	0.88	1.01
			3	13.1	98.9	2.33	2.37	2.92	2.92	2.78	2.25	1.88	1.58	1.42	1.54	1.72	2.03
					99.0	2.11	2.16	2.65	2.66	2.53	2.05	1.71	1.44	1.29	1.40	1.56	1.84
				8.71	98.9	1.72	1.76	2.16	2.16	2.06	1.66	1.39	1.17	1.05	1.14	1.27	1.50
					99.0	1.56	1.60	1.96	1.97	1.87	1.51	1.26	1.06	0.95	1.04	1.15	1.36
	LCL		2	13.1	98.9	1.38	1.47	1.90	2.00	1.98	1.64	1.35	1.08	0.94	0.98	1.04	1.19
					99.0	1.26	1.34	1.73	1.82	1.80	1.49	1.23	0.99	0.85	0.89	0.95	1.08
				8.71	98.9	1.02	1.09	1.41	1.48	1.47	1.21	1.00	0.80	0.69	0.72	0.77	0.88
					99.0	0.93	0.99	1.28	1.34	1.33	1.10	0.91	0.73	0.63	0.66	0.70	0.80
			3	13.1	98.9	1.84	1.87	2.29	2.30	2.21	1.79	1.49	1.23	1.11	1.21	1.36	1.61
					99.0	1.67	1.70	2.08	2.09	2.01	1.63	1.35	1.12	1.01	1.10	1.24	1.47
				8.71	98.9	1.36	1.38	1.70	1.70	1.63	1.33	1.10	0.91	0.82	0.89	1.00	1.19
					99.0	1.23	1.25	1.54	1.55	1.49	1.21	1.00	0.83	0.74	0.81	0.91	1.08
	Mean	UCL	2	13.1	98.9	2.15	2.30	2.98	3.13	3.10	2.56	2.10	1.70	1.47	1.53	1.62	1.85

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.0	1.96	2.09	2.71	2.85	2.82	2.32	1.91	1.55	1.34	1.39	1.47	1.69
				8.71	98.9	1.59	1.70	2.20	2.32	2.29	1.89	1.55	1.26	1.09	1.13	1.20	1.37
					99.0	1.45	1.55	2.00	2.10	2.08	1.72	1.41	1.14	0.99	1.03	1.09	1.25
			3	13.1	98.9	2.86	2.92	3.59	3.61	3.45	2.80	2.32	1.93	1.74	1.90	2.12	2.51
					99.0	2.60	2.65	3.27	3.28	3.14	2.54	2.11	1.76	1.58	1.72	1.93	2.28
				8.71	98.9	2.12	2.16	2.66	2.67	2.55	2.07	1.71	1.43	1.29	1.40	1.57	1.85
					99.0	1.92	1.96	2.41	2.43	2.32	1.88	1.56	1.30	1.17	1.27	1.42	1.69
		LCL	2	13.1	98.9	0.93	1.00	1.29	1.36	1.34	1.11	0.91	0.74	0.64	0.66	0.70	0.81
					99.0	0.85	0.91	1.18	1.24	1.22	1.01	0.83	0.67	0.58	0.60	0.64	0.73
				8.71	98.9	0.69	0.74	0.96	1.01	0.99	0.82	0.67	0.55	0.47	0.49	0.52	0.60
					99.0	0.63	0.67	0.87	0.91	0.90	0.75	0.61	0.50	0.43	0.45	0.47	0.54
			3	13.1	98.9	1.24	1.27	1.56	1.57	1.50	1.21	1.01	0.84	0.76	0.82	0.92	1.09
					99.0	1.13	1.15	1.42	1.42	1.36	1.10	0.91	0.76	0.69	0.75	0.84	0.99
				8.71	98.9	0.92	0.94	1.15	1.16	1.11	0.90	0.74	0.62	0.56	0.61	0.68	0.80
					99.0	0.84	0.85	1.05	1.05	1.01	0.82	0.68	0.56	0.51	0.55	0.62	0.73
Option 3	Mean	Maximum likelihood	2	13.1	98.0	0.49	0.53	0.68	0.72	0.71	0.59	0.48	0.39	0.34	0.35	0.37	0.42
				8.71	98.0	0.42	0.45	0.59	0.62	0.61	0.50	0.41	0.33	0.29	0.30	0.32	0.36
			3	13.1	98.0	0.66	0.67	0.82	0.83	0.79	0.64	0.53	0.44	0.40	0.43	0.49	0.57

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				8.71	98.0	0.56	0.57	0.71	0.71	0.68	0.55	0.46	0.38	0.34	0.37	0.42	0.49
	UCL		2	13.1	98.0	0.55	0.59	0.77	0.80	0.79	0.65	0.54	0.44	0.38	0.39	0.42	0.48
				8.71	98.0	0.48	0.51	0.66	0.69	0.68	0.56	0.46	0.38	0.33	0.34	0.36	0.41
			3	13.1	98.0	0.74	0.75	0.92	0.93	0.88	0.71	0.60	0.50	0.45	0.49	0.54	0.64
				8.71	98.0	0.63	0.65	0.79	0.79	0.76	0.61	0.51	0.43	0.39	0.42	0.47	0.55
	LCL		2	13.1	98.0	0.44	0.47	0.60	0.63	0.63	0.52	0.43	0.34	0.30	0.31	0.33	0.38
				8.71	98.0	0.38	0.40	0.52	0.54	0.54	0.45	0.37	0.29	0.26	0.27	0.28	0.32
			3	13.1	98.0	0.58	0.59	0.73	0.73	0.70	0.57	0.47	0.39	0.35	0.38	0.43	0.51
				8.71	98.0	0.50	0.51	0.62	0.63	0.60	0.49	0.40	0.33	0.30	0.33	0.37	0.44
	Mean	UCL	2	13.1	98.0	0.74	0.79	1.02	1.08	1.06	0.88	0.72	0.58	0.51	0.53	0.56	0.64
				8.71	98.0	0.63	0.67	0.87	0.92	0.91	0.75	0.62	0.50	0.43	0.45	0.48	0.54
			3	13.1	98.0	0.98	1.00	1.23	1.24	1.18	0.96	0.80	0.66	0.60	0.65	0.73	0.86
				8.71	98.0	0.84	0.85	1.05	1.06	1.01	0.82	0.68	0.57	0.51	0.56	0.62	0.73
		LCL	2	13.1	98.0	0.27	0.28	0.37	0.39	0.38	0.32	0.26	0.21	0.18	0.19	0.20	0.23
				8.71	98.0	0.23	0.25	0.32	0.33	0.33	0.27	0.22	0.18	0.16	0.16	0.17	0.20
			3	13.1	98.0	0.35	0.36	0.44	0.45	0.43	0.35	0.29	0.24	0.22	0.23	0.26	0.31
				8.71	98.0	0.31	0.31	0.38	0.39	0.37	0.30	0.25	0.21	0.19	0.20	0.23	0.27

Lesser black-backed gull

Table H.2.1- 12: Collision risk estimates for lesser black-backed gull at Preferred Project 3 incorporating variability associated with density, flight height distribution and avoidance rate

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Option 2	Mean	Maximum likelihood	2	13.1	99.4	0.16	0.15	0.31	0.55	0.65	0.72	0.80	0.49	0.26	0.23	0.18	0.16
					99.5	0.13	0.13	0.26	0.46	0.54	0.60	0.67	0.41	0.22	0.19	0.15	0.13
					99.6	0.11	0.10	0.21	0.37	0.44	0.48	0.53	0.33	0.18	0.15	0.12	0.11
				8.71	99.4	0.13	0.13	0.25	0.45	0.54	0.59	0.66	0.41	0.22	0.19	0.15	0.13
					99.5	0.11	0.10	0.21	0.38	0.45	0.49	0.55	0.34	0.18	0.16	0.12	0.11
					99.6	0.09	0.08	0.17	0.30	0.36	0.40	0.44	0.27	0.14	0.13	0.10	0.09
			3	13.1	99.4	0.21	0.19	0.37	0.63	0.73	0.79	0.88	0.56	0.31	0.28	0.24	0.22
					99.5	0.18	0.16	0.31	0.53	0.61	0.66	0.74	0.47	0.26	0.24	0.20	0.18
					99.6	0.14	0.13	0.25	0.42	0.48	0.53	0.59	0.37	0.21	0.19	0.16	0.15
				8.71	99.4	0.17	0.16	0.31	0.52	0.60	0.65	0.73	0.46	0.26	0.23	0.20	0.18
					99.5	0.14	0.13	0.25	0.43	0.50	0.54	0.61	0.38	0.21	0.19	0.16	0.15
					99.6	0.12	0.11	0.20	0.35	0.40	0.43	0.48	0.31	0.17	0.16	0.13	0.12
	UCL		2	13.1	99.5	0.18	0.18	0.36	0.63	0.72	0.77	0.87	0.55	0.30	0.25	0.20	0.18
				8.71	99.5	0.15	0.15	0.30	0.52	0.59	0.63	0.72	0.45	0.25	0.21	0.16	0.15
			3	13.1	99.5	0.24	0.23	0.43	0.73	0.80	0.84	0.96	0.63	0.35	0.32	0.26	0.24

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				8.71	99.5	0.20	0.19	0.36	0.60	0.66	0.69	0.79	0.51	0.29	0.26	0.21	0.20
	LCL		2	13.1	99.5	0.09	0.09	0.18	0.32	0.40	0.46	0.51	0.30	0.16	0.14	0.12	0.10
				8.71	99.5	0.08	0.07	0.15	0.27	0.33	0.38	0.42	0.25	0.13	0.12	0.09	0.08
			3	13.1	99.5	0.13	0.11	0.21	0.37	0.45	0.50	0.56	0.34	0.19	0.18	0.15	0.14
				8.71	99.5	0.10	0.09	0.18	0.31	0.37	0.41	0.46	0.28	0.16	0.15	0.12	0.11
	Mean	UCL	2	13.1	99.5	0.32	0.31	0.63	1.12	1.33	1.47	1.63	1.01	0.54	0.47	0.37	0.33
				8.71	99.5	0.27	0.26	0.52	0.92	1.10	1.21	1.34	0.83	0.44	0.38	0.30	0.27
			3	13.1	99.5	0.43	0.40	0.76	1.29	1.48	1.61	1.80	1.14	0.64	0.58	0.48	0.45
				8.71	99.5	0.35	0.33	0.62	1.06	1.22	1.32	1.48	0.94	0.52	0.48	0.40	0.37
		LCL	2	13.1	99.5	0.07	0.06	0.13	0.23	0.28	0.30	0.34	0.21	0.11	0.10	0.08	0.07
				8.71	99.5	0.06	0.05	0.11	0.19	0.23	0.25	0.28	0.17	0.09	0.08	0.06	0.06
			3	13.1	99.5	0.09	0.08	0.16	0.27	0.31	0.33	0.37	0.24	0.13	0.12	0.10	0.09
				8.71	99.5	0.07	0.07	0.13	0.22	0.25	0.27	0.31	0.19	0.11	0.10	0.08	0.08
Option 3	Mean	Maximum likelihood	2	13.1	98.7	0.10	0.09	0.18	0.33	0.39	0.43	0.48	0.30	0.16	0.14	0.11	0.10
					98.9	0.08	0.08	0.16	0.28	0.33	0.37	0.41	0.25	0.13	0.12	0.09	0.08
					99.1	0.07	0.06	0.13	0.23	0.27	0.30	0.33	0.20	0.11	0.10	0.08	0.07
					99.3	0.05	0.05	0.10	0.18	0.21	0.23	0.26	0.16	0.09	0.07	0.06	0.05
				8.71	98.7	0.09	0.08	0.17	0.30	0.35	0.39	0.43	0.27	0.14	0.12	0.10	0.09

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					98.9	0.07	0.07	0.14	0.25	0.30	0.33	0.37	0.23	0.12	0.10	0.08	0.07
					99.1	0.06	0.06	0.12	0.21	0.24	0.27	0.30	0.18	0.10	0.09	0.07	0.06
					99.3	0.05	0.04	0.09	0.16	0.19	0.21	0.23	0.14	0.08	0.07	0.05	0.05
			3	13.1	98.7	0.13	0.12	0.22	0.38	0.44	0.47	0.53	0.34	0.19	0.17	0.14	0.13
					98.9	0.11	0.10	0.19	0.32	0.37	0.40	0.45	0.28	0.16	0.14	0.12	0.11
					99.1	0.09	0.08	0.15	0.26	0.30	0.33	0.37	0.23	0.13	0.12	0.10	0.09
					99.3	0.07	0.06	0.12	0.20	0.23	0.25	0.29	0.18	0.10	0.09	0.08	0.07
				8.71	98.7	0.11	0.10	0.20	0.34	0.39	0.43	0.48	0.30	0.17	0.15	0.13	0.12
					98.9	0.10	0.09	0.17	0.29	0.33	0.36	0.40	0.26	0.14	0.13	0.11	0.10
					99.1	0.08	0.07	0.14	0.24	0.27	0.30	0.33	0.21	0.12	0.11	0.09	0.08
					99.3	0.06	0.06	0.11	0.18	0.21	0.23	0.26	0.16	0.09	0.08	0.07	0.06
	UCL		2	13.1	98.9	0.11	0.11	0.22	0.39	0.44	0.47	0.53	0.34	0.18	0.16	0.12	0.11
					99.3	0.07	0.07	0.14	0.25	0.28	0.30	0.34	0.21	0.12	0.10	0.08	0.07
				8.71	98.9	0.10	0.10	0.20	0.35	0.40	0.42	0.48	0.30	0.16	0.14	0.11	0.10
					99.3	0.06	0.06	0.13	0.22	0.25	0.27	0.30	0.19	0.10	0.09	0.07	0.06
			3	13.1	98.9	0.15	0.14	0.26	0.44	0.49	0.51	0.58	0.38	0.22	0.19	0.16	0.15
					99.3	0.09	0.09	0.17	0.28	0.31	0.33	0.37	0.24	0.14	0.12	0.10	0.09
				8.71	98.9	0.13	0.12	0.24	0.40	0.44	0.46	0.53	0.34	0.19	0.17	0.14	0.13

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.3	0.08	0.08	0.15	0.25	0.28	0.29	0.34	0.22	0.12	0.11	0.09	0.09
	LCL		2	13.1	98.9	0.06	0.05	0.11	0.20	0.24	0.28	0.31	0.19	0.10	0.09	0.07	0.06
					99.3	0.04	0.03	0.07	0.13	0.16	0.18	0.20	0.12	0.06	0.06	0.04	0.04
				8.71	98.9	0.05	0.05	0.10	0.18	0.22	0.25	0.28	0.17	0.09	0.08	0.06	0.06
					99.3	0.03	0.03	0.06	0.11	0.14	0.16	0.18	0.11	0.06	0.05	0.04	0.04
			3	13.1	98.9	0.08	0.07	0.13	0.23	0.27	0.31	0.34	0.21	0.12	0.11	0.09	0.08
					99.3	0.05	0.04	0.08	0.14	0.17	0.20	0.22	0.13	0.07	0.07	0.06	0.05
				8.71	98.9	0.07	0.06	0.12	0.21	0.25	0.28	0.31	0.19	0.10	0.10	0.08	0.07
					99.3	0.04	0.04	0.08	0.13	0.16	0.18	0.19	0.12	0.07	0.06	0.05	0.05
	Mean	UCL	2	13.1	98.9	0.27	0.26	0.52	0.93	1.11	1.22	1.36	0.84	0.45	0.39	0.31	0.27
					99.3	0.17	0.17	0.33	0.59	0.71	0.78	0.86	0.53	0.29	0.25	0.20	0.17
				8.71	98.9	0.24	0.23	0.46	0.82	0.98	1.08	1.20	0.74	0.39	0.34	0.27	0.24
					99.3	0.15	0.15	0.29	0.52	0.62	0.69	0.76	0.47	0.25	0.22	0.17	0.15
			3	13.1	98.9	0.36	0.33	0.63	1.07	1.23	1.34	1.50	0.95	0.53	0.48	0.40	0.37
					99.3	0.23	0.21	0.40	0.68	0.79	0.85	0.95	0.60	0.34	0.31	0.26	0.24
				8.71	98.9	0.32	0.29	0.56	0.95	1.09	1.18	1.32	0.84	0.47	0.43	0.35	0.33
					99.3	0.20	0.18	0.35	0.60	0.69	0.75	0.84	0.53	0.30	0.27	0.23	0.21
		LCL	2	13.1	98.9	0.03	0.03	0.07	0.12	0.14	0.15	0.17	0.11	0.06	0.05	0.04	0.03

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.3	0.02	0.02	0.04	0.07	0.09	0.10	0.11	0.07	0.04	0.03	0.02	0.02
				8.71	98.9	0.03	0.03	0.06	0.11	0.13	0.14	0.16	0.10	0.05	0.04	0.04	0.03
					99.3	0.02	0.02	0.04	0.07	0.08	0.09	0.10	0.06	0.03	0.03	0.02	0.02
			3	13.1	98.9	0.04	0.04	0.08	0.13	0.16	0.17	0.19	0.12	0.07	0.06	0.05	0.05
					99.3	0.03	0.03	0.05	0.09	0.10	0.11	0.12	0.08	0.04	0.04	0.03	0.03
				8.71	98.9	0.04	0.04	0.07	0.12	0.14	0.15	0.17	0.11	0.06	0.06	0.05	0.04
					99.3	0.03	0.02	0.05	0.08	0.09	0.10	0.11	0.07	0.04	0.04	0.03	0.03

Herring gull

Table H.2.1- 13: Collision risk estimates for herring gull at Preferred Project 3 incorporating variability associated with density, flight height distribution and avoidance rate

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Option 2	Mean	Maximum likelihood	2	12.8	99.4	1.58	1.82	1.31	0.65	0.53	0.33	0.21	0.29	0.54	0.67	0.88	1.20
					99.5	1.32	1.52	1.09	0.54	0.44	0.28	0.18	0.25	0.45	0.56	0.73	1.00
					99.6	1.06	1.21	0.87	0.43	0.36	0.22	0.14	0.20	0.36	0.45	0.59	0.80
				9.8	99.4	1.33	1.53	1.10	0.55	0.45	0.28	0.18	0.25	0.45	0.57	0.74	1.01
					99.5	1.11	1.27	0.92	0.46	0.37	0.23	0.15	0.21	0.38	0.47	0.61	0.84
					99.6	0.88	1.02	0.73	0.36	0.30	0.19	0.12	0.16	0.30	0.38	0.49	0.67
			3	12.8	99.4	2.11	2.31	1.58	0.75	0.59	0.37	0.23	0.33	0.63	0.84	1.15	1.63
					99.5	1.75	1.92	1.32	0.63	0.49	0.30	0.19	0.28	0.53	0.70	0.96	1.36
					99.6	1.40	1.54	1.05	0.50	0.40	0.24	0.16	0.22	0.42	0.56	0.77	1.08
				9.8	99.4	1.77	1.93	1.32	0.63	0.50	0.31	0.20	0.28	0.53	0.70	0.96	1.36
					99.5	1.47	1.61	1.10	0.53	0.41	0.26	0.16	0.23	0.44	0.58	0.80	1.14
					99.6	1.18	1.29	0.88	0.42	0.33	0.20	0.13	0.19	0.35	0.47	0.64	0.91
	UCL		2	12.8	99.5	1.68	1.93	1.41	0.73	0.59	0.37	0.24	0.32	0.57	0.71	0.92	1.27
				9.8	99.5	1.41	1.62	1.18	0.61	0.49	0.31	0.20	0.27	0.48	0.59	0.77	1.07
			3	12.8	99.5	2.23	2.44	1.70	0.84	0.66	0.40	0.26	0.36	0.67	0.88	1.21	1.72

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				9.8	99.5	1.87	2.05	1.43	0.70	0.55	0.34	0.22	0.30	0.56	0.73	1.01	1.44
	LCL		2	12.8	99.5	1.04	1.19	0.84	0.40	0.33	0.21	0.13	0.19	0.34	0.43	0.57	0.79
				9.8	99.5	0.87	1.00	0.70	0.34	0.28	0.17	0.11	0.16	0.28	0.36	0.48	0.66
			3	12.8	99.5	1.38	1.51	1.01	0.47	0.37	0.23	0.14	0.21	0.40	0.53	0.74	1.06
				9.8	99.5	1.16	1.26	0.85	0.39	0.31	0.19	0.12	0.18	0.34	0.45	0.62	0.89
	Mean	UCL	2	12.8	99.5	2.48	2.86	2.06	1.02	0.84	0.52	0.33	0.46	0.84	1.06	1.38	1.89
				9.8	99.5	2.08	2.39	1.72	0.86	0.70	0.44	0.28	0.39	0.71	0.89	1.16	1.58
			3	12.8	99.5	3.30	3.62	2.48	1.18	0.93	0.57	0.37	0.52	1.00	1.31	1.80	2.55
				9.8	99.5	2.77	3.03	2.08	0.99	0.78	0.48	0.31	0.44	0.84	1.10	1.51	2.14
		LCL	2	12.8	99.5	2.48	2.86	2.06	1.02	0.84	0.52	0.33	0.46	0.84	1.06	1.38	1.89
				9.8	99.5	0.69	0.79	0.57	0.28	0.23	0.15	0.09	0.13	0.23	0.29	0.38	0.52
			3	12.8	99.5	3.30	3.62	2.48	1.18	0.93	0.57	0.37	0.52	1.00	1.31	1.80	2.55
				9.8	99.5	0.92	1.00	0.69	0.33	0.26	0.16	0.10	0.15	0.28	0.36	0.50	0.71
Option 3	Mean	Maximum likelihood	2	12.8	98.8	0.97	1.11	0.80	0.40	0.33	0.20	0.13	0.18	0.33	0.41	0.54	0.73
					99.0	0.81	0.93	0.67	0.33	0.27	0.17	0.11	0.15	0.27	0.34	0.45	0.61
					99.2	0.64	0.74	0.53	0.27	0.22	0.14	0.09	0.12	0.22	0.27	0.36	0.49
					99.3	0.56	0.65	0.47	0.23	0.19	0.12	0.08	0.11	0.19	0.24	0.31	0.43
				9.8	98.8	0.88	1.01	0.73	0.36	0.29	0.18	0.12	0.16	0.30	0.37	0.49	0.67

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.0	0.73	0.84	0.60	0.30	0.25	0.15	0.10	0.14	0.25	0.31	0.41	0.56
					99.2	0.58	0.67	0.48	0.24	0.20	0.12	0.08	0.11	0.20	0.25	0.32	0.44
					99.3	0.51	0.59	0.42	0.21	0.17	0.11	0.07	0.10	0.17	0.22	0.28	0.39
			3	12.8	98.8	1.29	1.41	0.96	0.46	0.36	0.22	0.14	0.20	0.39	0.51	0.70	0.99
					99.0	1.07	1.17	0.80	0.38	0.30	0.19	0.12	0.17	0.32	0.43	0.58	0.83
					99.2	0.86	0.94	0.64	0.31	0.24	0.15	0.09	0.14	0.26	0.34	0.47	0.66
					99.3	0.75	0.82	0.56	0.27	0.21	0.13	0.08	0.12	0.23	0.30	0.41	0.58
				9.8	98.8	1.17	1.28	0.87	0.42	0.33	0.20	0.13	0.19	0.35	0.46	0.64	0.90
					99.0	0.97	1.06	0.73	0.35	0.27	0.17	0.11	0.15	0.29	0.39	0.53	0.75
					99.2	0.78	0.85	0.58	0.28	0.22	0.13	0.09	0.12	0.23	0.31	0.42	0.60
					99.3	0.68	0.74	0.51	0.24	0.19	0.12	0.08	0.11	0.20	0.27	0.37	0.53
	UCL		2	12.8	99.0	1.02	1.18	0.86	0.44	0.36	0.22	0.14	0.19	0.35	0.43	0.56	0.78
					99.3	0.72	0.82	0.60	0.31	0.25	0.16	0.10	0.14	0.24	0.30	0.39	0.54
				9.8	99.0	0.93	1.07	0.78	0.40	0.33	0.20	0.13	0.18	0.31	0.39	0.51	0.70
					99.3	0.65	0.75	0.55	0.28	0.23	0.14	0.09	0.12	0.22	0.27	0.36	0.49
			3	12.8	99.0	1.36	1.49	1.04	0.51	0.40	0.25	0.16	0.22	0.41	0.53	0.74	1.05
					99.3	0.95	1.04	0.73	0.36	0.28	0.17	0.11	0.15	0.29	0.37	0.52	0.74
				9.8	99.0	1.23	1.35	0.94	0.46	0.36	0.22	0.14	0.20	0.37	0.48	0.67	0.95

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.3	0.86	0.95	0.66	0.32	0.25	0.16	0.10	0.14	0.26	0.34	0.47	0.67
	LCL		2	12.8	99.0	0.63	0.73	0.51	0.25	0.20	0.13	0.08	0.11	0.21	0.26	0.35	0.48
					99.3	0.44	0.51	0.36	0.17	0.14	0.09	0.06	0.08	0.15	0.18	0.24	0.34
				9.8	99.0	0.57	0.66	0.46	0.22	0.18	0.11	0.07	0.10	0.19	0.24	0.32	0.44
					99.3	0.40	0.46	0.33	0.16	0.13	0.08	0.05	0.07	0.13	0.17	0.22	0.30
			3	12.8	99.0	0.84	0.92	0.62	0.28	0.23	0.14	0.09	0.13	0.24	0.33	0.45	0.65
					99.3	0.59	0.64	0.43	0.20	0.16	0.10	0.06	0.09	0.17	0.23	0.32	0.45
				9.8	99.0	0.76	0.83	0.56	0.26	0.20	0.13	0.08	0.12	0.22	0.30	0.41	0.59
					99.3	0.53	0.58	0.39	0.18	0.14	0.09	0.06	0.08	0.16	0.21	0.29	0.41
	Mean	UCL	2	12.8	99.0	2.32	2.66	1.92	0.95	0.78	0.49	0.31	0.43	0.79	0.99	1.29	1.76
					99.3	1.62	1.86	1.34	0.67	0.55	0.34	0.22	0.30	0.55	0.69	0.90	1.23
				9.8	99.0	2.03	2.33	1.68	0.84	0.68	0.43	0.27	0.38	0.69	0.86	1.13	1.54
					99.3	1.42	1.63	1.17	0.58	0.48	0.30	0.19	0.26	0.48	0.60	0.79	1.08
			3	12.8	99.0	3.08	3.37	2.31	1.10	0.87	0.53	0.34	0.49	0.93	1.22	1.68	2.38
					99.3	2.16	2.36	1.62	0.77	0.61	0.37	0.24	0.34	0.65	0.86	1.18	1.67
				9.8	99.0	2.70	2.95	2.02	0.96	0.76	0.47	0.30	0.43	0.81	1.07	1.47	2.08
					99.3	1.89	2.07	1.42	0.67	0.53	0.33	0.21	0.30	0.57	0.75	1.03	1.46
		LCL	2	12.8	99.0	0.44	0.51	0.37	0.18	0.15	0.09	0.06	0.08	0.15	0.19	0.25	0.34

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.3	0.31	0.36	0.26	0.13	0.10	0.07	0.04	0.06	0.11	0.13	0.17	0.24
				9.8	99.0	0.40	0.46	0.33	0.17	0.14	0.09	0.05	0.08	0.14	0.17	0.22	0.31
					99.3	0.28	0.32	0.23	0.12	0.10	0.06	0.04	0.05	0.10	0.12	0.16	0.21
			3	12.8	99.0	0.59	0.64	0.44	0.21	0.17	0.10	0.07	0.09	0.18	0.23	0.32	0.45
					99.3	0.41	0.45	0.31	0.15	0.12	0.07	0.05	0.07	0.12	0.16	0.22	0.32
				9.8	99.0	0.54	0.59	0.40	0.19	0.15	0.09	0.06	0.09	0.16	0.21	0.29	0.41
					99.3	0.38	0.41	0.28	0.13	0.11	0.07	0.04	0.06	0.11	0.15	0.20	0.29

H.8 Preferred Project 4

Gannet

Table H.2.1- 14: Collision risk estimates for gannet at Preferred Project 4 incorporating variability associated with density, flight height distribution and avoidance rate

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Option 2	Mean	Maximum likelihood	1	14.9	98.7	0.04	0.04	0.16	0.57	0.79	1.02	1.27	1.30	1.06	0.29	0.06	0.05
					98.9	0.04	0.04	0.14	0.49	0.67	0.86	1.07	1.10	0.90	0.25	0.05	0.04
					99.1	0.03	0.03	0.11	0.40	0.55	0.71	0.88	0.90	0.73	0.20	0.04	0.03
					99.5	0.02	0.02	0.06	0.22	0.30	0.39	0.49	0.50	0.41	0.11	0.02	0.02
				13.33	98.7	0.04	0.04	0.15	0.54	0.74	0.95	1.18	1.21	0.99	0.27	0.06	0.04
					98.9	0.03	0.03	0.13	0.46	0.63	0.81	1.00	1.03	0.84	0.23	0.05	0.04
					99.1	0.03	0.03	0.11	0.37	0.51	0.66	0.82	0.84	0.69	0.19	0.04	0.03
					99.5	0.02	0.02	0.06	0.21	0.28	0.37	0.46	0.47	0.38	0.11	0.02	0.02
			2	14.9	98.7	0.06	0.06	0.21	0.68	0.89	1.12	1.41	1.50	1.29	0.38	0.09	0.07
					98.9	0.05	0.05	0.17	0.57	0.75	0.95	1.19	1.27	1.09	0.33	0.08	0.06
					99.1	0.04	0.04	0.14	0.47	0.62	0.78	0.97	1.04	0.89	0.27	0.06	0.05
					99.5	0.02	0.02	0.08	0.26	0.34	0.43	0.54	0.58	0.50	0.15	0.03	0.03
				13.33	98.7	0.06	0.05	0.19	0.63	0.83	1.05	1.32	1.40	1.21	0.36	0.08	0.07
					98.9	0.05	0.05	0.16	0.54	0.71	0.89	1.12	1.18	1.02	0.30	0.07	0.06

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.1	0.04	0.04	0.13	0.44	0.58	0.73	0.91	0.97	0.84	0.25	0.06	0.05
					99.5	0.02	0.02	0.07	0.24	0.32	0.41	0.51	0.54	0.47	0.14	0.03	0.03
	UCL		1	14.9	98.9	0.05	0.05	0.19	0.63	0.84	1.06	1.30	1.33	1.09	0.32	0.07	0.05
					99.5	0.02	0.02	0.08	0.29	0.38	0.48	0.59	0.61	0.49	0.14	0.03	0.02
				13.33	98.9	0.05	0.05	0.18	0.59	0.79	0.99	1.22	1.25	1.02	0.30	0.07	0.05
					99.5	0.02	0.02	0.08	0.27	0.36	0.45	0.55	0.57	0.46	0.13	0.03	0.02
			2	14.9	98.9	0.07	0.07	0.24	0.74	0.95	1.17	1.45	1.54	1.33	0.42	0.11	0.08
					99.5	0.03	0.03	0.11	0.34	0.43	0.53	0.66	0.70	0.60	0.19	0.05	0.04
				13.33	98.9	0.07	0.06	0.22	0.70	0.89	1.10	1.36	1.44	1.24	0.39	0.10	0.08
					99.5	0.03	0.03	0.10	0.32	0.40	0.50	0.62	0.65	0.56	0.18	0.04	0.04
	LCL		1	14.9	98.9	0.03	0.03	0.10	0.37	0.52	0.70	0.89	0.92	0.75	0.20	0.04	0.03
					99.5	0.01	0.01	0.05	0.17	0.24	0.32	0.41	0.42	0.34	0.09	0.02	0.01
				13.33	98.9	0.02	0.02	0.10	0.35	0.49	0.66	0.84	0.86	0.70	0.18	0.04	0.03
					99.5	0.01	0.01	0.04	0.16	0.22	0.30	0.38	0.39	0.32	0.08	0.02	0.01
			2	14.9	98.9	0.04	0.03	0.13	0.44	0.59	0.77	0.99	1.06	0.92	0.26	0.06	0.04
					99.5	0.02	0.02	0.06	0.20	0.27	0.35	0.45	0.48	0.42	0.12	0.03	0.02
				13.33	98.9	0.04	0.03	0.12	0.41	0.55	0.73	0.93	0.99	0.86	0.24	0.05	0.04
					99.5	0.02	0.01	0.06	0.19	0.25	0.33	0.42	0.45	0.39	0.11	0.02	0.02

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Mean	UCL	1	14.9	98.9	0.07	0.07	0.28	1.00	1.37	1.77	2.19	2.24	1.83	0.51	0.11	0.08
					99.5	0.03	0.03	0.13	0.45	0.62	0.80	1.00	1.02	0.83	0.23	0.05	0.04
				13.33	98.9	0.07	0.07	0.27	0.93	1.28	1.65	2.05	2.10	1.72	0.47	0.10	0.07
					99.5	0.03	0.03	0.12	0.42	0.58	0.75	0.93	0.96	0.78	0.22	0.05	0.03
			2	14.9	98.9	0.11	0.10	0.36	1.18	1.54	1.95	2.44	2.59	2.24	0.67	0.16	0.12
					99.5	0.05	0.05	0.16	0.53	0.70	0.89	1.11	1.18	1.02	0.30	0.07	0.06
				13.33	98.9	0.10	0.09	0.34	1.10	1.45	1.82	2.29	2.43	2.10	0.62	0.15	0.12
					99.5	0.05	0.04	0.15	0.50	0.66	0.83	1.04	1.10	0.95	0.28	0.07	0.05
		LCL	1	14.9	98.9	0.01	0.01	0.05	0.17	0.23	0.30	0.37	0.38	0.31	0.09	0.02	0.01
					99.5	0.01	0.01	0.02	0.08	0.10	0.14	0.17	0.17	0.14	0.04	0.01	0.01
				13.33	98.9	0.01	0.01	0.04	0.16	0.22	0.28	0.35	0.35	0.29	0.08	0.02	0.01
					99.5	0.01	0.01	0.02	0.07	0.10	0.13	0.16	0.16	0.13	0.04	0.01	0.01
			2	14.9	98.9	0.02	0.02	0.06	0.20	0.26	0.33	0.41	0.44	0.38	0.11	0.03	0.02
					99.5	0.01	0.01	0.03	0.09	0.12	0.15	0.19	0.20	0.17	0.05	0.01	0.01
				13.33	98.9	0.02	0.02	0.06	0.19	0.24	0.31	0.38	0.41	0.35	0.10	0.02	0.02
					99.5	0.01	0.01	0.03	0.08	0.11	0.14	0.17	0.19	0.16	0.05	0.01	0.01

Kittiwake

Table H.2.1- 15: Collision risk estimates for kittiwake at Preferred Project 4 incorporating variability associated with density, flight height distribution and avoidance rate

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Option 2	Mean	Maximum likelihood	2	13.1	98.7	0.35	0.33	0.40	0.45	0.56	0.67	0.79	0.81	0.70	0.59	0.44	0.37
					98.9	0.30	0.28	0.34	0.38	0.48	0.57	0.67	0.69	0.60	0.50	0.37	0.32
					99.0	0.27	0.25	0.31	0.34	0.43	0.51	0.61	0.62	0.54	0.45	0.34	0.29
					99.1	0.24	0.23	0.28	0.31	0.39	0.46	0.55	0.56	0.49	0.41	0.30	0.26
				8.71	98.7	0.26	0.24	0.30	0.33	0.42	0.50	0.59	0.60	0.52	0.44	0.33	0.28
					98.9	0.22	0.21	0.25	0.28	0.35	0.42	0.50	0.51	0.44	0.37	0.28	0.23
					99.0	0.20	0.19	0.23	0.26	0.32	0.38	0.45	0.46	0.40	0.34	0.25	0.21
					99.1	0.18	0.17	0.21	0.23	0.29	0.34	0.41	0.42	0.36	0.30	0.23	0.19
			3	13.1	98.7	0.47	0.42	0.48	0.52	0.63	0.73	0.87	0.92	0.83	0.73	0.58	0.50
					98.9	0.39	0.35	0.41	0.44	0.53	0.62	0.74	0.78	0.70	0.62	0.49	0.43
					99.0	0.36	0.32	0.37	0.40	0.48	0.56	0.67	0.71	0.64	0.56	0.44	0.39
					99.1	0.32	0.29	0.33	0.36	0.43	0.51	0.60	0.64	0.57	0.50	0.40	0.35
				8.71	98.7	0.35	0.31	0.36	0.38	0.47	0.54	0.65	0.68	0.62	0.54	0.43	0.38
					98.9	0.29	0.26	0.30	0.32	0.39	0.46	0.55	0.58	0.52	0.46	0.36	0.32
					99.0	0.27	0.24	0.28	0.30	0.36	0.42	0.50	0.53	0.48	0.42	0.33	0.29

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.1	0.24	0.21	0.25	0.27	0.32	0.38	0.45	0.47	0.43	0.38	0.30	0.26
	UCL		2	13.1	98.9	0.36	0.34	0.41	0.47	0.58	0.68	0.81	0.83	0.72	0.61	0.46	0.38
					99.0	0.33	0.31	0.38	0.43	0.53	0.62	0.74	0.76	0.66	0.55	0.41	0.35
				8.71	98.9	0.27	0.25	0.31	0.35	0.43	0.51	0.60	0.62	0.54	0.45	0.34	0.29
					99.0	0.24	0.23	0.28	0.32	0.39	0.46	0.55	0.56	0.49	0.41	0.31	0.26
			3	13.1	98.9	0.48	0.43	0.50	0.54	0.65	0.75	0.89	0.95	0.85	0.76	0.60	0.52
					99.0	0.44	0.39	0.45	0.49	0.59	0.68	0.81	0.86	0.77	0.69	0.54	0.47
				8.71	98.9	0.36	0.32	0.37	0.40	0.48	0.56	0.66	0.70	0.63	0.56	0.44	0.39
					99.0	0.33	0.29	0.34	0.37	0.44	0.50	0.60	0.64	0.58	0.51	0.40	0.35
	LCL		2	13.1	98.9	0.24	0.22	0.27	0.30	0.39	0.47	0.56	0.57	0.49	0.41	0.31	0.26
					99.0	0.22	0.20	0.25	0.27	0.35	0.43	0.51	0.52	0.45	0.37	0.28	0.23
				8.71	98.9	0.18	0.17	0.20	0.22	0.29	0.35	0.41	0.42	0.37	0.30	0.23	0.19
					99.0	0.16	0.15	0.18	0.20	0.26	0.32	0.38	0.39	0.33	0.27	0.21	0.17
			3	13.1	98.9	0.32	0.28	0.33	0.35	0.43	0.51	0.61	0.65	0.58	0.50	0.40	0.35
					99.0	0.29	0.26	0.30	0.32	0.39	0.46	0.56	0.59	0.53	0.46	0.36	0.31
				8.71	98.9	0.24	0.21	0.24	0.26	0.32	0.38	0.46	0.48	0.43	0.37	0.30	0.26
					99.0	0.21	0.19	0.22	0.23	0.29	0.35	0.41	0.44	0.39	0.34	0.27	0.23
	Mean	UCL	2	13.1	98.9	0.38	0.35	0.43	0.48	0.61	0.72	0.85	0.88	0.76	0.63	0.48	0.40

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.0	0.34	0.32	0.39	0.44	0.55	0.66	0.77	0.80	0.69	0.58	0.43	0.37
				8.71	98.9	0.28	0.26	0.32	0.36	0.45	0.54	0.63	0.65	0.56	0.47	0.35	0.30
					99.0	0.26	0.24	0.29	0.33	0.41	0.49	0.58	0.59	0.51	0.43	0.32	0.27
			3	13.1	98.9	0.50	0.45	0.52	0.56	0.68	0.79	0.94	0.99	0.90	0.79	0.62	0.54
					99.0	0.46	0.41	0.47	0.51	0.61	0.72	0.85	0.90	0.81	0.71	0.56	0.49
				8.71	98.9	0.37	0.33	0.39	0.41	0.50	0.59	0.70	0.74	0.67	0.58	0.46	0.40
					99.0	0.34	0.30	0.35	0.38	0.46	0.53	0.63	0.67	0.61	0.53	0.42	0.37
		LCL	2	13.1	98.9	0.20	0.19	0.23	0.26	0.32	0.39	0.46	0.47	0.41	0.34	0.25	0.22
					99.0	0.18	0.17	0.21	0.24	0.30	0.35	0.41	0.43	0.37	0.31	0.23	0.20
				8.71	98.9	0.15	0.14	0.17	0.19	0.24	0.29	0.34	0.35	0.30	0.25	0.19	0.16
					99.0	0.14	0.13	0.16	0.17	0.22	0.26	0.31	0.32	0.27	0.23	0.17	0.15
			3	13.1	98.9	0.27	0.24	0.28	0.30	0.36	0.42	0.50	0.53	0.48	0.42	0.33	0.29
					99.0	0.24	0.22	0.25	0.27	0.33	0.38	0.46	0.48	0.44	0.38	0.30	0.26
				8.71	98.9	0.20	0.18	0.21	0.22	0.27	0.31	0.37	0.40	0.36	0.31	0.25	0.22
					99.0	0.18	0.16	0.19	0.20	0.24	0.29	0.34	0.36	0.32	0.28	0.22	0.20
Option 3	Mean	Maximum likelihood	2	13.1	98.0	0.10	0.09	0.11	0.13	0.16	0.19	0.22	0.23	0.20	0.17	0.12	0.10
				8.71	98.0	0.09	0.08	0.10	0.11	0.14	0.16	0.19	0.20	0.17	0.14	0.11	0.09
			3	13.1	98.0	0.13	0.12	0.14	0.14	0.18	0.21	0.24	0.26	0.23	0.20	0.16	0.14

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				8.71	98.0	0.11	0.10	0.12	0.13	0.15	0.18	0.21	0.22	0.20	0.18	0.14	0.12
	UCL		2	13.1	98.0	0.12	0.11	0.14	0.16	0.19	0.23	0.27	0.28	0.24	0.20	0.15	0.13
				8.71	98.0	0.10	0.10	0.12	0.14	0.17	0.20	0.23	0.24	0.21	0.18	0.13	0.11
			3	13.1	98.0	0.16	0.14	0.17	0.18	0.22	0.25	0.30	0.31	0.28	0.25	0.20	0.17
				8.71	98.0	0.14	0.12	0.14	0.16	0.19	0.22	0.26	0.27	0.25	0.22	0.17	0.15
	LCL		2	13.1	98.0	0.08	0.07	0.09	0.10	0.13	0.16	0.18	0.19	0.16	0.13	0.10	0.08
				8.71	98.0	0.07	0.06	0.08	0.09	0.11	0.13	0.16	0.16	0.14	0.12	0.09	0.07
			3	13.1	98.0	0.11	0.09	0.11	0.12	0.14	0.17	0.20	0.21	0.19	0.17	0.13	0.11
				8.71	98.0	0.09	0.08	0.09	0.10	0.12	0.15	0.18	0.19	0.17	0.15	0.12	0.10
	Mean	UCL	2	13.1	98.0	0.14	0.13	0.15	0.17	0.22	0.26	0.31	0.31	0.27	0.23	0.17	0.14
				8.71	98.0	0.12	0.11	0.13	0.15	0.19	0.22	0.26	0.27	0.24	0.20	0.15	0.12
			3	13.1	98.0	0.18	0.16	0.19	0.20	0.24	0.28	0.34	0.36	0.32	0.28	0.22	0.20
				8.71	98.0	0.16	0.14	0.16	0.17	0.21	0.24	0.29	0.31	0.28	0.24	0.19	0.17
		LCL	2	13.1	98.0	0.06	0.06	0.07	0.08	0.10	0.11	0.14	0.14	0.12	0.10	0.08	0.06
				8.71	98.0	0.05	0.05	0.06	0.07	0.08	0.10	0.12	0.12	0.11	0.09	0.07	0.06
			3	13.1	98.0	0.08	0.07	0.08	0.09	0.11	0.13	0.15	0.16	0.14	0.13	0.10	0.09
				8.71	98.0	0.07	0.06	0.07	0.08	0.09	0.11	0.13	0.14	0.12	0.11	0.09	0.08

Lesser black-backed gull

Table H.2.1- 16: Collision risk estimates for lesser black-backed gull at Preferred Project 4 incorporating variability associated with density, flight height distribution and avoidance rate

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Option 2	Mean	Maximum likelihood	2	13.1	99.4	0.18	0.16	0.37	0.75	0.94	1.12	1.32	0.77	0.36	0.30	0.23	0.19
					99.5	0.15	0.14	0.31	0.62	0.78	0.93	1.10	0.64	0.30	0.25	0.19	0.16
					99.6	0.12	0.11	0.24	0.50	0.63	0.74	0.88	0.51	0.24	0.20	0.15	0.13
				8.71	99.4	0.15	0.14	0.30	0.62	0.78	0.92	1.09	0.63	0.30	0.25	0.19	0.16
					99.5	0.12	0.11	0.25	0.52	0.65	0.77	0.91	0.53	0.25	0.21	0.16	0.13
					99.6	0.10	0.09	0.20	0.41	0.52	0.62	0.73	0.42	0.20	0.17	0.12	0.10
			3	13.1	99.4	0.23	0.21	0.44	0.86	1.04	1.22	1.46	0.87	0.43	0.38	0.30	0.26
					99.5	0.19	0.17	0.37	0.72	0.87	1.02	1.21	0.72	0.36	0.31	0.25	0.21
					99.6	0.16	0.14	0.29	0.58	0.70	0.81	0.97	0.58	0.29	0.25	0.20	0.17
				8.71	99.4	0.19	0.17	0.37	0.71	0.86	1.01	1.21	0.72	0.36	0.31	0.24	0.21
					99.5	0.16	0.14	0.30	0.59	0.72	0.84	1.00	0.60	0.30	0.26	0.20	0.18
					99.6	0.13	0.11	0.24	0.48	0.58	0.67	0.80	0.48	0.24	0.21	0.16	0.14
	UCL		2	13.1	99.5	0.21	0.20	0.44	0.88	1.08	1.26	1.48	0.88	0.43	0.36	0.26	0.22
				8.71	99.5	0.17	0.17	0.36	0.72	0.89	1.04	1.22	0.73	0.36	0.29	0.22	0.18
			3	13.1	99.5	0.28	0.25	0.53	1.01	1.20	1.38	1.63	0.99	0.51	0.44	0.35	0.30

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				8.71	99.5	0.23	0.21	0.44	0.83	0.99	1.14	1.35	0.82	0.42	0.37	0.29	0.25
	LCL		2	13.1	99.5	0.10	0.09	0.22	0.45	0.57	0.69	0.82	0.46	0.21	0.18	0.13	0.11
				8.71	99.5	0.08	0.08	0.18	0.37	0.47	0.57	0.68	0.38	0.18	0.15	0.11	0.09
			3	13.1	99.5	0.13	0.12	0.26	0.52	0.64	0.76	0.90	0.53	0.25	0.22	0.17	0.15
				8.71	99.5	0.11	0.10	0.22	0.43	0.53	0.63	0.75	0.43	0.21	0.18	0.14	0.12
	Mean	UCL	2	13.1	99.5	0.29	0.27	0.60	1.23	1.54	1.84	2.17	1.26	0.60	0.50	0.37	0.31
				8.71	99.5	0.24	0.22	0.50	1.02	1.28	1.52	1.80	1.04	0.50	0.41	0.31	0.26
			3	13.1	99.5	0.38	0.34	0.73	1.42	1.72	2.01	2.39	1.43	0.71	0.62	0.49	0.42
				8.71	99.5	0.32	0.28	0.60	1.17	1.42	1.66	1.98	1.18	0.59	0.51	0.40	0.35
		LCL	2	13.1	99.5	0.09	0.08	0.18	0.38	0.47	0.56	0.66	0.38	0.18	0.15	0.11	0.09
				8.71	99.5	0.07	0.07	0.15	0.31	0.39	0.46	0.55	0.32	0.15	0.13	0.09	0.08
			3	13.1	99.5	0.12	0.10	0.22	0.43	0.52	0.61	0.73	0.44	0.22	0.19	0.15	0.13
				8.71	99.5	0.10	0.09	0.18	0.36	0.43	0.51	0.60	0.36	0.18	0.16	0.12	0.11
Option 3	Mean	Maximum likelihood	2	13.1	98.7	0.11	0.10	0.23	0.47	0.59	0.70	0.83	0.48	0.23	0.19	0.14	0.12
					98.9	0.09	0.09	0.19	0.40	0.50	0.59	0.70	0.41	0.19	0.16	0.12	0.10
					99.1	0.08	0.07	0.16	0.32	0.41	0.48	0.57	0.33	0.16	0.13	0.10	0.08
					99.3	0.06	0.06	0.12	0.25	0.32	0.38	0.45	0.26	0.12	0.10	0.08	0.06
				8.71	98.7	0.10	0.09	0.21	0.43	0.53	0.63	0.75	0.44	0.21	0.17	0.13	0.11

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					98.9	0.08	0.08	0.18	0.36	0.45	0.54	0.64	0.37	0.18	0.15	0.11	0.09
					99.1	0.07	0.06	0.14	0.29	0.37	0.44	0.52	0.30	0.14	0.12	0.09	0.07
					99.3	0.05	0.05	0.11	0.23	0.29	0.34	0.40	0.23	0.11	0.09	0.07	0.06
			3	13.1	98.7	0.15	0.13	0.28	0.54	0.65	0.76	0.91	0.54	0.27	0.23	0.18	0.16
					98.9	0.12	0.11	0.23	0.46	0.55	0.65	0.77	0.46	0.23	0.20	0.16	0.14
					99.1	0.10	0.09	0.19	0.37	0.45	0.53	0.63	0.38	0.19	0.16	0.13	0.11
					99.3	0.08	0.07	0.15	0.29	0.35	0.41	0.49	0.29	0.14	0.13	0.10	0.09
				8.71	98.7	0.13	0.12	0.25	0.49	0.59	0.69	0.83	0.49	0.24	0.21	0.17	0.15
					98.9	0.11	0.10	0.21	0.41	0.50	0.59	0.70	0.42	0.21	0.18	0.14	0.12
					99.1	0.09	0.08	0.17	0.34	0.41	0.48	0.57	0.34	0.17	0.15	0.12	0.10
					99.3	0.07	0.06	0.14	0.26	0.32	0.37	0.45	0.27	0.13	0.11	0.09	0.08
	UCL		2	13.1	98.9	0.13	0.13	0.28	0.56	0.68	0.80	0.94	0.56	0.27	0.23	0.17	0.14
					99.3	0.09	0.08	0.18	0.35	0.44	0.51	0.60	0.35	0.17	0.14	0.11	0.09
				8.71	98.9	0.12	0.12	0.25	0.50	0.62	0.73	0.85	0.51	0.25	0.21	0.15	0.13
					99.3	0.08	0.07	0.16	0.32	0.40	0.46	0.54	0.32	0.16	0.13	0.10	0.08
			3	13.1	98.9	0.18	0.16	0.34	0.64	0.76	0.87	1.03	0.63	0.32	0.28	0.22	0.19
					99.3	0.11	0.10	0.21	0.41	0.48	0.56	0.66	0.40	0.21	0.18	0.14	0.12
				8.71	98.9	0.16	0.15	0.30	0.58	0.69	0.79	0.94	0.57	0.29	0.25	0.20	0.17

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.3	0.10	0.09	0.19	0.37	0.44	0.51	0.60	0.36	0.19	0.16	0.13	0.11
	LCL		2	13.1	98.9	0.06	0.06	0.14	0.28	0.36	0.44	0.52	0.29	0.14	0.11	0.08	0.07
					99.3	0.04	0.04	0.09	0.18	0.23	0.28	0.33	0.19	0.09	0.07	0.05	0.04
				8.71	98.9	0.06	0.05	0.13	0.26	0.33	0.40	0.47	0.27	0.12	0.10	0.08	0.06
					99.3	0.04	0.03	0.08	0.16	0.21	0.25	0.30	0.17	0.08	0.07	0.05	0.04
			3	13.1	98.9	0.09	0.08	0.17	0.33	0.40	0.48	0.57	0.33	0.16	0.14	0.11	0.09
					99.3	0.05	0.05	0.11	0.21	0.26	0.31	0.36	0.21	0.10	0.09	0.07	0.06
				8.71	98.9	0.08	0.07	0.15	0.30	0.37	0.44	0.52	0.30	0.15	0.13	0.10	0.09
					99.3	0.05	0.04	0.10	0.19	0.23	0.28	0.33	0.19	0.09	0.08	0.06	0.05
	Mean	UCL	2	13.1	98.9	0.25	0.24	0.53	1.07	1.35	1.60	1.90	1.10	0.52	0.43	0.32	0.27
					99.3	0.16	0.15	0.34	0.68	0.86	1.02	1.21	0.70	0.33	0.28	0.21	0.17
				8.71	98.9	0.22	0.21	0.47	0.95	1.20	1.42	1.69	0.98	0.47	0.39	0.29	0.24
					99.3	0.14	0.13	0.30	0.61	0.76	0.91	1.07	0.62	0.30	0.25	0.18	0.15
			3	13.1	98.9	0.34	0.30	0.63	1.24	1.50	1.75	2.09	1.25	0.62	0.54	0.42	0.37
					99.3	0.21	0.19	0.40	0.79	0.95	1.12	1.33	0.79	0.39	0.34	0.27	0.23
				8.71	98.9	0.30	0.27	0.56	1.10	1.33	1.56	1.86	1.11	0.55	0.48	0.38	0.33
					99.3	0.19	0.17	0.36	0.70	0.85	0.99	1.18	0.71	0.35	0.30	0.24	0.21
		LCL	2	13.1	98.9	0.05	0.04	0.10	0.20	0.25	0.29	0.35	0.20	0.10	0.08	0.06	0.05

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.3	0.03	0.03	0.06	0.13	0.16	0.19	0.22	0.13	0.06	0.05	0.04	0.03
				8.71	98.9	0.04	0.04	0.09	0.18	0.23	0.27	0.32	0.19	0.09	0.07	0.05	0.05
					99.3	0.03	0.03	0.06	0.12	0.14	0.17	0.20	0.12	0.06	0.05	0.03	0.03
			3	13.1	98.9	0.06	0.05	0.12	0.23	0.28	0.32	0.38	0.23	0.11	0.10	0.08	0.07
					99.3	0.04	0.03	0.07	0.14	0.18	0.21	0.24	0.15	0.07	0.06	0.05	0.04
				8.71	98.9	0.06	0.05	0.11	0.21	0.25	0.30	0.35	0.21	0.10	0.09	0.07	0.06
					99.3	0.04	0.03	0.07	0.13	0.16	0.19	0.22	0.13	0.07	0.06	0.05	0.04

Herring gull

Table H.2.1- 17: Collision risk estimates for herring gull at Preferred Project 4 incorporating variability associated with density, flight height distribution and avoidance rate

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Option 2	Mean	Maximum likelihood	2	12.8	99.4	0.66	0.70	0.72	0.60	0.60	0.51	0.43	0.45	0.50	0.51	0.52	0.58
					99.5	0.55	0.59	0.60	0.50	0.50	0.42	0.36	0.37	0.41	0.43	0.44	0.48
					99.6	0.44	0.47	0.48	0.40	0.40	0.34	0.29	0.30	0.33	0.34	0.35	0.39
				9.8	99.4	0.56	0.59	0.60	0.50	0.50	0.43	0.36	0.38	0.42	0.43	0.44	0.49
					99.5	0.46	0.49	0.50	0.42	0.42	0.36	0.30	0.31	0.35	0.36	0.37	0.41
					99.6	0.37	0.40	0.40	0.33	0.33	0.28	0.24	0.25	0.28	0.29	0.29	0.33
			3	12.8	99.4	0.88	0.89	0.86	0.69	0.66	0.55	0.48	0.51	0.59	0.64	0.68	0.78
					99.5	0.73	0.74	0.72	0.57	0.55	0.46	0.40	0.42	0.49	0.53	0.57	0.65
					99.6	0.59	0.59	0.58	0.46	0.44	0.37	0.32	0.34	0.39	0.43	0.45	0.52
				9.8	99.4	0.74	0.75	0.73	0.58	0.56	0.47	0.40	0.43	0.49	0.54	0.57	0.66
					99.5	0.62	0.63	0.61	0.48	0.47	0.39	0.33	0.36	0.41	0.45	0.48	0.55
					99.6	0.49	0.50	0.49	0.39	0.37	0.31	0.27	0.29	0.33	0.36	0.38	0.44
	UCL		2	12.8	99.5	0.71	0.76	0.77	0.65	0.64	0.55	0.47	0.48	0.53	0.55	0.55	0.62
				9.8	99.5	0.60	0.64	0.65	0.55	0.54	0.46	0.39	0.40	0.45	0.46	0.47	0.52
			3	12.8	99.5	0.95	0.97	0.93	0.75	0.72	0.60	0.52	0.54	0.63	0.68	0.72	0.83

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				9.8	99.5	0.80	0.81	0.78	0.63	0.60	0.50	0.43	0.46	0.53	0.57	0.61	0.70
	LCL		2	12.8	99.5	0.44	0.46	0.47	0.38	0.38	0.33	0.28	0.30	0.33	0.34	0.35	0.39
				9.8	99.5	0.37	0.39	0.39	0.32	0.32	0.28	0.23	0.25	0.28	0.29	0.29	0.33
			3	12.8	99.5	0.58	0.59	0.56	0.44	0.43	0.36	0.31	0.34	0.39	0.43	0.46	0.52
				9.8	99.5	0.49	0.49	0.48	0.37	0.36	0.30	0.26	0.28	0.33	0.36	0.38	0.44
	Mean	UCL	2	12.8	99.5	0.88	0.94	0.95	0.79	0.79	0.67	0.58	0.60	0.66	0.68	0.69	0.77
				9.8	99.5	0.74	0.79	0.80	0.67	0.67	0.57	0.49	0.50	0.56	0.58	0.59	0.65
			3	12.8	99.5	1.17	1.19	1.15	0.91	0.88	0.74	0.63	0.68	0.78	0.85	0.91	1.04
				9.8	99.5	0.99	1.00	0.97	0.77	0.74	0.62	0.53	0.57	0.66	0.71	0.76	0.88
		LCL	2	12.8	99.5	0.38	0.41	0.42	0.34	0.34	0.29	0.25	0.26	0.29	0.30	0.30	0.34
				9.8	99.5	0.32	0.34	0.35	0.29	0.29	0.25	0.21	0.22	0.24	0.25	0.25	0.28
			3	12.8	99.5	0.51	0.52	0.50	0.40	0.38	0.32	0.28	0.29	0.34	0.37	0.40	0.45
				9.8	99.5	0.43	0.44	0.42	0.33	0.32	0.27	0.23	0.25	0.29	0.31	0.33	0.38
Option 3	Mean	Maximum likelihood	2	12.8	98.8	0.42	0.45	0.46	0.38	0.38	0.32	0.28	0.29	0.32	0.33	0.33	0.37
					99.0	0.35	0.37	0.38	0.32	0.32	0.27	0.23	0.24	0.26	0.27	0.28	0.31
					99.2	0.28	0.30	0.30	0.25	0.25	0.21	0.18	0.19	0.21	0.22	0.22	0.25
					99.3	0.25	0.26	0.27	0.22	0.22	0.19	0.16	0.17	0.18	0.19	0.19	0.21
				9.8	98.8	0.38	0.41	0.42	0.35	0.35	0.29	0.25	0.26	0.29	0.30	0.30	0.34

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.0	0.32	0.34	0.35	0.29	0.29	0.25	0.21	0.22	0.24	0.25	0.25	0.28
					99.2	0.26	0.27	0.28	0.23	0.23	0.20	0.17	0.17	0.19	0.20	0.20	0.22
					99.3	0.22	0.24	0.24	0.20	0.20	0.17	0.15	0.15	0.17	0.17	0.18	0.20
			3	12.8	98.8	0.56	0.57	0.55	0.44	0.42	0.35	0.30	0.32	0.37	0.41	0.43	0.50
					99.0	0.47	0.47	0.46	0.36	0.35	0.29	0.25	0.27	0.31	0.34	0.36	0.42
					99.2	0.37	0.38	0.37	0.29	0.28	0.23	0.20	0.22	0.25	0.27	0.29	0.33
					99.3	0.33	0.33	0.32	0.25	0.25	0.21	0.18	0.19	0.22	0.24	0.25	0.29
				9.8	98.8	0.51	0.52	0.50	0.40	0.39	0.32	0.28	0.30	0.34	0.37	0.40	0.46
					99.0	0.43	0.43	0.42	0.33	0.32	0.27	0.23	0.25	0.28	0.31	0.33	0.38
					99.2	0.34	0.35	0.33	0.27	0.26	0.21	0.18	0.20	0.23	0.25	0.26	0.30
					99.3	0.30	0.30	0.29	0.23	0.22	0.19	0.16	0.17	0.20	0.22	0.23	0.27
	UCL		2	12.8	99.0	0.45	0.48	0.49	0.41	0.41	0.35	0.30	0.30	0.34	0.35	0.35	0.39
					99.3	0.32	0.34	0.34	0.29	0.29	0.24	0.21	0.21	0.24	0.24	0.25	0.27
				9.8	99.0	0.41	0.44	0.45	0.38	0.37	0.32	0.27	0.28	0.31	0.32	0.32	0.36
					99.3	0.29	0.31	0.31	0.26	0.26	0.22	0.19	0.19	0.22	0.22	0.22	0.25
			3	12.8	99.0	0.60	0.61	0.59	0.47	0.46	0.38	0.33	0.35	0.40	0.43	0.46	0.53
					99.3	0.42	0.43	0.41	0.33	0.32	0.27	0.23	0.24	0.28	0.30	0.32	0.37
				9.8	99.0	0.55	0.56	0.54	0.43	0.42	0.35	0.30	0.32	0.36	0.39	0.42	0.48

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.3	0.39	0.39	0.38	0.30	0.29	0.24	0.21	0.22	0.26	0.28	0.29	0.34
	LCL		2	12.8	99.0	0.28	0.29	0.30	0.24	0.24	0.21	0.18	0.19	0.21	0.22	0.22	0.25
					99.3	0.20	0.21	0.21	0.17	0.17	0.15	0.12	0.13	0.15	0.15	0.16	0.17
				9.8	99.0	0.25	0.27	0.27	0.22	0.22	0.19	0.16	0.17	0.19	0.20	0.20	0.22
					99.3	0.18	0.19	0.19	0.15	0.16	0.13	0.11	0.12	0.13	0.14	0.14	0.16
			3	12.8	99.0	0.37	0.37	0.36	0.28	0.27	0.23	0.19	0.21	0.25	0.27	0.29	0.33
					99.3	0.26	0.26	0.25	0.20	0.19	0.16	0.14	0.15	0.17	0.19	0.20	0.23
				9.8	99.0	0.34	0.34	0.33	0.25	0.25	0.21	0.18	0.20	0.23	0.25	0.27	0.30
					99.3	0.24	0.24	0.23	0.18	0.17	0.15	0.12	0.14	0.16	0.17	0.19	0.21
	Mean	UCL	2	12.8	99.0	0.79	0.84	0.86	0.71	0.71	0.61	0.52	0.54	0.60	0.62	0.63	0.69
					99.3	0.56	0.59	0.60	0.50	0.50	0.43	0.36	0.38	0.42	0.43	0.44	0.49
				9.8	99.0	0.70	0.75	0.76	0.63	0.63	0.54	0.46	0.48	0.53	0.55	0.56	0.62
					99.3	0.49	0.52	0.53	0.44	0.44	0.38	0.32	0.33	0.37	0.38	0.39	0.43
			3	12.8	99.0	1.06	1.07	1.04	0.82	0.80	0.66	0.57	0.61	0.70	0.77	0.82	0.94
					99.3	0.74	0.75	0.73	0.58	0.56	0.46	0.40	0.43	0.49	0.54	0.57	0.66
				9.8	99.0	0.94	0.95	0.92	0.73	0.71	0.59	0.51	0.54	0.62	0.68	0.73	0.83
					99.3	0.66	0.66	0.64	0.51	0.49	0.41	0.36	0.38	0.44	0.48	0.51	0.58
		LCL	2	12.8	99.0	0.21	0.23	0.23	0.19	0.19	0.16	0.14	0.14	0.16	0.17	0.17	0.19

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.3	0.15	0.16	0.16	0.13	0.13	0.11	0.10	0.10	0.11	0.12	0.12	0.13
				9.8	99.0	0.20	0.21	0.21	0.18	0.18	0.15	0.13	0.13	0.15	0.15	0.16	0.17
					99.3	0.14	0.15	0.15	0.12	0.12	0.11	0.09	0.09	0.10	0.11	0.11	0.12
			3	12.8	99.0	0.28	0.29	0.28	0.22	0.21	0.18	0.15	0.16	0.19	0.21	0.22	0.25
					99.3	0.20	0.20	0.20	0.15	0.15	0.13	0.11	0.11	0.13	0.14	0.15	0.18
				9.8	99.0	0.26	0.27	0.26	0.20	0.20	0.16	0.14	0.15	0.17	0.19	0.20	0.23
					99.3	0.18	0.19	0.18	0.14	0.14	0.12	0.10	0.11	0.12	0.13	0.14	0.16

H.9 Preferred Project 5

Gannet

Table H.2.1- 18: Collision risk estimates for gannet at Preferred Project 5 incorporating variability associated with density, flight height distribution and avoidance rate

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Option 2	Mean	Maximum likelihood	1	14.9	98.7	0.02	0.02	0.08	0.28	0.41	0.58	0.78	0.84	0.68	0.18	0.04	0.02
					98.9	0.02	0.02	0.07	0.24	0.35	0.49	0.66	0.71	0.58	0.15	0.03	0.02
					99.1	0.01	0.01	0.05	0.20	0.29	0.40	0.54	0.58	0.47	0.12	0.02	0.02
					99.5	0.01	0.01	0.03	0.11	0.16	0.22	0.30	0.32	0.26	0.07	0.01	0.01
				13.33	98.7	0.02	0.02	0.07	0.27	0.39	0.55	0.75	0.80	0.65	0.17	0.03	0.02
					98.9	0.02	0.02	0.06	0.23	0.33	0.47	0.63	0.68	0.55	0.14	0.03	0.02
					99.1	0.01	0.01	0.05	0.19	0.27	0.38	0.52	0.55	0.45	0.12	0.02	0.02
					99.5	0.01	0.01	0.03	0.10	0.15	0.21	0.29	0.31	0.25	0.06	0.01	0.01
			2	14.9	98.7	0.03	0.03	0.10	0.33	0.47	0.64	0.87	0.97	0.83	0.23	0.05	0.04
					98.9	0.03	0.02	0.08	0.28	0.39	0.54	0.74	0.82	0.71	0.20	0.04	0.03
					99.1	0.02	0.02	0.07	0.23	0.32	0.45	0.60	0.67	0.58	0.16	0.04	0.03
					99.5	0.01	0.01	0.04	0.13	0.18	0.25	0.34	0.37	0.32	0.09	0.02	0.01
				13.33	98.7	0.03	0.03	0.09	0.32	0.44	0.61	0.83	0.92	0.79	0.22	0.05	0.04
					98.9	0.02	0.02	0.08	0.27	0.37	0.52	0.70	0.78	0.67	0.19	0.04	0.03

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.1	0.02	0.02	0.06	0.22	0.31	0.42	0.57	0.64	0.55	0.15	0.03	0.02
					99.5	0.01	0.01	0.04	0.12	0.17	0.23	0.32	0.36	0.30	0.09	0.02	0.01
	UCL		1	14.9	98.9	0.02	0.02	0.09	0.32	0.45	0.61	0.81	0.88	0.71	0.19	0.04	0.03
					99.5	0.01	0.01	0.04	0.14	0.20	0.28	0.37	0.40	0.32	0.09	0.02	0.01
				13.33	98.9	0.02	0.02	0.09	0.30	0.43	0.58	0.77	0.83	0.68	0.19	0.04	0.03
					99.5	0.01	0.01	0.04	0.14	0.19	0.27	0.35	0.38	0.31	0.08	0.02	0.01
			2	14.9	98.9	0.04	0.03	0.11	0.38	0.51	0.68	0.90	1.01	0.87	0.26	0.06	0.04
					99.5	0.02	0.02	0.05	0.17	0.23	0.31	0.41	0.46	0.39	0.12	0.03	0.02
				13.33	98.9	0.04	0.03	0.11	0.36	0.48	0.64	0.86	0.96	0.83	0.24	0.06	0.04
					99.5	0.02	0.01	0.05	0.16	0.22	0.29	0.39	0.44	0.38	0.11	0.03	0.02
	LCL		1	14.9	98.9	0.01	0.01	0.05	0.18	0.27	0.40	0.55	0.59	0.48	0.12	0.02	0.01
					99.5	0.01	0.01	0.02	0.08	0.12	0.18	0.25	0.27	0.22	0.05	0.01	0.01
				13.33	98.9	0.01	0.01	0.05	0.17	0.26	0.38	0.52	0.56	0.45	0.11	0.02	0.01
					99.5	0.01	0.01	0.02	0.08	0.12	0.17	0.24	0.25	0.21	0.05	0.01	0.01
			2	14.9	98.9	0.02	0.02	0.06	0.21	0.31	0.44	0.61	0.68	0.58	0.16	0.03	0.02
					99.5	0.01	0.01	0.03	0.10	0.14	0.20	0.28	0.31	0.26	0.07	0.01	0.01
				13.33	98.9	0.02	0.02	0.06	0.20	0.29	0.42	0.58	0.64	0.55	0.15	0.03	0.02
					99.5	0.01	0.01	0.03	0.09	0.13	0.19	0.26	0.29	0.25	0.07	0.01	0.01

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Mean	UCL	1	14.9	98.9	0.03	0.03	0.13	0.46	0.67	0.94	1.27	1.36	1.10	0.29	0.06	0.04
					99.5	0.02	0.01	0.06	0.21	0.30	0.43	0.58	0.62	0.50	0.13	0.03	0.02
				13.33	98.9	0.03	0.03	0.12	0.43	0.63	0.89	1.20	1.29	1.05	0.27	0.05	0.04
					99.5	0.01	0.01	0.05	0.20	0.29	0.41	0.55	0.59	0.48	0.12	0.02	0.02
			2	14.9	98.9	0.05	0.04	0.16	0.54	0.75	1.04	1.41	1.57	1.35	0.38	0.08	0.06
					99.5	0.02	0.02	0.07	0.25	0.34	0.47	0.64	0.71	0.61	0.17	0.04	0.03
				13.33	98.9	0.05	0.04	0.15	0.51	0.71	0.98	1.34	1.49	1.28	0.36	0.08	0.06
					99.5	0.02	0.02	0.07	0.23	0.32	0.45	0.61	0.68	0.58	0.16	0.04	0.03
		LCL	1	14.9	98.9	0.01	0.01	0.03	0.09	0.13	0.19	0.25	0.27	0.22	0.06	0.01	0.01
					99.5	0.00	0.00	0.01	0.04	0.06	0.09	0.12	0.12	0.10	0.03	0.01	0.00
				13.33	98.9	0.01	0.01	0.02	0.09	0.13	0.18	0.24	0.26	0.21	0.05	0.01	0.01
					99.5	0.00	0.00	0.01	0.04	0.06	0.08	0.11	0.12	0.10	0.02	0.00	0.00
			2	14.9	98.9	0.01	0.01	0.03	0.11	0.15	0.21	0.28	0.32	0.27	0.08	0.02	0.01
					99.5	0.00	0.00	0.01	0.05	0.07	0.09	0.13	0.14	0.12	0.03	0.01	0.01
				13.33	98.9	0.01	0.01	0.03	0.10	0.14	0.20	0.27	0.30	0.26	0.07	0.02	0.01
					99.5	0.00	0.00	0.01	0.05	0.07	0.09	0.12	0.14	0.12	0.03	0.01	0.01

Kittiwake

Table H.2.1- 19: Collision risk estimates for kittiwake at Preferred Project 5 incorporating variability associated with density, flight height distribution and avoidance rate

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Option 2	Mean	Maximum likelihood	2	13.1	98.7	0.20	0.19	0.22	0.25	0.32	0.40	0.49	0.52	0.46	0.38	0.27	0.22
					98.9	0.17	0.16	0.19	0.21	0.27	0.34	0.42	0.44	0.39	0.32	0.23	0.19
					99.0	0.16	0.14	0.17	0.19	0.25	0.31	0.38	0.40	0.35	0.29	0.21	0.17
					99.1	0.14	0.13	0.15	0.17	0.22	0.28	0.34	0.36	0.32	0.26	0.19	0.15
				8.71	98.7	0.17	0.16	0.18	0.21	0.27	0.33	0.41	0.43	0.38	0.32	0.23	0.18
					98.9	0.14	0.13	0.16	0.17	0.23	0.28	0.35	0.37	0.32	0.27	0.19	0.16
					99.0	0.13	0.12	0.14	0.16	0.20	0.26	0.32	0.33	0.30	0.24	0.18	0.14
					99.1	0.12	0.11	0.13	0.14	0.18	0.23	0.28	0.30	0.27	0.22	0.16	0.13
			3	13.1	98.7	0.27	0.24	0.27	0.28	0.35	0.44	0.54	0.59	0.54	0.47	0.36	0.30
					98.9	0.23	0.20	0.23	0.24	0.30	0.37	0.46	0.50	0.46	0.40	0.30	0.25
					99.0	0.21	0.18	0.20	0.22	0.27	0.34	0.42	0.45	0.42	0.36	0.27	0.23
					99.1	0.19	0.16	0.18	0.20	0.25	0.30	0.37	0.41	0.38	0.33	0.25	0.21
				8.71	98.7	0.22	0.20	0.22	0.24	0.30	0.36	0.45	0.49	0.45	0.39	0.30	0.25
					98.9	0.19	0.17	0.19	0.20	0.25	0.31	0.38	0.42	0.38	0.33	0.25	0.21
					99.0	0.17	0.15	0.17	0.18	0.23	0.28	0.35	0.38	0.35	0.30	0.23	0.19

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.1	0.16	0.14	0.15	0.16	0.20	0.25	0.31	0.34	0.31	0.27	0.21	0.17
	UCL		2	13.1	98.9	0.22	0.20	0.24	0.26	0.34	0.41	0.51	0.54	0.48	0.40	0.29	0.23
					99.0	0.20	0.18	0.22	0.24	0.31	0.38	0.47	0.49	0.44	0.36	0.26	0.21
				8.71	98.9	0.18	0.17	0.20	0.22	0.28	0.35	0.43	0.45	0.40	0.33	0.24	0.20
					99.0	0.16	0.15	0.18	0.20	0.26	0.31	0.39	0.41	0.37	0.30	0.22	0.18
			3	13.1	98.9	0.29	0.25	0.29	0.31	0.38	0.45	0.56	0.62	0.57	0.50	0.37	0.32
					99.0	0.26	0.23	0.26	0.28	0.34	0.41	0.51	0.56	0.52	0.45	0.34	0.29
				8.71	98.9	0.24	0.21	0.24	0.25	0.31	0.38	0.47	0.52	0.47	0.41	0.31	0.26
					99.0	0.22	0.19	0.22	0.23	0.29	0.34	0.43	0.47	0.43	0.38	0.28	0.24
	LCL		2	13.1	98.9	0.13	0.12	0.14	0.16	0.21	0.27	0.34	0.35	0.31	0.26	0.18	0.15
					99.0	0.12	0.11	0.13	0.15	0.19	0.25	0.31	0.32	0.28	0.23	0.17	0.14
				8.71	98.9	0.11	0.10	0.12	0.13	0.18	0.23	0.28	0.29	0.26	0.21	0.15	0.12
					99.0	0.10	0.09	0.11	0.12	0.16	0.21	0.26	0.27	0.24	0.19	0.14	0.11
			3	13.1	98.9	0.18	0.15	0.17	0.18	0.24	0.30	0.37	0.40	0.37	0.32	0.24	0.20
					99.0	0.16	0.14	0.16	0.17	0.21	0.27	0.34	0.36	0.34	0.29	0.22	0.18
				8.71	98.9	0.15	0.13	0.14	0.15	0.20	0.25	0.31	0.33	0.31	0.27	0.20	0.17
					99.0	0.14	0.12	0.13	0.14	0.18	0.22	0.28	0.30	0.28	0.24	0.18	0.15
	Mean	UCL	2	13.1	98.9	0.21	0.20	0.23	0.26	0.34	0.42	0.52	0.55	0.48	0.40	0.29	0.23

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.0	0.19	0.18	0.21	0.23	0.30	0.38	0.47	0.50	0.44	0.36	0.26	0.21
				8.71	98.9	0.18	0.16	0.19	0.22	0.28	0.35	0.43	0.46	0.40	0.33	0.24	0.19
					99.0	0.16	0.15	0.18	0.20	0.25	0.32	0.39	0.42	0.37	0.30	0.22	0.18
			3	13.1	98.9	0.28	0.25	0.28	0.30	0.37	0.46	0.57	0.62	0.57	0.49	0.37	0.32
					99.0	0.26	0.23	0.25	0.27	0.34	0.42	0.52	0.56	0.52	0.45	0.34	0.29
				8.71	98.9	0.24	0.21	0.23	0.25	0.31	0.38	0.48	0.52	0.48	0.41	0.31	0.26
					99.0	0.21	0.19	0.21	0.23	0.28	0.35	0.43	0.47	0.43	0.38	0.28	0.24
		LCL	2	13.1	98.9	0.12	0.11	0.13	0.15	0.19	0.24	0.29	0.31	0.28	0.23	0.16	0.13
					99.0	0.11	0.10	0.12	0.13	0.17	0.22	0.27	0.28	0.25	0.21	0.15	0.12
				8.71	98.9	0.10	0.09	0.11	0.12	0.16	0.20	0.25	0.26	0.23	0.19	0.14	0.11
					99.0	0.09	0.08	0.10	0.11	0.15	0.18	0.22	0.24	0.21	0.17	0.12	0.10
			3	13.1	98.9	0.16	0.14	0.16	0.17	0.21	0.26	0.32	0.35	0.33	0.28	0.21	0.18
					99.0	0.15	0.13	0.15	0.15	0.19	0.24	0.30	0.32	0.30	0.26	0.19	0.16
				8.71	98.9	0.13	0.12	0.13	0.14	0.18	0.22	0.27	0.30	0.27	0.24	0.18	0.15
					99.0	0.12	0.11	0.12	0.13	0.16	0.20	0.25	0.27	0.25	0.21	0.16	0.14
Option 3	Mean	Maximum likelihood	2	13.1	98.0	0.06	0.06	0.07	0.08	0.10	0.13	0.16	0.16	0.15	0.12	0.09	0.07
				8.71	98.0	0.06	0.06	0.07	0.08	0.10	0.13	0.16	0.16	0.15	0.12	0.09	0.07
			3	13.1	98.0	0.09	0.07	0.08	0.09	0.11	0.14	0.17	0.19	0.17	0.15	0.11	0.10

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				8.71	98.0	0.08	0.07	0.08	0.09	0.11	0.14	0.17	0.19	0.17	0.15	0.11	0.09
	UCL		2	13.1	98.0	0.08	0.07	0.09	0.10	0.13	0.16	0.19	0.20	0.18	0.15	0.11	0.09
				8.71	98.0	0.08	0.07	0.09	0.10	0.13	0.15	0.19	0.20	0.18	0.15	0.11	0.09
			3	13.1	98.0	0.11	0.09	0.11	0.11	0.14	0.17	0.21	0.23	0.21	0.19	0.14	0.12
				8.71	98.0	0.11	0.09	0.11	0.11	0.14	0.17	0.21	0.23	0.21	0.19	0.14	0.12
	LCL		2	13.1	98.0	0.05	0.05	0.05	0.06	0.08	0.10	0.13	0.13	0.12	0.10	0.07	0.06
				8.71	98.0	0.05	0.05	0.05	0.06	0.08	0.10	0.13	0.13	0.12	0.10	0.07	0.06
			3	13.1	98.0	0.07	0.06	0.07	0.07	0.09	0.11	0.14	0.15	0.14	0.12	0.09	0.08
				8.71	98.0	0.07	0.06	0.06	0.07	0.09	0.11	0.14	0.15	0.14	0.12	0.09	0.08
	Mean	UCL	2	13.1	98.0	0.09	0.08	0.09	0.10	0.14	0.17	0.21	0.22	0.20	0.16	0.12	0.09
				8.71	98.0	0.09	0.08	0.09	0.10	0.13	0.17	0.21	0.22	0.19	0.16	0.12	0.09
			3	13.1	98.0	0.11	0.10	0.11	0.12	0.15	0.19	0.23	0.25	0.23	0.20	0.15	0.13
				8.71	98.0	0.11	0.10	0.11	0.12	0.15	0.18	0.23	0.25	0.23	0.20	0.15	0.13
		LCL	2	13.1	98.0	0.04	0.04	0.04	0.05	0.06	0.08	0.10	0.11	0.09	0.08	0.06	0.04
				8.71	98.0	0.04	0.04	0.04	0.05	0.06	0.08	0.10	0.11	0.09	0.08	0.06	0.04
			3	13.1	98.0	0.05	0.05	0.05	0.06	0.07	0.09	0.11	0.12	0.11	0.10	0.07	0.06
				8.71	98.0	0.05	0.05	0.05	0.06	0.07	0.09	0.11	0.12	0.11	0.10	0.07	0.06

Lesser black-backed gull

Table H.2.1- 20: Collision risk estimates for lesser black-backed gull at Preferred Project 5 incorporating variability associated with density, flight height distribution and avoidance rate

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Option 2	Mean	Maximum likelihood	2	13.1	99.4	0.24	0.23	0.51	1.03	1.26	1.45	1.64	0.96	0.46	0.39	0.30	0.25
					99.5	0.20	0.19	0.43	0.86	1.05	1.21	1.37	0.80	0.39	0.33	0.25	0.21
					99.6	0.16	0.15	0.34	0.69	0.84	0.96	1.10	0.64	0.31	0.26	0.20	0.17
				8.71	99.4	0.21	0.20	0.45	0.91	1.12	1.28	1.45	0.85	0.41	0.35	0.26	0.22
					99.5	0.18	0.17	0.38	0.76	0.93	1.07	1.21	0.71	0.34	0.29	0.22	0.19
					99.6	0.14	0.13	0.30	0.61	0.74	0.85	0.97	0.57	0.27	0.23	0.17	0.15
			3	13.1	99.4	0.32	0.29	0.62	1.18	1.40	1.58	1.81	1.09	0.55	0.48	0.39	0.34
					99.5	0.27	0.24	0.51	0.99	1.17	1.32	1.51	0.91	0.46	0.40	0.32	0.29
					99.6	0.21	0.19	0.41	0.79	0.94	1.06	1.21	0.73	0.36	0.32	0.26	0.23
				8.71	99.4	0.28	0.25	0.55	1.05	1.24	1.40	1.60	0.96	0.48	0.43	0.34	0.30
					99.5	0.24	0.21	0.45	0.87	1.03	1.17	1.33	0.80	0.40	0.36	0.29	0.25
					99.6	0.19	0.17	0.36	0.70	0.83	0.93	1.07	0.64	0.32	0.29	0.23	0.20
	UCL		2	13.1	99.5	0.28	0.27	0.60	1.16	1.41	1.60	1.82	1.11	0.55	0.45	0.34	0.29
				8.71	99.5	0.25	0.24	0.53	1.02	1.24	1.42	1.61	0.98	0.48	0.40	0.30	0.26
			3	13.1	99.5	0.37	0.34	0.72	1.33	1.57	1.75	2.00	1.25	0.64	0.56	0.44	0.40

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				8.71	99.5	0.33	0.30	0.64	1.18	1.38	1.55	1.77	1.11	0.57	0.49	0.39	0.35
	LCL		2	13.1	99.5	0.14	0.13	0.31	0.63	0.78	0.91	1.05	0.59	0.28	0.24	0.18	0.15
				8.71	99.5	0.13	0.12	0.27	0.56	0.69	0.80	0.92	0.53	0.25	0.21	0.16	0.13
			3	13.1	99.5	0.19	0.17	0.37	0.73	0.87	1.00	1.15	0.67	0.33	0.29	0.23	0.20
				8.71	99.5	0.17	0.15	0.33	0.64	0.77	0.88	1.02	0.60	0.29	0.26	0.21	0.18
	Mean	UCL	2	13.1	99.5	0.37	0.35	0.79	1.58	1.94	2.22	2.53	1.48	0.71	0.60	0.46	0.39
				8.71	99.5	0.33	0.31	0.69	1.40	1.71	1.97	2.23	1.31	0.63	0.53	0.40	0.34
			3	13.1	99.5	0.49	0.44	0.95	1.82	2.16	2.43	2.78	1.68	0.84	0.74	0.60	0.53
				8.71	99.5	0.43	0.39	0.84	1.61	1.91	2.15	2.46	1.48	0.74	0.66	0.53	0.47
		LCL	2	13.1	99.5	0.13	0.12	0.27	0.54	0.66	0.76	0.87	0.51	0.24	0.21	0.16	0.13
				8.71	99.5	0.11	0.11	0.24	0.48	0.59	0.67	0.77	0.45	0.22	0.18	0.14	0.12
			3	13.1	99.5	0.17	0.15	0.32	0.62	0.74	0.83	0.95	0.58	0.29	0.25	0.20	0.18
				8.71	99.5	0.15	0.13	0.29	0.55	0.65	0.74	0.84	0.51	0.25	0.23	0.18	0.16
Option 3	Mean	Maximum likelihood	2	13.1	98.7	0.16	0.15	0.35	0.70	0.86	0.99	1.12	0.66	0.32	0.27	0.20	0.17
					98.9	0.14	0.13	0.29	0.59	0.73	0.83	0.95	0.56	0.27	0.22	0.17	0.15
					99.1	0.11	0.11	0.24	0.48	0.60	0.68	0.78	0.45	0.22	0.18	0.14	0.12
					99.3	0.09	0.08	0.19	0.38	0.46	0.53	0.60	0.35	0.17	0.14	0.11	0.09
				8.71	98.7	0.16	0.15	0.34	0.69	0.85	0.97	1.11	0.65	0.31	0.26	0.20	0.17

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					98.9	0.14	0.13	0.29	0.59	0.72	0.82	0.94	0.55	0.26	0.22	0.17	0.14
					99.1	0.11	0.11	0.24	0.48	0.59	0.67	0.77	0.45	0.22	0.18	0.14	0.12
					99.3	0.09	0.08	0.19	0.37	0.46	0.52	0.60	0.35	0.17	0.14	0.11	0.09
			3	13.1	98.7	0.22	0.20	0.42	0.81	0.96	1.08	1.23	0.74	0.37	0.33	0.26	0.23
					98.9	0.18	0.17	0.36	0.68	0.81	0.91	1.04	0.63	0.31	0.28	0.22	0.20
					99.1	0.15	0.14	0.29	0.56	0.66	0.75	0.85	0.51	0.26	0.23	0.18	0.16
					99.3	0.12	0.11	0.23	0.43	0.52	0.58	0.66	0.40	0.20	0.18	0.14	0.13
				8.71	98.7	0.22	0.19	0.42	0.80	0.95	1.07	1.22	0.73	0.37	0.33	0.26	0.23
					98.9	0.18	0.16	0.35	0.67	0.80	0.90	1.03	0.62	0.31	0.28	0.22	0.20
					99.1	0.15	0.13	0.29	0.55	0.65	0.74	0.84	0.51	0.25	0.23	0.18	0.16
					99.3	0.12	0.10	0.22	0.43	0.51	0.57	0.66	0.40	0.20	0.18	0.14	0.12
	UCL		2	13.1	98.9	0.19	0.19	0.41	0.80	0.97	1.11	1.26	0.76	0.38	0.31	0.23	0.20
					99.3	0.12	0.12	0.26	0.51	0.62	0.71	0.80	0.49	0.24	0.20	0.15	0.13
				8.71	98.9	0.19	0.18	0.41	0.79	0.96	1.10	1.24	0.76	0.37	0.31	0.23	0.20
					99.3	0.12	0.12	0.26	0.50	0.61	0.70	0.79	0.48	0.24	0.20	0.15	0.13
			3	13.1	98.9	0.26	0.24	0.50	0.92	1.08	1.21	1.38	0.87	0.45	0.39	0.31	0.27
					99.3	0.16	0.15	0.32	0.59	0.69	0.77	0.88	0.55	0.28	0.25	0.20	0.17
				8.71	98.9	0.26	0.23	0.49	0.91	1.07	1.20	1.37	0.86	0.44	0.38	0.30	0.27

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.3	0.16	0.15	0.31	0.58	0.68	0.76	0.87	0.55	0.28	0.24	0.19	0.17
	LCL		2	13.1	98.9	0.10	0.09	0.22	0.44	0.54	0.63	0.72	0.41	0.19	0.16	0.12	0.10
					99.3	0.06	0.06	0.14	0.28	0.34	0.40	0.46	0.26	0.12	0.10	0.08	0.07
				8.71	98.9	0.10	0.09	0.21	0.43	0.53	0.62	0.71	0.41	0.19	0.16	0.12	0.10
					99.3	0.06	0.06	0.14	0.28	0.34	0.40	0.45	0.26	0.12	0.10	0.08	0.07
			3	13.1	98.9	0.13	0.12	0.26	0.50	0.60	0.69	0.80	0.47	0.23	0.20	0.16	0.14
					99.3	0.08	0.07	0.16	0.32	0.38	0.44	0.51	0.30	0.14	0.13	0.10	0.09
				8.71	98.9	0.13	0.11	0.26	0.50	0.60	0.68	0.79	0.46	0.22	0.20	0.16	0.14
					99.3	0.08	0.07	0.16	0.32	0.38	0.43	0.50	0.29	0.14	0.13	0.10	0.09
	Mean	UCL	2	13.1	98.9	0.35	0.33	0.74	1.48	1.82	2.08	2.37	1.39	0.67	0.56	0.43	0.36
					99.3	0.22	0.21	0.47	0.94	1.16	1.33	1.51	0.88	0.42	0.36	0.27	0.23
				8.71	98.9	0.33	0.32	0.71	1.43	1.76	2.02	2.29	1.34	0.65	0.54	0.41	0.35
					99.3	0.21	0.20	0.45	0.91	1.12	1.28	1.46	0.85	0.41	0.35	0.26	0.22
			3	13.1	98.9	0.46	0.41	0.89	1.70	2.02	2.28	2.61	1.57	0.79	0.70	0.56	0.49
					99.3	0.29	0.26	0.57	1.08	1.29	1.45	1.66	1.00	0.50	0.44	0.36	0.31
				8.71	98.9	0.45	0.40	0.86	1.65	1.96	2.21	2.53	1.52	0.76	0.67	0.54	0.48
					99.3	0.28	0.25	0.55	1.05	1.25	1.40	1.61	0.97	0.48	0.43	0.34	0.30
		LCL	2	13.1	98.9	0.07	0.07	0.16	0.31	0.38	0.44	0.50	0.29	0.14	0.12	0.09	0.08

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.3	0.05	0.04	0.10	0.20	0.24	0.28	0.32	0.19	0.09	0.08	0.06	0.05
				8.71	98.9	0.07	0.07	0.16	0.31	0.38	0.44	0.50	0.29	0.14	0.12	0.09	0.08
					99.3	0.05	0.04	0.10	0.20	0.24	0.28	0.32	0.19	0.09	0.08	0.06	0.05
			3	13.1	98.9	0.10	0.09	0.19	0.36	0.43	0.48	0.55	0.33	0.17	0.15	0.12	0.10
					99.3	0.06	0.06	0.12	0.23	0.27	0.31	0.35	0.21	0.11	0.09	0.08	0.07
				8.71	98.9	0.10	0.09	0.19	0.36	0.43	0.48	0.55	0.33	0.17	0.15	0.12	0.10
					99.3	0.06	0.06	0.12	0.23	0.27	0.31	0.35	0.21	0.11	0.09	0.07	0.07

Herring gull

Table H.2.1- 21: Collision risk estimates for herring gull at Preferred Project 5 incorporating variability associated with density, flight height distribution and avoidance rate

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Option 2	Mean	Maximum likelihood	2	12.8	99.4	0.43	0.46	0.47	0.39	0.39	0.33	0.28	0.29	0.32	0.33	0.34	0.38
					99.5	0.36	0.38	0.39	0.33	0.33	0.28	0.24	0.24	0.27	0.28	0.28	0.31
					99.6	0.29	0.31	0.31	0.26	0.26	0.22	0.19	0.19	0.21	0.22	0.23	0.25
				9.8	99.4	0.39	0.41	0.42	0.35	0.35	0.30	0.25	0.26	0.29	0.30	0.30	0.34
					99.5	0.32	0.34	0.35	0.29	0.29	0.25	0.21	0.22	0.24	0.25	0.25	0.28
					99.6	0.26	0.27	0.28	0.24	0.23	0.20	0.17	0.17	0.19	0.20	0.20	0.22
			3	12.8	99.4	0.57	0.58	0.57	0.45	0.44	0.36	0.31	0.33	0.38	0.41	0.44	0.51
					99.5	0.48	0.48	0.47	0.38	0.36	0.30	0.26	0.27	0.31	0.34	0.37	0.42
					99.6	0.38	0.39	0.38	0.30	0.29	0.24	0.21	0.22	0.25	0.27	0.29	0.34
				9.8	99.4	0.51	0.52	0.51	0.41	0.39	0.32	0.28	0.29	0.34	0.37	0.40	0.46
					99.5	0.43	0.43	0.42	0.34	0.33	0.27	0.23	0.25	0.28	0.31	0.33	0.38
					99.6	0.34	0.35	0.34	0.27	0.26	0.22	0.19	0.20	0.22	0.25	0.26	0.30
	UCL		2	12.8	99.5	0.46	0.49	0.51	0.43	0.43	0.36	0.31	0.31	0.34	0.35	0.35	0.40
				9.8	99.5	0.41	0.44	0.46	0.39	0.38	0.32	0.28	0.28	0.31	0.32	0.32	0.35
			3	12.8	99.5	0.61	0.62	0.62	0.50	0.48	0.39	0.34	0.35	0.40	0.44	0.46	0.54

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				9.8	99.5	0.55	0.56	0.55	0.45	0.43	0.35	0.30	0.32	0.36	0.39	0.42	0.48
	LCL		2	12.8	99.5	0.28	0.30	0.30	0.25	0.25	0.21	0.18	0.19	0.21	0.22	0.22	0.25
				9.8	99.5	0.25	0.27	0.27	0.22	0.22	0.19	0.16	0.17	0.19	0.19	0.20	0.22
			3	12.8	99.5	0.37	0.38	0.37	0.29	0.28	0.23	0.19	0.21	0.24	0.27	0.29	0.33
				9.8	99.5	0.33	0.34	0.33	0.26	0.25	0.20	0.17	0.19	0.22	0.24	0.26	0.30
	Mean	UCL	2	12.8	99.5	0.55	0.58	0.60	0.50	0.50	0.42	0.36	0.37	0.40	0.42	0.43	0.48
				9.8	99.5	0.49	0.52	0.54	0.45	0.45	0.38	0.32	0.33	0.36	0.38	0.38	0.43
			3	12.8	99.5	0.73	0.74	0.72	0.58	0.55	0.46	0.40	0.42	0.48	0.52	0.56	0.65
				9.8	99.5	0.65	0.66	0.65	0.52	0.50	0.41	0.35	0.37	0.43	0.47	0.50	0.58
		LCL	2	12.8	99.5	0.26	0.27	0.28	0.24	0.23	0.20	0.17	0.17	0.19	0.20	0.20	0.22
				9.8	99.5	0.23	0.25	0.25	0.21	0.21	0.18	0.15	0.16	0.17	0.18	0.18	0.20
			3	12.8	99.5	0.34	0.35	0.34	0.27	0.26	0.22	0.19	0.20	0.23	0.25	0.26	0.30
				9.8	99.5	0.31	0.31	0.30	0.24	0.23	0.19	0.17	0.18	0.20	0.22	0.24	0.27
Option 3	Mean	Maximum likelihood	2	12.8	98.8	0.30	0.32	0.33	0.27	0.27	0.23	0.20	0.20	0.22	0.23	0.23	0.26
					99.0	0.25	0.26	0.27	0.23	0.23	0.19	0.16	0.17	0.18	0.19	0.19	0.22
					99.2	0.20	0.21	0.22	0.18	0.18	0.15	0.13	0.13	0.15	0.15	0.16	0.17
					99.3	0.17	0.19	0.19	0.16	0.16	0.13	0.11	0.12	0.13	0.13	0.14	0.15
				9.8	98.8	0.29	0.31	0.32	0.27	0.27	0.23	0.19	0.20	0.22	0.23	0.23	0.26

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.0	0.24	0.26	0.27	0.22	0.22	0.19	0.16	0.16	0.18	0.19	0.19	0.21
					99.2	0.20	0.21	0.21	0.18	0.18	0.15	0.13	0.13	0.14	0.15	0.15	0.17
					99.3	0.17	0.18	0.19	0.16	0.16	0.13	0.11	0.12	0.13	0.13	0.13	0.15
				12.8	98.8	0.40	0.40	0.39	0.31	0.30	0.25	0.22	0.23	0.26	0.28	0.31	0.35
					99.0	0.33	0.34	0.33	0.26	0.25	0.21	0.18	0.19	0.22	0.24	0.25	0.29
					99.2	0.26	0.27	0.26	0.21	0.20	0.17	0.14	0.15	0.17	0.19	0.20	0.23
			3		99.3	0.23	0.23	0.23	0.18	0.18	0.15	0.13	0.13	0.15	0.17	0.18	0.21
				9.8	98.8	0.39	0.40	0.39	0.31	0.30	0.25	0.21	0.22	0.26	0.28	0.30	0.35
					99.0	0.33	0.33	0.32	0.26	0.25	0.21	0.18	0.19	0.21	0.23	0.25	0.29
					99.2	0.26	0.26	0.26	0.21	0.20	0.16	0.14	0.15	0.17	0.19	0.20	0.23
					99.3	0.23	0.23	0.23	0.18	0.17	0.14	0.12	0.13	0.15	0.16	0.18	0.20
	UCL		2	12.8	99.0	0.32	0.34	0.35	0.30	0.30	0.25	0.21	0.21	0.24	0.24	0.24	0.27
					99.3	0.22	0.24	0.25	0.21	0.21	0.17	0.15	0.15	0.17	0.17	0.17	0.19
				9.8	99.0	0.31	0.34	0.35	0.30	0.29	0.25	0.21	0.21	0.23	0.24	0.24	0.27
					99.3	0.22	0.24	0.24	0.21	0.20	0.17	0.15	0.15	0.16	0.17	0.17	0.19
			3	12.8	99.0	0.42	0.43	0.43	0.35	0.33	0.27	0.23	0.24	0.28	0.30	0.32	0.37
					99.3	0.30	0.30	0.30	0.24	0.23	0.19	0.16	0.17	0.20	0.21	0.22	0.26
				9.8	99.0	0.42	0.43	0.42	0.34	0.33	0.27	0.23	0.24	0.28	0.30	0.32	0.36

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.3	0.29	0.30	0.29	0.24	0.23	0.19	0.16	0.17	0.19	0.21	0.22	0.26
	LCL		2	12.8	99.0	0.19	0.20	0.21	0.17	0.17	0.14	0.12	0.13	0.14	0.15	0.15	0.17
					99.3	0.14	0.14	0.15	0.12	0.12	0.10	0.09	0.09	0.10	0.10	0.11	0.12
				9.8	99.0	0.19	0.20	0.21	0.17	0.17	0.14	0.12	0.13	0.14	0.15	0.15	0.17
					99.3	0.13	0.14	0.15	0.12	0.12	0.10	0.08	0.09	0.10	0.10	0.10	0.12
			3	12.8	99.0	0.26	0.26	0.25	0.20	0.19	0.16	0.13	0.15	0.17	0.19	0.20	0.23
					99.3	0.18	0.18	0.18	0.14	0.13	0.11	0.09	0.10	0.12	0.13	0.14	0.16
				9.8	99.0	0.25	0.26	0.25	0.19	0.19	0.16	0.13	0.14	0.17	0.18	0.20	0.23
					99.3	0.18	0.18	0.17	0.14	0.13	0.11	0.09	0.10	0.12	0.13	0.14	0.16
	Mean	UCL	2	12.8	99.0	0.51	0.55	0.56	0.47	0.47	0.39	0.34	0.35	0.38	0.40	0.40	0.45
					99.3	0.36	0.38	0.39	0.33	0.33	0.28	0.24	0.24	0.27	0.28	0.28	0.31
				9.8	99.0	0.49	0.52	0.54	0.45	0.45	0.38	0.32	0.33	0.36	0.38	0.39	0.43
					99.3	0.34	0.37	0.38	0.31	0.31	0.26	0.23	0.23	0.25	0.27	0.27	0.30
			3	12.8	99.0	0.68	0.69	0.68	0.54	0.52	0.43	0.37	0.39	0.45	0.49	0.53	0.61
					99.3	0.48	0.48	0.47	0.38	0.36	0.30	0.26	0.27	0.31	0.34	0.37	0.42
				9.8	99.0	0.65	0.66	0.65	0.52	0.50	0.41	0.36	0.38	0.43	0.47	0.50	0.58
					99.3	0.46	0.46	0.45	0.36	0.35	0.29	0.25	0.26	0.30	0.33	0.35	0.41
		LCL	2	12.8	99.0	0.16	0.17	0.17	0.14	0.14	0.12	0.10	0.11	0.12	0.12	0.12	0.14

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.3	0.11	0.12	0.12	0.10	0.10	0.08	0.07	0.07	0.08	0.08	0.09	0.10
				9.8	99.0	0.16	0.17	0.17	0.14	0.14	0.12	0.10	0.10	0.12	0.12	0.12	0.14
					99.3	0.11	0.12	0.12	0.10	0.10	0.08	0.07	0.07	0.08	0.08	0.09	0.10
			3	12.8	99.0	0.21	0.21	0.21	0.17	0.16	0.13	0.11	0.12	0.14	0.15	0.16	0.19
					99.3	0.15	0.15	0.14	0.12	0.11	0.09	0.08	0.08	0.10	0.11	0.11	0.13
				9.8	99.0	0.21	0.21	0.21	0.16	0.16	0.13	0.11	0.12	0.14	0.15	0.16	0.18
					99.3	0.15	0.15	0.14	0.11	0.11	0.09	0.08	0.08	0.10	0.10	0.11	0.13

Little gull

Table H.2.1- 22: Collision risk estimates for little gull at Preferred Project 5 incorporating variability associated with flight height distribution and avoidance rate

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Option 2	Mean	Maximum likelihood	2	11.5	99.0	0.15	0.15	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.15	0.15
					99.2	0.12	0.12	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.12	0.12
					99.4	0.09	0.09	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.09	0.09
		UCL			99.2	0.29	0.29	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.29	0.28
		LCL			99.2	0.03	0.03	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.03	0.03

H.10 Preferred Project 6

Gannet

Table H.2.1- 23: Collision risk estimates for gannet at Preferred Project 6 incorporating variability associated with density, flight height distribution and avoidance rate

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Option 2	Mean	Maximum likelihood	1	14.9	98.7	0.04	0.04	0.16	0.59	0.81	1.05	1.31	1.34	1.09	0.30	0.06	0.05
					98.9	0.04	0.04	0.14	0.50	0.69	0.89	1.11	1.13	0.92	0.25	0.05	0.04
					99.1	0.03	0.03	0.11	0.41	0.56	0.73	0.90	0.93	0.76	0.20	0.04	0.03
					99.5	0.02	0.02	0.06	0.23	0.31	0.41	0.50	0.51	0.42	0.11	0.02	0.02
				13.33	98.7	0.04	0.04	0.15	0.55	0.76	0.99	1.22	1.25	1.02	0.28	0.06	0.04
					98.9	0.03	0.03	0.13	0.47	0.64	0.84	1.04	1.06	0.87	0.23	0.05	0.04
					99.1	0.03	0.03	0.11	0.38	0.53	0.68	0.85	0.87	0.71	0.19	0.04	0.03
					99.5	0.01	0.01	0.06	0.21	0.29	0.38	0.47	0.48	0.39	0.11	0.02	0.02
			2	14.9	98.7	0.06	0.06	0.21	0.69	0.92	1.16	1.45	1.54	1.33	0.39	0.09	0.07
					98.9	0.05	0.05	0.18	0.59	0.77	0.98	1.23	1.31	1.13	0.33	0.08	0.06
					99.1	0.04	0.04	0.14	0.48	0.63	0.80	1.01	1.07	0.92	0.27	0.06	0.05
					99.5	0.02	0.02	0.08	0.27	0.35	0.45	0.56	0.59	0.51	0.15	0.03	0.03
				13.33	98.7	0.06	0.05	0.19	0.65	0.86	1.09	1.36	1.45	1.25	0.36	0.08	0.07
					98.9	0.05	0.04	0.16	0.55	0.73	0.92	1.15	1.22	1.06	0.31	0.07	0.06

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.1	0.04	0.04	0.13	0.45	0.59	0.75	0.94	1.00	0.86	0.25	0.06	0.05
					99.5	0.02	0.02	0.07	0.25	0.33	0.42	0.52	0.56	0.48	0.14	0.03	0.03
	UCL		1	14.9	98.9	0.05	0.05	0.19	0.65	0.86	1.09	1.34	1.36	1.11	0.32	0.07	0.05
					99.5	0.02	0.02	0.08	0.29	0.39	0.50	0.61	0.62	0.51	0.15	0.03	0.02
				13.33	98.9	0.05	0.05	0.17	0.61	0.81	1.02	1.25	1.28	1.04	0.30	0.07	0.05
					99.5	0.02	0.02	0.08	0.28	0.37	0.46	0.57	0.58	0.47	0.14	0.03	0.02
			2	14.9	98.9	0.07	0.07	0.24	0.76	0.97	1.20	1.49	1.57	1.36	0.42	0.10	0.08
					99.5	0.03	0.03	0.11	0.35	0.44	0.55	0.68	0.72	0.62	0.19	0.05	0.04
				13.33	98.9	0.07	0.06	0.22	0.71	0.91	1.12	1.39	1.47	1.27	0.39	0.10	0.08
					99.5	0.03	0.03	0.10	0.32	0.41	0.51	0.63	0.67	0.58	0.18	0.04	0.03
	LCL		1	14.9	98.9	0.03	0.02	0.10	0.38	0.54	0.73	0.92	0.95	0.78	0.20	0.04	0.03
					99.5	0.01	0.01	0.05	0.17	0.25	0.33	0.42	0.43	0.35	0.09	0.02	0.01
				13.33	98.9	0.02	0.02	0.10	0.36	0.51	0.68	0.87	0.89	0.73	0.19	0.04	0.03
					99.5	0.01	0.01	0.04	0.16	0.23	0.31	0.39	0.41	0.33	0.08	0.02	0.01
			2	14.9	98.9	0.04	0.03	0.13	0.45	0.61	0.80	1.03	1.10	0.95	0.26	0.06	0.04
					99.5	0.02	0.02	0.06	0.21	0.28	0.37	0.47	0.50	0.43	0.12	0.03	0.02
				13.33	98.9	0.04	0.03	0.12	0.42	0.57	0.75	0.96	1.03	0.89	0.25	0.05	0.04
					99.5	0.02	0.01	0.06	0.19	0.26	0.34	0.44	0.47	0.40	0.11	0.02	0.02

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Mean	UCL	1	14.9	98.9	0.07	0.07	0.29	1.02	1.41	1.83	2.27	2.32	1.89	0.51	0.11	0.08
					99.5	0.03	0.03	0.13	0.46	0.64	0.83	1.03	1.05	0.86	0.23	0.05	0.04
				13.33	98.9	0.07	0.07	0.27	0.96	1.32	1.71	2.12	2.17	1.77	0.48	0.10	0.07
					99.5	0.03	0.03	0.12	0.43	0.60	0.78	0.96	0.99	0.81	0.22	0.05	0.03
			2	14.9	98.9	0.11	0.10	0.36	1.20	1.59	2.01	2.52	2.68	2.31	0.67	0.15	0.12
					99.5	0.05	0.04	0.16	0.55	0.72	0.92	1.15	1.22	1.05	0.31	0.07	0.06
				13.33	98.9	0.10	0.09	0.34	1.13	1.49	1.89	2.36	2.51	2.16	0.63	0.15	0.11
					99.5	0.05	0.04	0.15	0.51	0.68	0.86	1.07	1.14	0.98	0.29	0.07	0.05
		LCL	1	14.9	98.9	0.01	0.01	0.05	0.17	0.24	0.31	0.38	0.39	0.32	0.09	0.02	0.01
					99.5	0.01	0.01	0.02	0.08	0.11	0.14	0.17	0.18	0.14	0.04	0.01	0.01
				13.33	98.9	0.01	0.01	0.05	0.16	0.22	0.29	0.36	0.37	0.30	0.08	0.02	0.01
					99.5	0.01	0.01	0.02	0.07	0.10	0.13	0.16	0.17	0.14	0.04	0.01	0.01
			2	14.9	98.9	0.02	0.02	0.06	0.20	0.27	0.34	0.42	0.45	0.39	0.11	0.03	0.02
					99.5	0.01	0.01	0.03	0.09	0.12	0.15	0.19	0.20	0.18	0.05	0.01	0.01
				13.33	98.9	0.02	0.02	0.06	0.19	0.25	0.32	0.40	0.42	0.36	0.11	0.02	0.02
					99.5	0.01	0.01	0.03	0.09	0.11	0.14	0.18	0.19	0.17	0.05	0.01	0.01

Kittiwake

Table H.2.1- 24: Collision risk estimates for kittiwake at Preferred Project 6 incorporating variability associated with density, flight height distribution and avoidance rate

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Option 2	Mean	Maximum likelihood	2	13.1	98.7	0.32	0.30	0.36	0.40	0.50	0.60	0.72	0.74	0.65	0.55	0.41	0.35
					98.9	0.27	0.26	0.31	0.34	0.43	0.51	0.61	0.62	0.55	0.47	0.35	0.29
					99.0	0.25	0.23	0.28	0.31	0.39	0.46	0.55	0.57	0.50	0.43	0.32	0.27
					99.1	0.22	0.21	0.25	0.28	0.35	0.42	0.50	0.51	0.45	0.38	0.29	0.24
				8.71	98.7	0.24	0.23	0.27	0.30	0.37	0.45	0.53	0.55	0.48	0.41	0.31	0.26
					98.9	0.20	0.19	0.23	0.25	0.32	0.38	0.45	0.46	0.41	0.35	0.26	0.22
					99.0	0.19	0.17	0.21	0.23	0.29	0.34	0.41	0.42	0.37	0.32	0.24	0.20
					99.1	0.17	0.16	0.19	0.21	0.26	0.31	0.37	0.38	0.34	0.29	0.21	0.18
			3	13.1	98.7	0.43	0.39	0.44	0.46	0.56	0.66	0.79	0.84	0.77	0.69	0.54	0.47
					98.9	0.37	0.33	0.37	0.39	0.47	0.56	0.67	0.71	0.65	0.58	0.46	0.40
					99.0	0.33	0.30	0.34	0.35	0.43	0.51	0.61	0.64	0.59	0.53	0.41	0.36
					99.1	0.30	0.27	0.30	0.32	0.39	0.46	0.55	0.58	0.53	0.48	0.37	0.33
				8.71	98.7	0.32	0.29	0.32	0.34	0.42	0.49	0.59	0.62	0.57	0.51	0.40	0.35
					98.9	0.27	0.24	0.27	0.29	0.35	0.41	0.50	0.53	0.48	0.43	0.34	0.30
					99.0	0.25	0.22	0.25	0.26	0.32	0.38	0.45	0.48	0.44	0.39	0.31	0.27

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.1	0.22	0.20	0.22	0.24	0.29	0.34	0.41	0.43	0.40	0.35	0.28	0.24
	UCL		2	13.1	98.9	0.34	0.32	0.38	0.42	0.53	0.62	0.74	0.76	0.67	0.58	0.43	0.36
					99.0	0.31	0.29	0.34	0.38	0.48	0.56	0.67	0.69	0.61	0.52	0.39	0.33
				8.71	98.9	0.25	0.24	0.28	0.31	0.39	0.46	0.55	0.57	0.50	0.43	0.32	0.27
					99.0	0.23	0.21	0.26	0.29	0.36	0.42	0.50	0.52	0.45	0.39	0.29	0.24
			3	13.1	98.9	0.45	0.40	0.46	0.49	0.58	0.68	0.81	0.86	0.79	0.71	0.56	0.48
					99.0	0.41	0.37	0.41	0.44	0.53	0.62	0.74	0.79	0.72	0.65	0.51	0.44
				8.71	98.9	0.33	0.30	0.34	0.36	0.43	0.50	0.60	0.64	0.59	0.53	0.41	0.36
					99.0	0.30	0.27	0.31	0.33	0.40	0.46	0.55	0.58	0.54	0.48	0.38	0.33
	LCL		2	13.1	98.9	0.22	0.21	0.25	0.27	0.34	0.42	0.50	0.52	0.46	0.38	0.28	0.24
					99.0	0.20	0.19	0.22	0.24	0.31	0.38	0.46	0.47	0.42	0.35	0.26	0.22
				8.71	98.9	0.16	0.15	0.18	0.20	0.26	0.31	0.38	0.39	0.34	0.28	0.21	0.18
					99.0	0.15	0.14	0.17	0.18	0.23	0.28	0.34	0.35	0.31	0.26	0.19	0.16
			3	13.1	98.9	0.29	0.26	0.30	0.31	0.38	0.46	0.56	0.59	0.54	0.47	0.37	0.32
					99.0	0.27	0.24	0.27	0.28	0.35	0.42	0.50	0.53	0.49	0.43	0.34	0.29
				8.71	98.9	0.22	0.19	0.22	0.23	0.28	0.34	0.41	0.44	0.40	0.35	0.28	0.24
					99.0	0.20	0.18	0.20	0.21	0.26	0.31	0.38	0.40	0.37	0.32	0.25	0.22
	Mean	UCL	2	13.1	98.9	0.35	0.33	0.39	0.43	0.54	0.65	0.77	0.80	0.70	0.60	0.44	0.37

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.0	0.32	0.30	0.36	0.39	0.49	0.59	0.70	0.72	0.64	0.54	0.40	0.34
				8.71	98.9	0.26	0.24	0.29	0.32	0.40	0.48	0.57	0.59	0.52	0.44	0.33	0.28
					99.0	0.24	0.22	0.26	0.29	0.37	0.44	0.52	0.54	0.48	0.40	0.30	0.25
			3	13.1	98.9	0.47	0.42	0.47	0.50	0.60	0.71	0.85	0.90	0.83	0.74	0.58	0.51
					99.0	0.42	0.38	0.43	0.45	0.55	0.65	0.77	0.82	0.75	0.67	0.53	0.46
				8.71	98.9	0.35	0.31	0.35	0.37	0.45	0.53	0.63	0.67	0.62	0.55	0.43	0.38
					99.0	0.32	0.28	0.32	0.34	0.41	0.48	0.57	0.61	0.56	0.50	0.39	0.34
		LCL	2	13.1	98.9	0.19	0.18	0.21	0.23	0.29	0.35	0.41	0.43	0.38	0.32	0.24	0.20
					99.0	0.17	0.16	0.19	0.21	0.26	0.32	0.38	0.39	0.34	0.29	0.22	0.18
				8.71	98.9	0.14	0.13	0.16	0.17	0.22	0.26	0.31	0.32	0.28	0.24	0.18	0.15
					99.0	0.13	0.12	0.14	0.16	0.20	0.24	0.28	0.29	0.25	0.22	0.16	0.14
			3	13.1	98.9	0.25	0.22	0.25	0.27	0.32	0.38	0.46	0.48	0.44	0.40	0.31	0.27
					99.0	0.23	0.20	0.23	0.24	0.29	0.35	0.41	0.44	0.40	0.36	0.28	0.25
				8.71	98.9	0.19	0.17	0.19	0.20	0.24	0.28	0.34	0.36	0.33	0.29	0.23	0.20
					99.0	0.17	0.15	0.17	0.18	0.22	0.26	0.31	0.33	0.30	0.27	0.21	0.18
Option 3	Mean	Maximum likelihood	2	13.1	98.0	0.09	0.09	0.10	0.11	0.14	0.17	0.20	0.21	0.18	0.16	0.12	0.10
				8.71	98.0	0.08	0.07	0.09	0.10	0.12	0.15	0.17	0.18	0.16	0.14	0.10	0.08
			3	13.1	98.0	0.12	0.11	0.12	0.13	0.16	0.18	0.22	0.23	0.22	0.19	0.15	0.13

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				8.71	98.0	0.11	0.09	0.11	0.11	0.14	0.16	0.19	0.20	0.19	0.17	0.13	0.11
	UCL		2	13.1	98.0	0.11	0.11	0.13	0.14	0.17	0.21	0.24	0.25	0.22	0.19	0.14	0.12
				8.71	98.0	0.10	0.09	0.11	0.12	0.15	0.18	0.21	0.22	0.19	0.17	0.12	0.10
			3	13.1	98.0	0.15	0.13	0.15	0.16	0.19	0.22	0.27	0.29	0.26	0.24	0.18	0.16
				8.71	98.0	0.13	0.12	0.13	0.14	0.17	0.20	0.23	0.25	0.23	0.21	0.16	0.14
	LCL		2	13.1	98.0	0.07	0.07	0.08	0.09	0.11	0.14	0.17	0.17	0.15	0.13	0.09	0.08
				8.71	98.0	0.06	0.06	0.07	0.08	0.10	0.12	0.15	0.15	0.13	0.11	0.08	0.07
			3	13.1	98.0	0.10	0.09	0.10	0.10	0.13	0.15	0.18	0.20	0.18	0.16	0.12	0.11
				8.71	98.0	0.08	0.08	0.09	0.09	0.11	0.13	0.16	0.17	0.16	0.14	0.11	0.09
	Mean	UCL	2	13.1	98.0	0.13	0.12	0.14	0.15	0.19	0.23	0.28	0.29	0.25	0.21	0.16	0.13
				8.71	98.0	0.11	0.10	0.12	0.13	0.17	0.20	0.24	0.25	0.22	0.19	0.14	0.12
			3	13.1	98.0	0.17	0.15	0.17	0.18	0.22	0.25	0.30	0.32	0.30	0.27	0.21	0.18
				8.71	98.0	0.14	0.13	0.15	0.15	0.19	0.22	0.26	0.28	0.26	0.23	0.18	0.16
		LCL	2	13.1	98.0	0.06	0.05	0.06	0.07	0.09	0.10	0.12	0.13	0.11	0.10	0.07	0.06
				8.71	98.0	0.05	0.05	0.05	0.06	0.08	0.09	0.11	0.11	0.10	0.08	0.06	0.05
			3	13.1	98.0	0.07	0.07	0.08	0.08	0.10	0.11	0.14	0.14	0.13	0.12	0.09	0.08
				8.71	98.0	0.07	0.06	0.07	0.07	0.08	0.10	0.12	0.13	0.12	0.10	0.08	0.07

Lesser black-backed gull

Table H.2.1- 25: Collision risk estimates for lesser black-backed gull at Preferred Project 6 incorporating variability associated with density, flight height distribution and avoidance rate

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Option 2	Mean	Maximum likelihood	2	13.1	99.4	0.17	0.16	0.36	0.73	0.90	1.04	1.20	0.67	0.32	0.27	0.21	0.18
					99.5	0.14	0.13	0.30	0.61	0.75	0.87	1.00	0.56	0.26	0.22	0.17	0.15
					99.6	0.11	0.11	0.24	0.49	0.60	0.70	0.80	0.45	0.21	0.18	0.14	0.12
				8.71	99.4	0.14	0.13	0.30	0.61	0.75	0.86	0.99	0.55	0.26	0.22	0.17	0.15
					99.5	0.12	0.11	0.25	0.51	0.62	0.72	0.82	0.46	0.22	0.18	0.14	0.12
					99.6	0.09	0.09	0.20	0.40	0.50	0.57	0.66	0.37	0.17	0.15	0.11	0.10
			3	13.1	99.4	0.22	0.20	0.43	0.84	1.01	1.14	1.32	0.76	0.37	0.33	0.27	0.24
					99.5	0.19	0.17	0.36	0.70	0.84	0.95	1.10	0.63	0.31	0.28	0.22	0.20
					99.6	0.15	0.13	0.29	0.56	0.67	0.76	0.88	0.51	0.25	0.22	0.18	0.16
				8.71	99.4	0.19	0.17	0.36	0.70	0.83	0.94	1.09	0.63	0.31	0.27	0.22	0.20
					99.5	0.15	0.14	0.30	0.58	0.69	0.79	0.91	0.52	0.26	0.23	0.19	0.16
					99.6	0.12	0.11	0.24	0.47	0.55	0.63	0.73	0.42	0.20	0.18	0.15	0.13
	UCL		2	13.1	99.5	0.20	0.19	0.43	0.86	1.04	1.17	1.34	0.76	0.37	0.31	0.24	0.21
				8.71	99.5	0.17	0.16	0.36	0.71	0.86	0.97	1.11	0.63	0.31	0.26	0.20	0.17
			3	13.1	99.5	0.27	0.24	0.52	0.99	1.15	1.28	1.48	0.86	0.44	0.39	0.31	0.28

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				8.71	99.5	0.22	0.20	0.43	0.82	0.96	1.06	1.22	0.71	0.36	0.32	0.26	0.23
	LCL		2	13.1	99.5	0.10	0.09	0.21	0.44	0.55	0.65	0.74	0.41	0.19	0.16	0.12	0.10
				8.71	99.5	0.08	0.08	0.18	0.36	0.45	0.54	0.62	0.34	0.16	0.13	0.10	0.08
			3	13.1	99.5	0.13	0.12	0.26	0.51	0.61	0.71	0.82	0.47	0.22	0.20	0.16	0.14
				8.71	99.5	0.11	0.10	0.21	0.42	0.51	0.59	0.68	0.38	0.18	0.16	0.13	0.11
	Mean	UCL	2	13.1	99.5	0.28	0.26	0.59	1.20	1.49	1.71	1.96	1.10	0.52	0.44	0.34	0.29
				8.71	99.5	0.23	0.22	0.49	1.00	1.23	1.42	1.62	0.91	0.43	0.36	0.28	0.24
			3	13.1	99.5	0.37	0.33	0.71	1.39	1.65	1.87	2.16	1.25	0.61	0.55	0.44	0.39
				8.71	99.5	0.30	0.27	0.59	1.15	1.37	1.55	1.79	1.03	0.51	0.45	0.37	0.33
		LCL	2	13.1	99.5	0.08	0.08	0.18	0.37	0.45	0.52	0.60	0.34	0.16	0.13	0.10	0.09
				8.71	99.5	0.07	0.07	0.15	0.30	0.37	0.43	0.50	0.28	0.13	0.11	0.09	0.07
			3	13.1	99.5	0.11	0.10	0.22	0.42	0.50	0.57	0.66	0.38	0.19	0.17	0.13	0.12
				8.71	99.5	0.09	0.08	0.18	0.35	0.42	0.47	0.55	0.31	0.15	0.14	0.11	0.10
Option 3	Mean	Maximum likelihood	2	13.1	98.7	0.10	0.10	0.22	0.46	0.56	0.65	0.75	0.42	0.20	0.17	0.13	0.11
					98.9	0.09	0.08	0.19	0.39	0.48	0.55	0.63	0.35	0.17	0.14	0.11	0.09
					99.1	0.07	0.07	0.16	0.32	0.39	0.45	0.52	0.29	0.14	0.12	0.09	0.08
					99.3	0.06	0.05	0.12	0.25	0.30	0.35	0.40	0.23	0.11	0.09	0.07	0.06
				8.71	98.7	0.10	0.09	0.20	0.42	0.51	0.59	0.68	0.38	0.18	0.15	0.12	0.10

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					98.9	0.08	0.08	0.17	0.35	0.43	0.50	0.57	0.32	0.15	0.13	0.10	0.08
					99.1	0.07	0.06	0.14	0.29	0.36	0.41	0.47	0.26	0.12	0.11	0.08	0.07
					99.3	0.05	0.05	0.11	0.22	0.28	0.32	0.37	0.20	0.10	0.08	0.06	0.05
			3	13.1	98.7	0.14	0.13	0.27	0.53	0.63	0.71	0.82	0.47	0.23	0.21	0.17	0.15
					98.9	0.12	0.11	0.23	0.45	0.53	0.60	0.70	0.40	0.20	0.18	0.14	0.13
					99.1	0.10	0.09	0.19	0.37	0.43	0.49	0.57	0.33	0.16	0.14	0.12	0.10
					99.3	0.08	0.07	0.15	0.28	0.34	0.38	0.44	0.26	0.13	0.11	0.09	0.08
				8.71	98.7	0.13	0.11	0.25	0.48	0.57	0.65	0.75	0.43	0.21	0.19	0.15	0.14
					98.9	0.11	0.10	0.21	0.41	0.48	0.55	0.63	0.36	0.18	0.16	0.13	0.11
					99.1	0.09	0.08	0.17	0.33	0.40	0.45	0.52	0.30	0.15	0.13	0.11	0.09
					99.3	0.07	0.06	0.13	0.26	0.31	0.35	0.40	0.23	0.11	0.10	0.08	0.07
	UCL		2	13.1	98.9	0.13	0.12	0.27	0.55	0.66	0.74	0.85	0.48	0.23	0.20	0.15	0.13
					99.3	0.08	0.08	0.17	0.35	0.42	0.47	0.54	0.31	0.15	0.13	0.10	0.08
				8.71	98.9	0.12	0.11	0.25	0.50	0.60	0.68	0.77	0.44	0.21	0.18	0.14	0.12
					99.3	0.07	0.07	0.16	0.32	0.38	0.43	0.49	0.28	0.14	0.11	0.09	0.08
			3	13.1	98.9	0.17	0.16	0.33	0.63	0.73	0.81	0.94	0.55	0.28	0.25	0.20	0.18
					99.3	0.11	0.10	0.21	0.40	0.47	0.52	0.60	0.35	0.18	0.16	0.13	0.11
				8.71	98.9	0.15	0.14	0.30	0.57	0.67	0.74	0.85	0.50	0.25	0.22	0.18	0.16

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.3	0.10	0.09	0.19	0.36	0.42	0.47	0.54	0.32	0.16	0.14	0.11	0.10
	LCL		2	13.1	98.9	0.06	0.06	0.13	0.28	0.35	0.41	0.47	0.26	0.12	0.10	0.08	0.07
					99.3	0.04	0.04	0.09	0.18	0.22	0.26	0.30	0.17	0.08	0.06	0.05	0.04
				8.71	98.9	0.06	0.05	0.12	0.25	0.32	0.37	0.43	0.24	0.11	0.09	0.07	0.06
					99.3	0.04	0.03	0.08	0.16	0.20	0.24	0.27	0.15	0.07	0.06	0.04	0.04
			3	13.1	98.9	0.08	0.07	0.16	0.32	0.39	0.45	0.52	0.30	0.14	0.13	0.10	0.09
					99.3	0.05	0.05	0.10	0.20	0.25	0.29	0.33	0.19	0.09	0.08	0.06	0.06
				8.71	98.9	0.07	0.07	0.15	0.29	0.35	0.41	0.47	0.27	0.13	0.11	0.09	0.08
					99.3	0.05	0.04	0.09	0.19	0.22	0.26	0.30	0.17	0.08	0.07	0.06	0.05
	Mean	UCL	2	13.1	98.9	0.24	0.23	0.52	1.05	1.30	1.50	1.72	0.96	0.45	0.38	0.29	0.25
					99.3	0.15	0.15	0.33	0.67	0.83	0.95	1.09	0.61	0.29	0.24	0.19	0.16
				8.71	98.9	0.21	0.20	0.46	0.93	1.15	1.33	1.52	0.85	0.40	0.34	0.26	0.23
					99.3	0.14	0.13	0.29	0.59	0.73	0.85	0.97	0.54	0.26	0.22	0.17	0.14
			3	13.1	98.9	0.32	0.29	0.62	1.21	1.44	1.64	1.89	1.09	0.53	0.48	0.39	0.34
					99.3	0.20	0.18	0.40	0.77	0.92	1.04	1.20	0.69	0.34	0.30	0.25	0.22
				8.71	98.9	0.29	0.26	0.55	1.08	1.28	1.45	1.68	0.97	0.47	0.42	0.34	0.31
					99.3	0.18	0.16	0.35	0.68	0.82	0.92	1.07	0.62	0.30	0.27	0.22	0.19
		LCL	2	13.1	98.9	0.04	0.04	0.09	0.19	0.24	0.27	0.32	0.18	0.08	0.07	0.05	0.05

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.3	0.03	0.03	0.06	0.12	0.15	0.17	0.20	0.11	0.05	0.04	0.03	0.03
				8.71	98.9	0.04	0.04	0.09	0.18	0.22	0.25	0.29	0.16	0.08	0.06	0.05	0.04
					99.3	0.03	0.02	0.06	0.11	0.14	0.16	0.18	0.10	0.05	0.04	0.03	0.03
			3	13.1	98.9	0.06	0.05	0.11	0.22	0.27	0.30	0.35	0.20	0.10	0.09	0.07	0.06
					99.3	0.04	0.03	0.07	0.14	0.17	0.19	0.22	0.13	0.06	0.06	0.05	0.04
				8.71	98.9	0.05	0.05	0.11	0.20	0.24	0.28	0.32	0.18	0.09	0.08	0.07	0.06
					99.3	0.03	0.03	0.07	0.13	0.15	0.18	0.20	0.12	0.06	0.05	0.04	0.04

Herring gull

Table H.2.1- 26: Collision risk estimates for herring gull at Preferred Project 6 incorporating variability associated with density, flight height distribution and avoidance rate

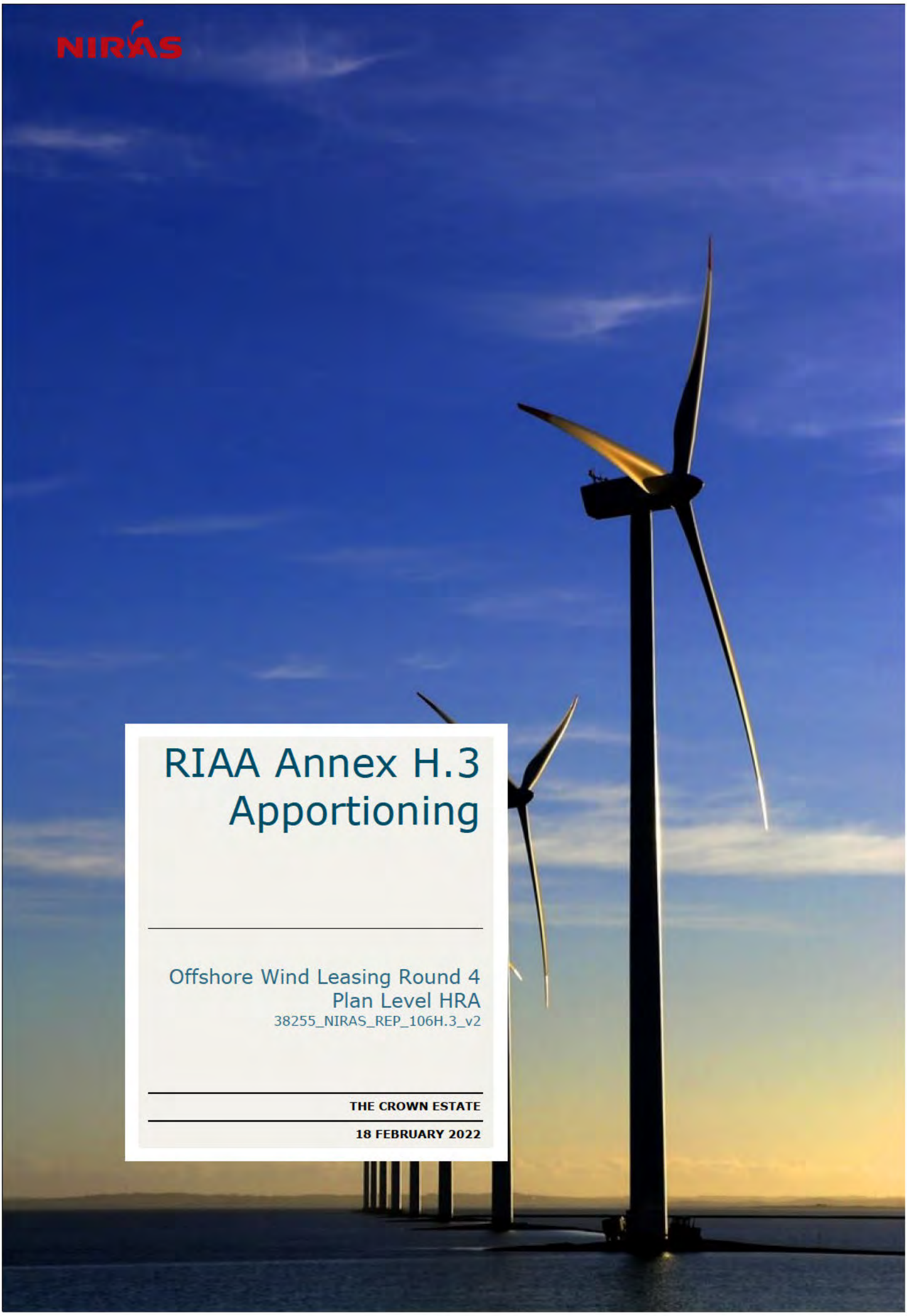
Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Option 2	Mean	Maximum likelihood	2	12.8	99.4	0.71	0.75	0.77	0.64	0.65	0.55	0.47	0.48	0.53	0.55	0.56	0.62
					99.5	0.59	0.63	0.64	0.54	0.54	0.46	0.39	0.40	0.44	0.46	0.47	0.52
					99.6	0.47	0.50	0.51	0.43	0.43	0.37	0.31	0.32	0.36	0.37	0.37	0.41
				9.8	99.4	0.60	0.63	0.65	0.54	0.54	0.46	0.40	0.41	0.45	0.47	0.47	0.52
					99.5	0.50	0.53	0.54	0.45	0.45	0.38	0.33	0.34	0.37	0.39	0.39	0.43
					99.6	0.40	0.42	0.43	0.36	0.36	0.31	0.26	0.27	0.30	0.31	0.31	0.35
			3	12.8	99.4	0.94	0.95	0.93	0.74	0.72	0.60	0.52	0.55	0.63	0.68	0.73	0.84
					99.5	0.79	0.80	0.77	0.62	0.60	0.50	0.43	0.46	0.52	0.57	0.61	0.70
					99.6	0.63	0.64	0.62	0.49	0.48	0.40	0.34	0.37	0.42	0.46	0.49	0.56
				9.8	99.4	0.79	0.80	0.78	0.62	0.60	0.50	0.44	0.46	0.53	0.58	0.62	0.71
					99.5	0.66	0.67	0.65	0.52	0.50	0.42	0.36	0.38	0.44	0.48	0.51	0.59
					99.6	0.53	0.54	0.52	0.42	0.40	0.34	0.29	0.31	0.35	0.38	0.41	0.47
	UCL		2	12.8	99.5	0.76	0.81	0.82	0.70	0.70	0.59	0.50	0.51	0.57	0.58	0.59	0.66
				9.8	99.5	0.64	0.68	0.69	0.59	0.59	0.50	0.43	0.43	0.48	0.49	0.50	0.55
			3	12.8	99.5	1.01	1.03	0.99	0.80	0.77	0.64	0.56	0.58	0.67	0.72	0.77	0.89

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				9.8	99.5	0.85	0.87	0.84	0.68	0.65	0.54	0.47	0.49	0.56	0.61	0.65	0.75
	LCL		2	12.8	99.5	0.47	0.50	0.51	0.42	0.42	0.36	0.30	0.32	0.36	0.37	0.38	0.41
				9.8	99.5	0.40	0.42	0.43	0.35	0.35	0.30	0.26	0.27	0.30	0.31	0.32	0.35
			3	12.8	99.5	0.63	0.63	0.61	0.48	0.47	0.39	0.33	0.36	0.42	0.46	0.49	0.56
				9.8	99.5	0.53	0.53	0.51	0.40	0.39	0.33	0.28	0.31	0.35	0.39	0.41	0.47
	Mean	UCL	2	12.8	99.5	0.94	1.00	1.03	0.86	0.86	0.73	0.62	0.64	0.71	0.73	0.74	0.82
				9.8	99.5	0.79	0.84	0.86	0.72	0.72	0.61	0.53	0.54	0.60	0.62	0.63	0.69
			3	12.8	99.5	1.25	1.27	1.24	0.99	0.95	0.80	0.69	0.73	0.84	0.91	0.97	1.12
				9.8	99.5	1.06	1.07	1.04	0.83	0.80	0.67	0.58	0.61	0.71	0.77	0.82	0.94
		LCL	2	12.8	99.5	0.41	0.44	0.45	0.37	0.37	0.32	0.27	0.28	0.31	0.32	0.32	0.36
				9.8	99.5	0.34	0.37	0.38	0.31	0.31	0.27	0.23	0.24	0.26	0.27	0.27	0.30
			3	12.8	99.5	0.55	0.55	0.54	0.43	0.42	0.35	0.30	0.32	0.36	0.40	0.42	0.49
				9.8	99.5	0.46	0.47	0.45	0.36	0.35	0.29	0.25	0.27	0.31	0.33	0.36	0.41
Option 3	Mean	Maximum likelihood	2	12.8	98.8	0.41	0.44	0.45	0.38	0.38	0.32	0.27	0.28	0.31	0.32	0.33	0.36
					99.0	0.37	0.40	0.41	0.34	0.34	0.29	0.25	0.26	0.28	0.29	0.30	0.33
					99.2	0.30	0.32	0.33	0.27	0.27	0.23	0.20	0.21	0.23	0.23	0.24	0.26
					99.3	0.26	0.28	0.29	0.24	0.24	0.20	0.17	0.18	0.20	0.20	0.21	0.23
				9.8	98.8	0.38	0.40	0.41	0.34	0.34	0.29	0.25	0.26	0.28	0.29	0.30	0.33

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.0	0.34	0.36	0.37	0.31	0.31	0.27	0.23	0.23	0.26	0.27	0.27	0.30
					99.2	0.27	0.29	0.30	0.25	0.25	0.21	0.18	0.19	0.21	0.21	0.22	0.24
					99.3	0.24	0.26	0.26	0.22	0.22	0.19	0.16	0.16	0.18	0.19	0.19	0.21
			3	12.8	98.8	0.55	0.56	0.54	0.43	0.42	0.35	0.30	0.32	0.37	0.40	0.43	0.49
					99.0	0.50	0.51	0.49	0.39	0.38	0.32	0.27	0.29	0.33	0.36	0.39	0.44
					99.2	0.40	0.40	0.39	0.31	0.30	0.25	0.22	0.23	0.27	0.29	0.31	0.36
					99.3	0.35	0.35	0.34	0.28	0.27	0.22	0.19	0.20	0.23	0.25	0.27	0.31
				9.8	98.8	0.50	0.51	0.49	0.40	0.38	0.32	0.28	0.29	0.34	0.36	0.39	0.45
					99.0	0.46	0.46	0.45	0.36	0.35	0.29	0.25	0.27	0.30	0.33	0.35	0.41
					99.2	0.36	0.37	0.36	0.29	0.28	0.23	0.20	0.21	0.24	0.27	0.28	0.32
					99.3	0.32	0.32	0.31	0.25	0.24	0.20	0.18	0.19	0.21	0.23	0.25	0.28
	UCL		2	12.8	99.0	0.48	0.52	0.52	0.44	0.44	0.37	0.32	0.33	0.36	0.37	0.37	0.42
					99.3	0.34	0.36	0.37	0.31	0.31	0.26	0.22	0.23	0.25	0.26	0.26	0.29
				9.8	99.0	0.44	0.47	0.48	0.41	0.40	0.34	0.29	0.30	0.33	0.34	0.34	0.38
					99.3	0.31	0.33	0.33	0.28	0.28	0.24	0.21	0.21	0.23	0.24	0.24	0.27
			3	12.8	99.0	0.64	0.66	0.63	0.51	0.49	0.41	0.35	0.37	0.43	0.46	0.49	0.57
					99.3	0.45	0.46	0.44	0.36	0.34	0.29	0.25	0.26	0.30	0.32	0.34	0.40
				9.8	99.0	0.59	0.60	0.58	0.47	0.45	0.37	0.32	0.34	0.39	0.42	0.45	0.52

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.3	0.41	0.42	0.40	0.33	0.31	0.26	0.23	0.24	0.27	0.29	0.31	0.36
	LCL		2	12.8	99.0	0.30	0.31	0.32	0.26	0.27	0.23	0.19	0.20	0.23	0.24	0.24	0.26
					99.3	0.21	0.22	0.23	0.19	0.19	0.16	0.14	0.14	0.16	0.17	0.17	0.18
				9.8	99.0	0.27	0.29	0.29	0.24	0.24	0.21	0.18	0.19	0.21	0.22	0.22	0.24
					99.3	0.19	0.20	0.21	0.17	0.17	0.14	0.12	0.13	0.14	0.15	0.15	0.17
			3	12.8	99.0	0.40	0.40	0.39	0.31	0.30	0.25	0.21	0.23	0.27	0.29	0.31	0.36
					99.3	0.28	0.28	0.27	0.21	0.21	0.17	0.15	0.16	0.19	0.21	0.22	0.25
				9.8	99.0	0.36	0.36	0.35	0.28	0.27	0.23	0.19	0.21	0.24	0.27	0.29	0.33
					99.3	0.25	0.26	0.25	0.20	0.19	0.16	0.14	0.15	0.17	0.19	0.20	0.23
	Mean	UCL	2	12.8	99.0	0.85	0.90	0.93	0.77	0.77	0.66	0.56	0.58	0.64	0.66	0.67	0.74
					99.3	0.59	0.63	0.65	0.54	0.54	0.46	0.39	0.41	0.45	0.46	0.47	0.52
				9.8	99.0	0.75	0.80	0.82	0.69	0.69	0.58	0.50	0.52	0.57	0.59	0.59	0.66
					99.3	0.53	0.56	0.57	0.48	0.48	0.41	0.35	0.36	0.40	0.41	0.42	0.46
			3	12.8	99.0	1.13	1.15	1.12	0.89	0.86	0.72	0.62	0.66	0.76	0.82	0.88	1.01
					99.3	0.79	0.80	0.78	0.62	0.60	0.50	0.43	0.46	0.53	0.58	0.61	0.70
				9.8	99.0	1.00	1.02	0.99	0.79	0.76	0.64	0.55	0.58	0.67	0.73	0.78	0.89
					99.3	0.70	0.71	0.69	0.55	0.53	0.45	0.38	0.41	0.47	0.51	0.54	0.63
		LCL	2	12.8	99.0	0.23	0.24	0.25	0.21	0.21	0.18	0.15	0.16	0.17	0.18	0.18	0.20

Band (2012) Model Option	Density	Flight height distribution	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Monthly collision risk estimates											
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					99.3	0.16	0.17	0.17	0.15	0.15	0.12	0.11	0.11	0.12	0.12	0.13	0.14
				9.8	99.0	0.21	0.22	0.23	0.19	0.19	0.16	0.14	0.14	0.16	0.16	0.17	0.18
					99.3	0.15	0.16	0.16	0.13	0.13	0.11	0.10	0.10	0.11	0.11	0.12	0.13
			3	12.8	99.0	0.30	0.31	0.30	0.24	0.23	0.19	0.17	0.18	0.20	0.22	0.24	0.27
					99.3	0.21	0.22	0.21	0.17	0.16	0.14	0.12	0.12	0.14	0.15	0.17	0.19
				9.8	99.0	0.28	0.28	0.28	0.22	0.21	0.18	0.15	0.16	0.19	0.20	0.22	0.25
					99.3	0.20	0.20	0.19	0.15	0.15	0.12	0.11	0.11	0.13	0.14	0.15	0.17



RIAA Annex H.3 Apportioning

Offshore Wind Leasing Round 4
Plan Level HRA

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THE CROWN ESTATE

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1. Introduction

1.1.1 A key step in the RIAA is apportioning of impacts i.e. an assessment of which Protected Sites impacted birds originate from, and in what proportion. This Annex presents the bird apportioning methodology and results for the Preferred Projects alone, which have been used to inform the Array Assessment (Part 2) in the RIAA.

2. Protected Sites and associated features

2.1.1 Table 2.1 identifies the Protected Sites and associated features for which a Likely Significant Effect (LSE) has been identified and therefore apportioning values are required to apportion impacts from each of the Preferred Projects to each relevant designated site. Table 2.1 has been compiled following the screening exercise presented in the Screening Report (NIRAS, 2021) and the Array Assessment (Part 1). A separation has been made between the breeding and non-breeding seasons. Different apportioning methods have been applied to these groups to account for the movements of birds throughout the annual cycle and the seasonal interactions with the Preferred Projects. The apportioning process, especially in the non-breeding season, will include populations of birds at other designated sites as part of the larger population from which birds will derive, however, Table 2.1 only includes those designated sites of relevance to the RIAA (i.e. those for which LSE was identified through the Round 4 screening process).

Table 2.1: Protected Sites and associated features for which apportioning is required at each of the Preferred Projects (i.e. those for which LSE has been identified)

Feature	SPAs	Preferred Projects under consideration	
		Breeding season	Non-breeding seasons
Gannet	Ireland's Eye SAC Ireland's Eye SPA Ailsa Craig SPA	4, 5, 6	All
	Forth Islands SPA Flamborough & Filey Coast SPA Outer Firth of Forth and St Andrews Bay Complex SPA	1, 2, 3	

Feature	SPAs	Preferred Projects under consideration	
		Breeding season	Non-breeding seasons
Lesser black-backed gull	Lambay Island SAC Lambay Island SPA Morecambe Bay Ramsar Ribble & Alt Estuaries Ramsar Upper Solway Flats & Marshes Ramsar Lough Neagh & Lough Beg Ramsar Strangford Lough Ramsar Ailsa Craig SPA Ribble and Alt Estuaries SPA Bowland Fells SPA Rathlin Island SPA Morecambe Bay and Duddon Estuary SPA	4, 5, 6	All
	Duinen en Lage Land Texel SPA Duinen Vlieland SPA Waddenzee SPA Alde-Ore Estuary Ramsar Coquet Island SPA Alde-Ore Estuary SPA Northumberland Marine SPA The Wash Ramsar	1, 2, 3	
Kittiwake	Inishtrahull SAC Howth Head SAC Lambay Island SAC Saltee Islands SAC Bray Head SAC North Inishowen Coast SAC Ireland's Eye SAC Saltee Islands SPA	4, 5, 6	All

Feature	SPAs	Preferred Projects under consideration	
		Breeding season	Non-breeding seasons
	Rockabill SPA Lambay Island SPA Inishtrahull SPA Howth Head Coast SPA Ireland's Eye SPA Wicklow Head SPA Ailsa Craig SPA Skomer, Skokholm and the Seas off Pembrokeshire SPA Rathlin Island SPA		
	Northumbria Coast Forth Islands SPA St Abb`s Head to Fast Castle SPA Farne Islands SPA Coquet Island SPA Flamborough & Filey Coast SPA Outer Firth of Forth and St Andrews Bay Complex SPA Northumberland Marine SPA	1, 2, 3	
Guillemot	Howth Head SAC Lambay Island SAC Bray Head SAC Ireland's Eye SAC Lambay Island SPA Howth Head Coast SPA Ireland's Eye SPA Wicklow Head SPA	4, 5, 6	All
	Flamborough & Filey Coast SPA	1, 2, 3	

Feature	SPAs	Preferred Projects under consideration	
		Breeding season	Non-breeding seasons
Puffin	Lambay Island SAC Saltee Islands SAC Ireland's Eye SAC Saltee Islands SPA Lambay Island SPA Ireland's Eye SPA Skomer, Skokholm and the Seas off Pembrokeshire SPA Rathlin Island SPA	4, 5, 6	All
	Farne Islands SPA Coquet Island SPA Flamborough & Filey Coast SPA Outer Firth of Forth and St Andrews Bay Complex SPA Northumberland Marine SPA	1, 2, 3	
Razorbill	Howth Head SAC Lambay Island SAC Bray Head SAC Ireland's Eye SAC Lambay Island SPA Howth Head Coast SPA Ireland's Eye SPA Wicklow Head SPA	4, 5, 6	All
	Flamborough & Filey Coast SPA	1, 2, 3	
Herring gull	Morecambe Bay Ramsar Upper Solway Flats & Marshes Ramsar Morecambe Bay and Duddon Estuary SPA	4, 5, 6	All
	Flamborough & Filey Coast SPA	1, 2, 3	

2.1.2 For Protected Sites that are designated to protect important sea areas for associated features (e.g. Outer Firth of Forth and St Andrews Bay Complex SPA), the approach described in this Annex has not been applied as the impacts relevant to these SPAs are those apportioned to those SPAs that protect the breeding populations of the birds for which Protected Sites such as the Outer Firth of Forth and St Andrews Bay Complex SPA protect important sea areas. In the case of the gannet at the Outer Firth of Forth and St Andrews Bay Complex SPA, impacts apportioned to the Forth Islands SPA would be considered equally attributable to the Outer Firth of Forth and St Andrews Bay Complex SPA.

3. Breeding season

3.1.1 In the breeding season, a population of birds in a given sea area can contain breeding adult birds from breeding colonies, immature birds (i.e. birds that have not yet reached breeding age) and non-breeding birds (i.e. birds that have reached breeding age but have not yet started breeding or are skipping a breeding season (sabbatical birds)). In order to determine the impact upon the breeding adult population for which a Protected Site is designated, the proportion of each of these components must be estimated, so that only the value assigned to breeding birds can be retained. This section considers each of these population components and outlines how each has been considered in the apportioning approach for the RIAA.

3.1.2 Where apportioning is required in an assessment the full range of apportioning rates will be presented. However, to understand which of these rates is most likely the following will be considered:

- Application of the apportioning methodology proposed by SNH (2018)
- Available tracking data
- Other relevant information

3.1.3 Each of these sources is explored in the RIAA to determine the most appropriate rate to include in the assessment.

3.1.4 The methodology based on SNH (2018) for breeding adult birds is detailed below.

3.2 Breeding adult birds

Methodology

3.2.1 The apportioning of Preferred Project impacts to Protected Sites within foraging range for breeding species has followed a two stage approach.

<u>Stage 1: Apportioning impacts between Protected Site and non-Protected Site breeding colonies within foraging range of the Preferred Projects</u>

3.2.2 The method followed SNH (2018) "Interim Guidance on Apportioning Impacts from Marine Renewable Developments to Breeding Seabird Populations in Special Protection Areas".

3.2.3 To identify those breeding colonies (Protected Sites and other) for which there may be connectivity between breeding birds and the Preferred Projects, the mean-maximum foraging range (i.e. the mean average of the maximum foraging trips recorded) as published by Woodward *et al.,* (2019), has been applied.

3.2.4 Next, three colony-specific weighting factors have been applied to each colony:

i. Colony size (with consistent count unit used between colonies for a species e.g. individuals, breeding pairs or apparently occupied sites);
ii. Distance of colony from the development site (using the geometric centre of both); and
iii. Sea area (the areal extent of the open sea within the foraging range of the relevant species).

3.2.5 Large colonies will contribute more individuals to the number of seabirds found at a Preferred Project, all other factors being equal. To account for this, a weighting factor based on colony size has been derived. For all colonies considered, colony size has been calculated from Seabirds Count data with this providing a common reference point as all count data is contemporaneous. Seabirds Count data is comprised of separate count sections with long stretches of coastline (e.g. Flamborough and Filey Cliffs SPA), made up of several count sections. For the purposes of this analysis each count section has been treated as a separate colony. If a single Protected Site is made up of several count sections the combined Protected Site impact has been reconstructed after the weighting for each count section has been completed.

3.2.6 Weighting by distance from the colony has been calculated using the measured distance between the geometric centre of the Preferred Project to the geometric centre of the colony. As birds radiate out from a colony density will decrease by a factor proportional to $1/\text{distance}^2$ as area increases proportionally by πr^2. For the purposes of this assessment, a weighting factor based on $1/\text{distance}_i^2$ has been used as advised by SNH (2018).

3.2.7 The available sea area for foraging has been measured by plotting a circle defined by the species-specific foraging range around the colony in ArcGIS and calculating the area of sea available to each seabird species. The fraction of the disc centred on the colony that is occupied by sea surface is then expressed as a decimal. As the density of birds will increase as the area of available foraging area decreases, this is used in the formula as 1/estimated area.

3.2.8 The three weighting factors (weightings by colony size, distance from the colony and sea area) have been combined to produce an overall weighting for each colony. Each factor is given equal weight in the combined weighting. This calculation is provided below:

$$\text{Colony Weight} = \frac{\text{Colony Population}}{\text{Sum of Populations}} \times \frac{\text{Sum of Distance}^2}{\text{Colony Distance}^2} \times 1/\frac{\text{Colony Sea Proportion}}{\text{Sum of } 1/\text{ Sea Proportions}}$$

3.2.9 The weighting was then used to calculate the proportion of birds attributed to each colony ("proportional weight of colony") by calculating colony weight divided by sum of all colony weights.

Stage 2: Calculation of the number of birds allocated to each SPA at each Preferred Project

3.2.10 To estimate the contribution of each Protected Site to the population of birds at each Preferred Project, the total number of breeding birds at the latter has been multiplied by the proportion allocated to the Protected Site ("proportional weight of colony"). This required the effect estimates count to be adjusted to account for the presence of birds aged as sub-adult, immatures or on sabbatical. The approaches used for defining the age composition of a species population at the Preferred Project sites is described below.

Results

3.2.11 Table 3.1 presents the apportioning values to be used to apportion impacts from the Preferred Projects to breeding populations of relevant species at Protected Sites for which connectivity has been identified.

Table 3.1: Breeding adult apportioning values calculated for Protected Sites and associated features at Preferred Projects in the North Sea and Irish Sea

Protected Site	Feature	Preferred Project	Apportioning value (%)
Ailsa Craig	Gannet	4	54.43
		5	57.08
		6	61.20
	Lesser black-backed gull	4, 5 and 6	0 (Not in foraging range)
	Kittiwake	4, 5 and 6	0 (Not in foraging range)
Alde-Ore Estuary	Lesser black-backed gull	1, 2 and 3	0 (Not in foraging range)
Bowland Fells	Lesser black-backed gull	4	45.64
		5	42.90
		6	48.00
Bray Head	Kittiwake	4	3.27
		5 and 6	0 (Not in foraging range)
	Guillemot	4, 5 and 6	0 (Not in foraging range)
	Razorbill	4, 5 and 6	0 (Not in foraging range)
Coquet Island	Lesser black-backed gull	1, 2 and 3	0 (Not in foraging range)
	Kittiwake	1, 2 and 3	0 (Not in foraging range)
	Puffin	1, 2 and 3	0 (Not in foraging range)

Protected Site	Feature	Preferred Project	Apportioning value (%)
Duinen en Lage Land Texel	Lesser black-backed gull	1, 2 and 3	0 (Not in foraging range)
Duinen Vlieland	Lesser black-backed gull	1, 2 and 3	0 (Not in foraging range)
Farne Islands	Kittiwake	1, 2 and 3	0 (Not in foraging range)
	Puffin	1, 2 and 3	0 (Not in foraging range)
Flamborough and Filey Coast	Gannet	1	54.37
		2	99.99
		3	100
	Kittiwake	1	90.75
		2	95.24
		3	94.92
	Guillemot	1, 2 and 3	0 (Not in foraging range)
	Razorbill	1, 2 and 3	0 (Not in foraging range)
	Puffin	1, 2 and 3	0 (Not in foraging range)
Forth Islands	Gannet	1	45.63
		2 and 3	0 (Not in foraging range)
	Kittiwake	1, 2 and 3	0 (Not in foraging range)
Howth Head/Howth Head Coast	Kittiwake	4	4.67
		5	0 (Not in foraging range)
		6	5.25
	Guillemot	4, 5 and 6	0 (Not in foraging range)

Protected Site	Feature	Preferred Project	Apportioning value (%)
	Razorbill	4, 5 and 6	0 (Not in foraging range)
Inishtrahull	Kittiwake	4, 5 and 6	0 (Not in foraging range)
Ireland's Eye	Gannet	4	0.51
		5	0.41
		6	0.38
	Kittiwake	4	4.11
		5	0 (Not in foraging range)
		6	4.67
	Guillemot	4, 5 and 6	0 (Not in foraging range)
	Razorbill	4, 5 and 6	0 (Not in foraging range)
	Puffin	4, 5 and 6	0 (Not in foraging range)
Lambay Island	Lesser black-backed gull	4, 5 and 6	0 (Not in foraging range)
	Kittiwake	4	9.51
		5	0 (Not in foraging range)
		6	11.04
	Guillemot	4, 5 and 6	0 (Not in foraging range)
	Razorbill	4, 5 and 6	0 (Not in foraging range)
	Puffin	4, 5 and 6	0 (Not in foraging range)
Lough Neagh and Lough Beg	Lesser black-backed gull	4, 5 and 6	0 (Not in foraging range)
		4	2.00

Protected Site	Feature	Preferred Project	Apportioning value (%)
Morecambe Bay/Morecambe Bay and Duddon Estuary	Lesser black-backed gull	5	2.52
		6	2.69
	Herring gull	4	0 (Not in foraging range)
		5	21.51
		6	17.93
North Inishowen Coast	Kittiwake	4, 5 and 6	0 (Not in foraging range)
North Norfolk Coast	Sandwich tern	1, 2 and 3	0 (Not in foraging range)
Northumbria Coast	Kittiwake	1, 2 and 3	0 (Not in foraging range)
Rathlin Island	Lesser black-backed gull	4, 5 and 6	0 (Not in foraging range)
	Kittiwake	4, 5 and 6	0 (Not in foraging range)
	Puffin	4, 5 and 6	0 (Not in foraging range)
Ribble and Alt Estuaries	Lesser black-backed gull	4	38.67
		5	42.55
		6	29.50
Rockabill	Kittiwake	4, 5 and 6	0 (Not in foraging range)
Saltee Islands	Kittiwake	4, 5 and 6	0 (Not in foraging range)
	Puffin	4, 5 and 6	0 (Not in foraging range)
Skomer, Skokholm and Seas off Pembrokeshire	Kittiwake	4, 5 and 6	0 (Not in foraging range)
	Puffin	4, 5 and 6	0 (Not in foraging range)

Protected Site	Feature	Preferred Project	Apportioning value (%)
	Lesser black-backed gull	4, 5 and 6	0 (Not in foraging range)
Strangford Lough	Lesser black-backed gull	4 and 5	0 (Not in foraging range)
		6	0.30
St Abb's to Fast Castle	Kittiwake	1, 2 and 3	0 (Not in foraging range)
The Wash	Lesser black-backed gull	1 and 2	0 (Not in foraging range)
		3	83.37
Upper Solway Flats and Marshes	Lesser black-backed gull	4 and 5	0 (Not in foraging range)
		6	0.49
	Herring gull	4, 5 and 6	0 (Not in foraging range)
Waddenzee	Lesser black-backed gull	1, 2 and 3	0 (Not in foraging range)
Wicklow Head	Kittiwake	4, 5 and 6	0 (Not in foraging range)
	Guillemot	4, 5 and 6	0 (Not in foraging range)
	Razorbill	4, 5 and 6	0 (Not in foraging range)

Limitations

3.2.12 The use of the generic approach described above results in certain assumptions that may lead to under or over-estimates of the proportion of breeding adult birds present in a given area. These include:

- That birds are evenly distributed at sea, with this being extremely unlikely due to the known patchy distribution of prey species and information gained from tracking studies;
- That seabird colonies are independent of one another; and
- Larger foraging ranges at larger breeding colonies due to competition and prey depletion closer to the colony (Storer-Ashmole's Halo; Elliot *et al.*, 2009).

3.2.13 Consideration has been given in the RIAA to these assumptions, including where available site-specific tracking studies, and what effect they may have on the overall magnitude of any impacts.

3.3 Immature birds

3.3.1 A major part of any seabird population comprises immature birds. This is especially relevant for many of the species considered in this report with some species not breeding until they reach nine years of age. A proportion of immature birds return to natal waters during the breeding season, with the proportion of each immature age class increasing as individuals get closer to breeding age.

3.3.2 The population of immature birds associated with each breeding population has been estimated by applying simple population models following the approach in Furness (2015). This requires information on the breeding population, breeding productivity and survival rates for each age class. Furness (2015) produced stable population models by adjusting demographic parameters to provide a zero net population change and, where available the demographic parameters in Furness (2015) have been used in this report. Within this assessment consideration has also been given to the proportion of each immature age class that will return to natal waters.

3.3.3 The proportion of immatures present in the populations of relevant species are presented in Table 3.2.

Table 3.2: Proportion of immatures in a modelled population of relevant species

Species	Proportion of immatures (%)
Gannet	42.59
Kittiwake	43.86
Lesser black-backed gull	38.24
Guillemot	41.24
Razorbill	40.50
Puffin	47.64
Herring gull	49.17

Limitations

3.3.4 Although any population of breeding seabirds has an immature component associated with it, the spatial distribution of that component is often very different to the breeding adult component, especially in the breeding season. For many seabird species, immature birds gradually begin to return to natal waters in the breeding season as they get nearer to breeding age. The proportion of older immature age classes in natal waters is therefore higher than the proportion of younger immature age classes. In addition, the distribution of immature birds in natal waters may be dictated by proximity to breeding colonies either because birds are prospecting for breeding sites or due to competition with breeding adult birds. As site-specific baseline data is unavailable for use, consideration of the

return rate of immature birds to natal waters and the distribution of immature birds within natal waters will be conducted qualitatively.

3.4 Sabbatical birds

3.4.1 In every breeding season a proportion of adults skip breeding and take a 'sabbatical'. To include any impacts occurring on any sabbatical birds would likely overestimate the effects to these species/populations (Marine Scotland 2017a, b), as breeding colony population size estimates do not include these sabbatical birds. Therefore, in accordance with Marine Scotland guidance (Marine Scotland 2017a, b), the impacts assigned to sabbaticals are removed from the assessment including any subsequent population modelling (i.e. PVA) using the values presented in Table 3.3 as advised by SNH (2018) or sourced from Horswill and Robinson (2015). These values are considered likely to be underestimates and therefore remain precautionary.

Table 3.3: Proportion of sabbatical birds to be applied

Species	Sabbaticals (%)
Gannet	10
Lesser black-backed gull	34
Kittiwake	10
Guillemot	7
Puffin	7
Razorbill	7
Herring gull	35

4. Non-breeding seasons

4.1.1 The calculation of apportioning values for non-breeding seasons (post-breeding, non-breeding and pre-breeding) has followed the approach used previously in the application and examination documentation for multiple offshore wind farms (e.g. East Anglia THREE Ltd. 2015, Forewind 2013, SMart Wind 2015a). The contribution of adult birds from an individual Protected Site, as estimated by Furness (2015), to the relevant BDMPS population for each species/season combination is divided by the total BDMPS population, to calculate the proportion of the BDMPS population represented by adult birds from the Protected Site considered. An example of the computation involved is given below. It should be noted that no updates have been made to the population data presented in Furness (2015) as any updates will not be contemporaneous with those data not updated. For any Protected Sites not named in Furness (2015), the proportion of birds present in the relevant BDMPS areas in each season has been taken from the nearest named Protected Site.

4.1.2 Not all sites are explicitly included in Furness (2015) with those located outside of UK waters grouped into national populations (e.g. Ireland, France, etc.). LSEs have been identified for a number of non-UK Protected Sites and in order to calculate apportioning values for use in the non-breeding season, the same

calculation process as described has been followed albeit with the designated population for the site of interest used.

4.1.3 For guillemot, the Irish population is not included in the BDMPS populations presented in Furness (2015). In order to calculate apportioning values to use for relevant Irish Protected Sites, the Irish national population of guillemot, sourced from Mitchell *et al.,* (2014) to provide data contemporaneous with that included in Furness (2015), has been added to the BDMPS population presented in Furness (2015).

Worked example

4.1.4 The following calculations are an example, in this case for guillemot, of the approach used to assess the contribution of the focal colony to the BDMPS population (i.e. what proportion of the adults in the BDMPS region consist of birds from the focal colony). In this example the focal colony is the Flamborough and Filey Coast SPA. Furness (2015) defines the guillemot non-breeding season (winter BDMPS) as one period. The population of guillemot in the relevant BDMPS region, i.e. 'UK North Sea and Channel waters', is estimated in the non-breeding season to be 1,617,306 birds (Furness 2015, p375, table 62). The Flamborough and Filey Coast SPA breeding adult population is 79,282 individuals. The proportion of the Flamborough and Filey Coast SPA adult population present in the non-breeding season in the BDMPS region is 0.9 (Furness 2015, p375, table 62). Therefore:

- The number of Flamborough and Filey Coast SPA breeding adult birds in the BDMPS = (Flamborough and Filey Coast SPA breeding adult population in the BDMPS region) * (proportion of Flamborough and Filey Coast SPA breeding adult population present in the non-breeding season in the BDMPS region) = 79,282 * 0.9 = 71,354
- The proportion of breeding adults of the non-breeding BDMPS comprising Flamborough and Filey Coast SPA birds = (No. of Flamborough and Filey Coast SPA breeding adult birds in the BDMPS) / (Total no. of birds in the BDMPS) = 71,354 / 1,617,306 = 0.04 (to two significant figures)

4.2 Apportioning values

4.2.1 The apportioning values for all relevant Protected Sites and features are presented in Table 4.1 for Preferred Projects in the North Sea and Table 4.2 for Preferred Projects in the Irish Sea.

Table 4.1: Apportioning values applied in non-breeding seasons for Preferred Projects in the North Sea

Protected site	Feature	Apportioning values (%)		
		Post-breeding	Non-breeding	Pre-breeding
Ailsa Craig	Gannet	0	N/A	0
	Lesser black-backed gull	0.09	0.09	0.09
	Kittiwake	<0.01	N/A	<0.01

Protected site	Feature	Apportioning values (%)		
		Post-breeding	Non-breeding	Pre-breeding
Alde-Ore Estuary	Lesser black-backed gull	0.61	1.63	0.65
Bowland Fells	Lesser black-backed gull	2.19	2.33	2.32
Bray Head	Kittiwake	<0.01	N/A	<0.01
	Guillemot	N/A	0	N/A
	Razorbill	<0.01	0.01	<0.01
Coquet Island	Lesser black-backed gull	0.05	0.13	0.05
	Kittiwake	0.03	N/A	0.04
	Puffin	N/A	10.64	N/A
Duinen en Lage Land Texel	Lesser black-backed gull	13.4	35.61	14.18
Duinen Vlieland	Lesser black-backed gull	2.39	6.36	2.53
Farne Islands	Kittiwake	0.5	N/A	0.66
	Puffin	N/A	17.23	N/A
Flamborough and Filey Coast	Gannet	4.85	N/A	6.23
	Kittiwake	5.44	N/A	7.19
	Guillemot	N/A	4.41	N/A
	Razorbill	3.38	2.74	3.38
	Puffin	N/A	0.41	N/A
Forth Islands	Gannet	24.34	N/A	31.27
	Kittiwake	0.45	N/A	0.59
Howth Head/Howth Head Coast	Kittiwake	0.01	N/A	0.01
	Guillemot	N/A	0	N/A
	Razorbill	<0.01	0.01	<0.01
Inishtrahull	Kittiwake	<0.01	N/A	<0.01

Protected site	Feature	Apportioning values (%)		
		Post-breeding	Non-breeding	Pre-breeding
Ireland's Eye	Gannet	0	N/A	0
	Kittiwake	<0.01	N/A	<0.01
	Guillemot	N/A	0	N/A
	Razorbill	<0.01	0.02	<0.01
	Puffin	N/A	<0.01	N/A
Lambay Island	Lesser black-backed gull	0.15	0.16	0.16
	Kittiwake	0.01	N/A	0.01
	Guillemot	N/A	0	N/A
	Razorbill	0.02	0.13	0.02
	Puffin	N/A	<0.01	N/A
Lough Neagh and Lough Beg	Lesser black-backed gull	0.22	0.23	0.23
Morecambe Bay/Morecambe Bay and Duddon Estuary	Lesser black-backed gull	2.39	2.54	2.53
	Herring gull	N/A	0.04	N/A
North Inishowen Coast	Kittiwake	<0.01	N/A	<0.01
North Norfolk Coast	Sandwich tern	21.73	N/A	21.73
Northumbria Coast	Kittiwake	0.59	N/A	0.78
Rathlin Island	Lesser black-backed gull	0.05	0.05	0.05
	Kittiwake	0.02	N/A	0.03
	Puffin	N/A	<0.01	N/A
Ribble and Alt Estuaries	Lesser black-backed gull	3.96	4.2	4.19
Rockabill	Kittiwake	<0.01	N/A	<0.01

Protected site	Feature	Apportioning values (%)		
		Post-breeding	Non-breeding	Pre-breeding
Saltee Islands	Kittiwake	0.01	N/A	0.01
	Puffin	N/A	<0.01	N/A
Skomer, Skokholm and Seas off Pembrokeshire	Kittiwake	<0.01	N/A	<0.01
	Puffin	N/A	0.02	N/A
	Lesser black-backed gull	2.77	4.9	2.93
St Abb's to Fast Castle	Kittiwake	0.49	N/A	0.65
Strangford Lough	Lesser black-backed gull	0.06	0.07	0.06
The Wash	Lesser black-backed gull	1.32	3.51	1.4
Upper Solway Flats and Marshes	Lesser black-backed gull	1.15	6.11	0.24
	Herring gull	N/A	0.15	N/A
Waddenzee	Lesser black-backed gull	24.88	66.13	26.33
Wicklow Head	Kittiwake	<0.01	N/A	<0.01
	Guillemot	N/A	0	N/A
	Razorbill	<0.01	0.01	<0.01

Table 4.2: Apportioning values applied in non-breeding seasons for Preferred Projects in the Irish Sea

Protected site	Feature	Apportioning values (%)		
		Post-breeding	Non-breeding	Pre-breeding
Ailsa Craig	Gannet	9.94	N/A	8.2
	Lesser black-backed gull	0.11	0.18	0.11

Protected site	Feature	Apportioning values (%)		
		Post-breeding	Non-breeding	Pre-breeding
	Kittiwake	0.06	N/A	0.11
Alde-Ore Estuary	Lesser black-backed gull	0	0	0
Bowland Fells	Lesser black-backed gull	2.8	4.45	2.8
Bray Head	Kittiwake	0.1	N/A	0.18
	Guillemot	N/A	0.03	N/A
	Razorbill	0.04	0.03	0.04
Coquet Island	Lesser black-backed gull	0	0	0
	Kittiwake	0.01	N/A	0.02
	Puffin	N/A	0.57	N/A
Duinen en Lage Land Texel	Lesser black-backed gull	0	0	0
Duinen Vlieland	Lesser black-backed gull	0	0	0
Farne Islands	Kittiwake	0.15	N/A	0.3
	Puffin	N/A	1.84	N/A
Flamborough and Filey Coast	Gannet	0	N/A	1
	Kittiwake	1.65	N/A	3.26
	Guillemot	N/A	0	N/A
	Razorbill	0	0.06	0
	Puffin	N/A	0.04	N/A
Forth Islands	Gannet	0	N/A	5.03
	Kittiwake	0.14	N/A	0.27
Howth Head/Howth Head Coast	Kittiwake	0.31	N/A	0.54
	Guillemot	N/A	0.1	N/A
	Razorbill	0.09	0.07	0.09

Protected site	Feature	Apportioning values (%)		
		Post-breeding	Non-breeding	Pre-breeding
Inishtrahull	Kittiwake	0.01	N/A	0.01
Ireland's Eye	Gannet	0.01	N/A	0.01
	Kittiwake	0.12	N/A	0.22
	Guillemot	N/A	0.23	N/A
	Razorbill	0.11	0.08	0.11
	Puffin	N/A	<0.01	N/A
Lambay Island	Lesser black-backed gull	0.19	0.3	0.19
	Kittiwake	0.54	N/A	0.95
	Guillemot	N/A	6.28	N/A
	Razorbill	0.94	0.68	0.94
	Puffin	N/A	0.02	N/A
Lough Neagh and Lough Beg	Lesser black-backed gull	0.28	0.44	0.28
Morecambe Bay/Morecambe Bay and Duddon Estuary	Lesser black-backed gull	3.05	4.85	3.05
	Herring gull	N/A	1.6	N/A
North Inishowen Coast	Kittiwake	0.07	N/A	0.12
North Norfolk Coast	Sandwich tern	0	N/A	0
Northumbria Coast	Kittiwake	0.18	N/A	0.35
Rathlin Island	Lesser black-backed gull	0.07	0.1	0.07
	Kittiwake	1.04	N/A	1.83
	Puffin	N/A	0.08	N/A
Ribble and Alt Estuaries	Lesser black-backed gull	5.06	8.03	5.06

Protected site	Feature	Apportioning values (%)		
		Post-breeding	Non-breeding	Pre-breeding
Rockabill	Kittiwake	0.01	N/A	0.03
Saltee Islands	Kittiwake	0.28	N/A	0.49
	Puffin	N/A	0.11	N/A
Skomer, Skokholm and Seas off Pembrokeshire	Kittiwake	0.14	N/A	0.24
	Puffin	N/A	2.85	N/A
	Lesser black-backed gull	8.26	9.37	8.26
St Abb's to Fast Castle	Kittiwake	0.15	N/A	0.2
Strangford Lough	Lesser black-backed gull	0.08	0.12	0.08
The Wash	Lesser black-backed gull	0	0	0
Upper Solway Flats and Marshes	Lesser black-backed gull	1.47	5.84	0.59
	Herring gull	N/A	6.67	N/A
Waddenzee	Lesser black-backed gull	0	0	0
Wicklow Head	Kittiwake	0.13	N/A	0.22
	Guillemot	N/A	0.04	N/A
	Razorbill	0.04	0.03	0.04

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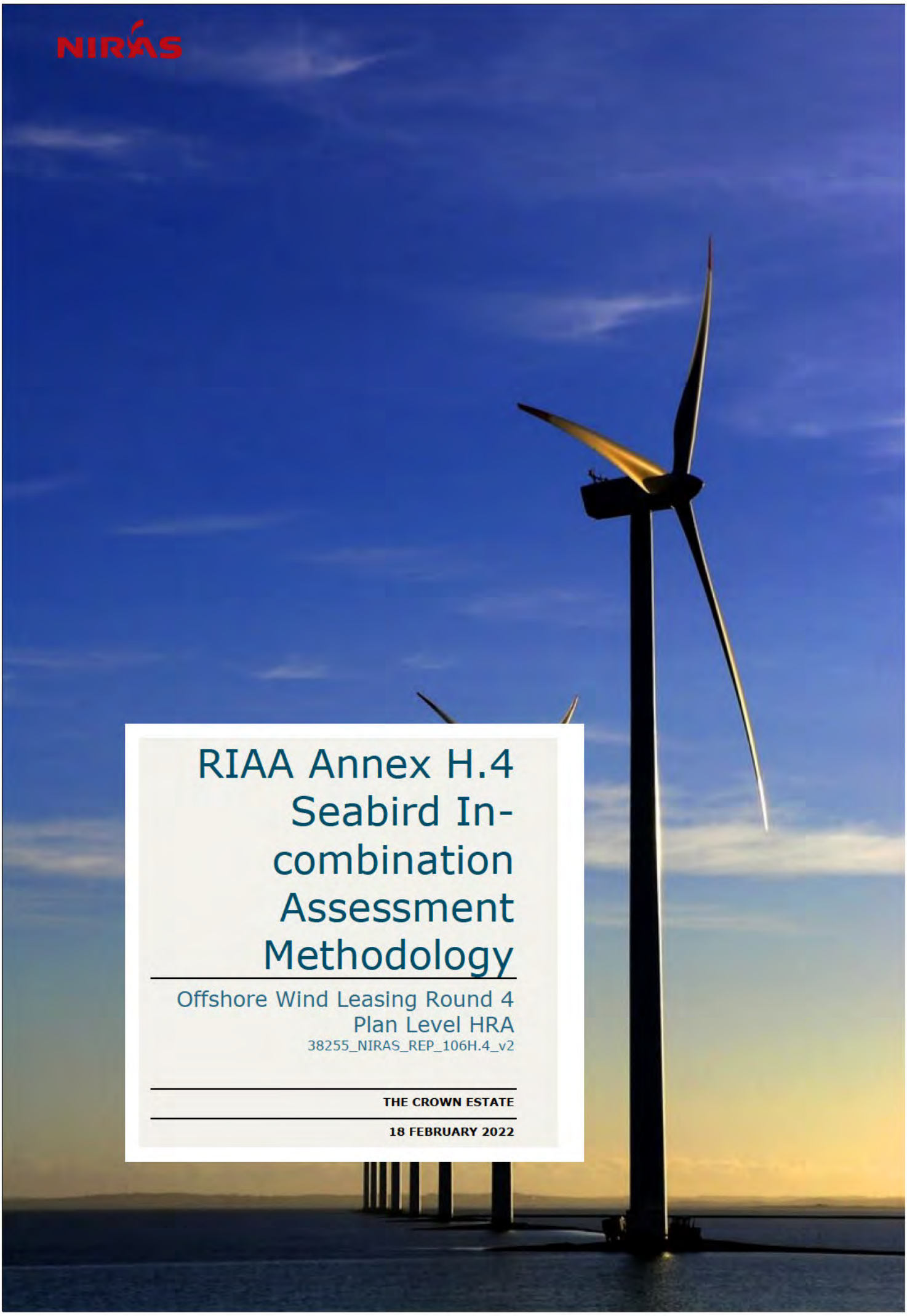
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RIAA Annex H.4 Seabird In-combination Assessment Methodology

Offshore Wind Leasing Round 4 Plan Level HRA

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1. Introduction

1.1.1 Within the RIAA, in-combination assessments are either provided qualitatively or quantitatively. Quantitative in-combination assessments are undertaken in cases where any predicted impact (including the highest impact predicted) from the Round 4 Plan alone exceeds 0.5% of the baseline mortality of the relevant Protected Site population. Exceptions are applied to small populations where the estimated number of mortalities associated with collision or displacement are very low (e.g. below five birds). For small populations, even minor impact mortality causes an unproportionally large increase to baseline mortality, which in reality is likely to be indiscernible given the uncertainty described above. A qualitative in-combination assessment is provided in all other cases.

1.1.2 This annex presents the methodology and figures to be used to undertake quantitative in-combination assessments for collision (P5) and displacement (P7) used to inform the Array Assessment (Part 2) in the RIAA.

2. Methodology

2.1 Identification of Projects

2.1.1 The methodology to identify the list of plans and projects used for the in-combination assessment is provided in Appendix A. The full list of plans and projects that have been considered in-combination with the Round 4 Plan is provided in Appendix B. Of these, only other offshore wind farm plans and projects have been considered further for collision and displacement, as the magnitude of any impact associated with collision and displacement from other project types would make a negligible contribution to any in-combination effect.

2.1.2 The identification of specific offshore windfarm plans and projects to include in the in-combination assessments for displacement and collision has been based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved. In undertaking this exercise it is important to bear in mind that different plans and projects will have differing potential for proceeding to an operational stage and hence a differing potential to ultimately contribute to an in-combination impact alongside the Round 4 Plan. For example, offshore windfarms that are already under construction are likely to contribute to an in-combination impact with the Round 4 Plan (providing effect or spatial pathways exist), whereas projects and plans not yet approved or not yet submitted are less certain to contribute to such an impact, as some may not achieve approval or may not ultimately be built due to other factors. For this reason, all relevant offshore wind plans and projects considered in-combination alongside the Round 4 Plan have been allocated into 'Tiers', reflecting their current stage within the planning and development process. This allows the in-combination assessment to present several future development scenarios, each with a differing potential for ultimately being built out. Appropriate weight may therefore be given to each Tier in the decision-making process when considering the potential in-combination impact associated with the Round 4 Plan (e.g. it may be considered that greater weight can be placed on the Tier 1 assessment relative to Tier 2). The tiers to be used are those previously advised by Natural England and JNCC and are shown in

2.1.3 Table 2.1.

Table 2.1: Tiers used for project and plans considered in-combination

Tier	Consenting or construction stage	Data availability
1	Built and operational projects should be included within the cumulative assessment where they have not been included within the environmental characterisation survey, i.e. they were not operational when baseline surveys were undertaken, and/or any residual impact may not have yet fed through to and been captured in estimates of "baseline" conditions e.g. "background" distribution or mortality rate for birds	Pre-construction (and possibly post-construction) survey data from the built project(s) and environmental characterisation survey data from proposed project (including data analysis and interpretation within the ES for the project)
2	Tier 1 + projects under construction	As Tier 1 but not including post-construction survey data
3	Tier 2 + projects that have been consented (but construction has not yet commenced)	Environmental characterisation survey data from proposed project (including data analysis and interpretation within the ES for the project) and possibly pre-construction survey data from built project
4	Tier 3 + projects that have an application submitted to the appropriate regulatory body that have not yet been determined	Environmental characterisation survey data from proposed project (including data analysis and interpretation within the ES for the project)
5	Tier 4 + projects that regulatory bodies are expecting to be submitted to them for determination (e.g. projects listed under the Planning Inspectorate programme of projects)	Possibly environmental characterisation survey data (but strong likelihood that this data will not be publicly available at this stage)
6	Tier 5 + projects that have been identified in relevant strategic plans or programmes (e.g. projects identified in the Scottish Government's Sectoral Marine Plan)	Historic survey data (values assumed and associated conclusions drawn from) collected for other purposes/by other projects or industries or at a strategic level

2.2 Collision risk

Obtaining values

2.2.1 Collision risk values have been taken from project or plan specific documentation.

2.2.2 Direct comparison of the collision risks predicted by plans and projects considered in-combination can prove problematic due to the differing assumptions made in the calculations used in the different studies, and the limited amount of species data presented in Environmental Statement chapters (Maclean *et al*., 2009).

2.2.3 The earliest collision risk assessments of offshore wind farms for Round 1 and 2 projects were generally undertaken by adapting the Band (2000) collision risk model (updated in Band *et al*., 2007), developed on behalf of Scottish Natural Heritage (now NatureScot) to quantify mortality rates for birds at onshore wind farms. As flight data are collected in a fundamentally different way in the onshore and offshore environments, the boat survey data collected at these offshore sites required significant reinterpretation to become compatible with the model. This is a potential source of variability in interpretation of results between projects, particularly as a standard method of interpretation was not available at that time.

2.2.4 For these projects' models it was also assumed that for birds transiting through turbines at risk height, collision risk was distributed evenly within the rotor swept area (as per Option 1 or 2 of the Band model), which in the majority of cases overestimates the risk for most species which predominantly fly at lower altitudes (including some within the lower rotor swept area). As the probability of colliding with a rotor blade is lower at these lower altitudes, using the mean value instead will invariably overestimate risk.

2.2.5 The most recent plans and projects have run collision risk analyses using the Band model, updated for the offshore environment (Band, 2012; sometimes the draft version Band (2011)). The updates within Band (2012) mean that projects that have used the Band (2012) or Band (2011) models are likely to produce more realistic mortality rates than earlier projects that had to interpret the onshore Band models.

2.2.6 In addition to the different models used to estimate collision mortality, different avoidance rates have been selected for impact assessment in different projects. This is the most sensitive parameter in the model, and so leads to a great deal of uncertainty in results. Mortality estimates from other projects have been converted to a common currency in this assessment consistent with those avoidance rates recommended by Cook *et al*. (2014), JNCC *et al.* (2014) and Bowgen and Cook (2018).

2.2.7 In-combination assessments are further complicated by the presentation format of collision risk estimates in plan and project-specific documentation. For the in-combination assessment presented in the RIAA, values from plans and projects considered in-combination are required on a monthly basis so that total in-combination impacts can be apportioned seasonally (i.e. breeding or non-breeding seasons) to the colony of interest. The collision risk estimates presented in plan and project-specific documentation are often only presented on annual or seasonal bases. Under these circumstances, and following the approach applied at previous offshore wind farm projects (Dogger Bank, East Anglia and Hornsea Zone projects), project-specific abundance data is used to attribute collision risk estimates on a monthly basis so that seasonal totals that can be apportioned to individual colonies can be calculated. Where possible density data used in collision risk modelling is used for this process, however, for many projects this isn't available and so other sources of abundance data are used. Where no project-

specific abundance estimates are available, collision risk estimates are attributed equally across all months.

2.2.8 In addition to consented projects, some projects for consideration in-combination are still within the planning process at the time of writing, meaning that collision risk figures provided may not have been finalised. The levels of mortality predicted are therefore subject to change, and so the confidence level in their results is low. Therefore, whilst the modelling approach applied may lead to an assumption of high confidence, in reality given that the numbers used in this assessment are known to be subject to refinement (which it is understood in the majority of cases will lead to a reduction in predicted mortality numbers) the confidence in these data is low. Furthermore, it is frequently the case that projects when constructed do not reflect the maximum design scenario assessed. In many cases, the as-built scenario will represent a significantly lower impact than that assessed as the worst case for the purpose of obtaining consent.

2.2.9 As part of the Hornsea Three application, the Applicant for that project, undertook an analysis of consented and as-built scenarios for projects in the North Sea. The conclusions of that work have been considered qualitatively, where necessary, in the results.

Apportioning

2.2.10 The apportioning values applied for collision risk estimates derived for other offshore windfarm projects are as follows:

- In the breeding season, project-specific values, where available have been used. Where unavailable, it has been assumed that 100% of breeding adult birds are attributable to the colony under consideration with consideration then given to the proportion of immature and non-breeding birds likely to be present.
- In non-breeding season, apportioning values calculated using the population data presented in Furness (2015) have been used.

2.3 Displacement

Derivation of population estimates

2.3.1 Guidance published by JNCC *et al*. (2017) states that displacement impacts for relevant species should be assessed based on a wide range of potential displacement and mortality rates in a 'matrix'. While some recent Environmental Statements use this matrix approach (e.g. Hornsea Project One, Aberdeen European Offshore Wind Deployment Centre, Dogger Bank Creyke Beck Projects A and B, Dogger Bank Teesside Project A and Sofia (formerly Dogger Bank Teesside B), and Seagreen Alpha and Bravo), many older projects do not, with these projects generally having presented a qualitative assessment. For the aforementioned projects the seasonal mean-peak population estimates, often found within project specific Environmental Statements and HRA, is a key parameter required to calculate quantitative displacement rates.

2.3.2 For projects where seasonal mean-peak populations were not presented, an approach was developed for the Dogger Bank projects, and subsequently applied for other projects (including projects in the Hornsea Zone and East Anglia Zone).

2.3.3 Following this approach, SEAMAST data (WWT and MacArthur Green, 2013) has been used to calculate mean densities for all relevant species and for individual wind farm project areas. GIS is used to calculate the development area plus a 2km buffer for each wind farm project. Numbers of birds present within the footprint of each project (and project + buffer) has then been calculated through

simply multiplying area (in km^2) by mean density. The SEAMAST data is presented for both breeding and non-breeding seasons, with no further division into a post-breeding dispersion season.

Displacement analysis

2.3.4 Upon obtaining mean-peak population estimates for the individual plans and projects the numbers of birds affected through displacement and subsequent mortality has been calculated using appropriate displacement and mortality rates for each species. The derivation of these rates follows the methods presented in Appendix H.

Apportioning

2.3.5 The apportioning values that have been applied for displacement mortality used for plans and projects considered in-combination are as follows:

- In the breeding season, project-specific values, where available have been used. Where unavailable, it is assumed that 100% of breeding adult birds are attributable to the colony under consideration with consideration then given to the proportion of immature and non-breeding birds likely to be present
- In non-breeding season, apportioning values calculated using the population data presented in Furness (2015) has been used.

3. In-combination values

3.1.1 The values for use in in-combination assessment are summarised below for projects in Tiers 1-4 and, separately, for plans and projects in Tiers 5-6 (where these are available). It should be noted that there is considerable uncertainty about the predicted impacts for plan and projects in Tiers 5 and 6.

3.2 Collision risk

Gannet

Table 3.1: Collision risk estimates for use in cumulative assessments for gannet (Tiers 1-4)

Project	Annual collision risk estimate at 98.9% avoidance
Aberdeen European Offshore Wind Deployment Centre	9.4
Barrow	Unavailable
Beatrice	95.7
Beatrice Demonstrator	2.8
Blyth Demonstration Project	8.4
Burbo Bank	Unavailable
Burbo Bank Extension	18.7
Dogger Bank Creyke Beck A and B	16.5
Dogger Bank Teesside A and B	35.7
Dounreay Tri	0
Dudgeon	79.7
East Anglia One	178.2
East Anglia One North	24.5
East Anglia Three	56.0

Project	Annual collision risk estimate at 98.9% avoidance
East Anglia Two	39.6
Erebus	Unavailable
Galloper	55.8
Greater Gabbard	27.5
Gunfleet Sands I	0
Gunfleet Sands II	0
Gunfleet Sands III	Unavailable
Gwynt y Mor	Unavailable
Hornsea Project One	66.0
Hornsea Project Two	27.0
Hornsea Three	24.0
Hornsea Four	20.1
Humber Gateway	3.9
Hywind	7.2
Inch Cape	365.1
Kentish Flats	Unavailable
Kentish Flats Extension	0.2

Project	Annual collision risk estimate at 98.9% avoidance
Kincardine	21.0
Lincs	5.0
London Array	5.5
Lynn and Inner Dowsing	0.6
Levenmouth demonstration turbine (Fife Energy Park) (Methil)	0.9
Moray East	124.9
Moray West	12.5
Neart na Gaoithe	569.6
Norfolk Boreas	30.7
Norfolk Vanguard	32.0
North Hoyle	Unavailable
Ormonde	10.3
Race Bank	49.5
Rampion	101.6
Rhyl Flats	Unavailable
Robin Rigg	Unavailable
Scroby Sands	Unavailable

Project	Annual collision risk estimate at 98.9% avoidance
Seagreen Bravo	363.3
Seagreen Alpha	552.2
Sheringham Shoal	17.6
Teesside	6.6
Thanet	1.1
Triton Knoll	121.6
Walney 1&2	Unavailable
Walney Extension	37.4
West of Duddon Sands	Unavailable
Westermost Rough	0.3

Table 3.2: Collision risk estimates for use in cumulative assessments for gannet (Tiers 5-6)

Project	Annual collision risk estimate at 98.9% avoidance
Dudgeon Extension	9.0
Galloper Extension (Five Estuaries)	Unavailable
Greater Gabbard Extension	Unavailable
Gwynt y Môr Extension (Awel y Môr)	Unavailable
Rampion Extension	Unavailable
Rambion (Southern Array)	Unavailable
Sheringham Shoal Extension	1.5

Kittiwake

Table 3.3: Collision risk estimates for use in cumulative assessments for kittiwake (Tiers 1-4)

Project	Annual collision risk estimate at 98.9% avoidance
Aberdeen European Offshore Wind Deployment Centre	18.7
Barrow	Unavailable
Beatrice	144.7
Beatrice Demonstrator	5.0
Blyth Demonstration Project	5.4
Burbo Bank	Unavailable
Burbo Bank Extension	35.2
Dogger Bank Creyke Beck A and B	718.8
Dogger Bank Teesside A and B	444.5
Dounreay Tri	0
Dudgeon	Unavailable
East Anglia One	580.8
East Anglia One North	52.0
East Anglia Three	106.0

Project	Annual collision risk estimate at 98.9% avoidance
East Anglia Two	42.3
Erebus	Unavailable
Galloper	66.0
Greater Gabbard	27.5
Gunfleet Sands I	0
Gunfleet Sands II	0
Gunfleet Sands III	Unavailable
Gwynt y Mor	Unavailable
Hornsea Project One	122.1
Hornsea Project Two	27.0
Hornsea Three	121
Hornsea Four	93.3
Humber Gateway	7.2
Hywind	18.3
Inch Cape	301.4
Kentish Flats	Unavailable
Kentish Flats Extension	2.7

Project	Annual collision risk estimate at 98.9% avoidance
Kincardine	32.0
Lincs	2.8
London Array	5.5
Lynn and Inner Dowsing	0
Levenmouth demonstration turbine (Fife Energy Park) (Methil)	0.7
Moray East	82.5
Moray West	109.0
Neart na Gaoithe	93.4
Norfolk Boreas	57.5
Norfolk Vanguard	57.5
North Hoyle	Unavailable
Ormonde	5.0
Race Bank	31.4
Rampion	121.5
Rhyl Flats	Unavailable
Robin Rigg	Unavailable
Scroby Sands	Unavailable

Project	Annual collision risk estimate at 98.9% avoidance
Seagreen Bravo	343.2
Seagreen Alpha	371.3
Sheringham Shoal	Unavailable
Teesside	81.3
Thanet	0
Triton Knoll	209.0
Walney 1&2	Unavailable
Walney Extension	187.6
West of Duddon Sands	Unavailable
Westermost Rough	0.5

Table 3.4: Collision risk estimates for use in cumulative assessments for kittiwake (Tiers 5-6)

Project	Annual collision risk estimate at 98.9% avoidance
Dudgeon Extension	28
Galloper Extension (Five Estuaries)	Unavailable
Greater Gabbard Extension	Unavailable
Gwynt y Môr Extension (Awel y Môr)	Unavailable
Rampion Extension	Unavailable

Project	Annual collision risk estimate at 98.9% avoidance
Rampion (Southern Array)	Unavailable
Sheringham Shoal Extension	2.8

Herring gull

Table 3.5: Collision risk estimates for use in cumulative assessments for herring gull (Tiers 1-4)

Project	Annual collision risk estimate at 99.5% avoidance
Aberdeen European Offshore Wind Deployment Centre	5.0
Barrow	Unavailable
Beatrice	68.7
Beatrice Demonstrator	0.5
Blyth Demonstration Project	0
Burbo Bank	Unavailable
Burbo Bank Extension	23.8
Dogger Bank Creyke Beck A and B	Unavailable
Dogger Bank Teesside A and B	Unavailable
Dounreay Tri	0
Dudgeon	Unavailable
Dudgeon Extension	0.3
East Anglia One	57.3
East Anglia One North	Unavailable
East Anglia Three	19.0

Project	Annual collision risk estimate at 99.5% avoidance
East Anglia Two	0.5
Erebus	Unavailable
Galloper	19.7
Greater Gabbard	Unavailable
Gunfleet Sands I	Unavailable
Gunfleet Sands II	Unavailable
Gunfleet Sands III	Unavailable
Gwynt y Mor	Unavailable
Hornsea Project One	14.0
Hornsea Project Two	Unavailable
Hornsea Three	6.0
Hornsea Four	0.8
Humber Gateway	13.5
Hywind	0
Inch Cape	13.4
Kentish Flats	Unavailable
Kentish Flats Extension	0

Project	Annual collision risk estimate at 99.5% avoidance
Kincardine	0
Lincs	Unavailable
London Array	Unavailable
Lynn and Inner Dowsing	Unavailable
Levenmouth demonstration turbine (Fife Energy Park) (Methil)	Unavailable
Moray East	57.5
Moray West	12.6
Neart na Gaoithe	32.0
Norfolk Boreas	6.9
Norfolk Vanguard	7.7
North Hoyle	Unavailable
Ormonde	3.3
Race Bank	Unavailable
Rampion	155.1
Rhyl Flats	Unavailable
Robin Rigg	Unavailable
Scroby Sands	Unavailable

Project	Annual collision risk estimate at 99.5% avoidance
Seagreen Bravo	19.0
Seagreen Alpha	12.0
Sheringham Shoal	Unavailable
Teesside	43.2
Thanet	4.5
Triton Knoll	Unavailable
Walney 1&2	Unavailable
Walney Extension	54.5
West of Duddon Sands	Unavailable
Westermost Rough	0

Table 3.6: Collision risk estimates for use in cumulative assessments for herring gull (Tiers 5-6)

Project	Annual collision risk estimate at 98.9% avoidance
Dudgeon Extension	Unavailable
Galloper Extension (Five Estuaries)	Unavailable
Greater Gabbard Extension	Unavailable
Gwynt y Môr Extension (Awel y Môr)	Unavailable
Rampion Extension	Unavailable

Project	Annual collision risk estimate at 98.9% avoidance
Rampion (Southern Array)	Unavailable
Sheringham Shoal Extension	Unavailable

Lesser black-backed gull

Table 3.7: Collision risk estimates for use in cumulative assessments for lesser black-backed gull (Tiers 1-4)

Project	Annual collision risk estimate at 99.5% avoidance
Aberdeen European Offshore Wind Deployment Centre	Unavailable
Barrow	Unavailable
Beatrice	Unavailable
Beatrice Demonstrator	Unavailable
Blyth Demonstration Project	Unavailable
Burbo Bank	2.0
Burbo Bank Extension	44.0
Dogger Bank Creyke Beck A and B	12.8
Dogger Bank Teesside A and B	12.0
Dounreay Tri	Unavailable
Dudgeon	27.0

Project	Annual collision risk estimate at 99.5% avoidance
East Anglia One	98.3
East Anglia One North	1.5
East Anglia Three	20.0
East Anglia Two	4.7
Erebus	Unavailable
Galloper	138.9
Greater Gabbard	61.5
Gunfleet Sands I	Unavailable
Gunfleet Sands II	Unavailable
Gunfleet Sands III	Unavailable
Gwynt y Mor	5.0
Hornsea Project One	22.0
Hornsea Project Two	3.0
Hornsea Three	11.0
Hornsea Four	0.4
Humber Gateway	1.5
Hywind	Unavailable

Project	Annual collision risk estimate at 99.5% avoidance
Inch Cape	Unavailable
Kentish Flats	Unavailable
Kentish Flats Extension	1.6
Kincardine	Unavailable
Lincs	9.0
London Array	Unavailable
Lynn and Inner Dowsing	Unavailable
Levenmouth demonstration turbine (Fife Energy Park) (Methil)	Unavailable
Moray East	Unavailable
Moray West	Unavailable
Neart na Gaoithe	1.7
Norfolk Boreas	14.3
Norfolk Vanguard	11.9
North Hoyle	1.0
Ormonde	22.1
Race Bank	53.8
Rampion	7.9

Project	Annual collision risk estimate at 99.5% avoidance
Rhyl Flats	1.0
Robin Rigg	Unavailable
Scroby Sands	Unavailable
Seagreen Bravo	3.3
Seagreen Alpha	7.3
Sheringham Shoal	8.3
Teesside	Unavailable
Thanet	5.5
Triton Knoll	32.0
Walney 1&2	28.6
Walney Extension	28.3
West of Duddon Sands	26.2
Westermost Rough	0.3

Table 3.8: Collision risk estimates for use in cumulative assessments for lesser black-backed gull (Tiers 5-6)

Project	Annual collision risk estimate at 98.9% avoidance
Dudgeon Extension	0.7

Project	Annual collision risk estimate at 98.9% avoidance
Galloper Extension (Five Estuaries)	51
Greater Gabbard Extension	35
Gwynt y Môr Extension (Awel y Môr)	Unavailable
Rampion Extension	Unavailable
Rampion (Southern Array)	Unavailable
Sheringham Shoal Extension	0.4

3.3 Displacement

Guillemot

Table 3.9: Population estimates for use in cumulative assessments for guillemot (Tiers 1-4)

Project	Seasonal population estimates for displacement analysis	
	Breeding	Non-breeding
Aberdeen European Offshore Wind Deployment Centre	547	225
Barrow	Unavailable	
Beatrice	13,610	2,755
Beatrice Demonstrator	Unavailable	
Blyth Demonstration Project	1,220	1,321
Burbo Bank	Unavailable	
Burbo Bank Extension	2,414	3,549
Dogger Bank Creyke Beck A	5,407	6,142
Dogger Bank Creyke Beck B	9,479	10,621
Dogger Bank Teesside A	3,283	2,268
Dogger Bank Teesside B	5,211	3,701
Dounreay Tri	Unavailable	

Project	Seasonal population estimates for displacement analysis	
	Breeding	Non-breeding
Dudgeon	334	542
East Anglia One	274	640
East Anglia One North	4,183	1,888
East Anglia Three	626	1,396
East Anglia Two	2,077	1,675
Erebus	Unavailable	
Galloper	305	593
Greater Gabbard	345	548
Gunfleet Sands I	Unavailable	
Gunfleet Sands II	Unavailable	
Gunfleet Sands III	Unavailable	
Gwynt y Mor	Unavailable	
Hornsea Project One	9,836	8,097
Hornsea Project Two	7,735	13,164
Hornsea Three	13,374	17,772
Hornsea Four	8,553	17,062

Project	Seasonal population estimates for displacement analysis	
	Breeding	Non-breeding
Humber Gateway	99	138
Hywind	431	Unavailable
Inch Cape	4,371	3,177
Kentish Flats	Unavailable	
Kentish Flats Extension	Unavailable	
Kincardine	632	Unavailable
Levenmouth demonstration turbine (Fife Energy Park) (Methil)	Unavailable	
Lincs and Lynn and Inner Dowsing	582	814
London Array	192	377
Moray East	9,820	547
Moray West	24,426	38,174
Neart na Gaoithe	1,755	3,761
Norfolk Boreas	7,767	13,777
Norfolk Vanguard	4,320	4,794
North Hoyle	Unavailable	

Project	Seasonal population estimates for displacement analysis	
	Breeding	Non-breeding
Ormonde	238	Unavailable
Race Bank	361	708
Rampion	1,610	2,183
Rhyl Flats	Unavailable	
Robin Rigg	28	Unavailable
Scroby Sands	Unavailable	
Seagreen Alpha	16,500	Unavailable
Seagreen Bravo	16,054	Unavailable
Sheringham Shoal	390	715
Teesside	267	901
Thanet	18	124
Triton Knoll	425	746
Walney 1&2	Unavailable	
Walney Extension	4,167	1,926
West of Duddon Sands	347	486
Westermost Rough	Unavailable	

Table 3.10: Population estimates for use in cumulative assessments for guillemot (Tiers 5-6)

Project	Seasonal population estimates for displacement analysis	
	Breeding	Non-breeding
Dudgeon Extension	7,222	11,857
Galloper Extension (Five Estuaries)	387	822
Greater Gabbard Extension	518	753
Gwynt y Môr Extension (Awel y Môr)	Unavailable	Unavailable
Rampion Extension	2,696	3,657
Rampion (Southern Array)	Unavailable	
Sheringham Shoal Extension	976	877

Razorbill

Table 3.11: Population estimates for use in cumulative assessments for razorbill (Tiers 1-4)

Project	Seasonal population estimates for displacement analysis			
	Breeding	Post-breeding	Non-breeding	Pre-breeding
Aberdeen European Offshore Wind Deployment Centre	161	64	7	26
Barrow	Unavailable			
Beatrice	873	833	555	833
Beatrice Demonstrator	Unavailable			
Blyth Demonstration Project	121	91	61	91
Burbo Bank	Unavailable			
Burbo Bank Extension	534	193	375	1,252
Dogger Bank Creyke Beck A	1,250	1,576	1,728	4,149
Dogger Bank Creyke Beck B	1,538	2,097	2,143	5,119
Dogger Bank Teesside A	834	310	959	1,919
Dogger Bank Teesside B	1,153	592	1,426	2,953

Project	Seasonal population estimates for displacement analysis			
	Breeding	Post-breeding	Non-breeding	Pre-breeding
Dounreay Tri	Unavailable			
Dudgeon	256	346	745	346
East Anglia One	16	26	155	336
East Anglia One North	403	85	54	207
East Anglia Three	673	563	1,206	1,547
East Anglia Two	281	44	136	230
Erebus	Unavailable			
Galloper	44	43	106	394
Greater Gabbard	0	0	387	84
Gunfleet Sands I	Unavailable			
Gunfleet Sands II	Unavailable			
Gunfleet Sands III	Unavailable			
Gwynt y Mor	Unavailable			
Hornsea Project One	1,109	4,812	1,518	1,803
Hornsea Project Two	2,511	4,221	720	1,668
Hornsea Three	630	2,020	3,649	1,236

Project	Seasonal population estimates for displacement analysis			
	Breeding	Post-breeding	Non-breeding	Pre-breeding
Hornsea Four	276	3590	474	371
Humber Gateway	27	20	13	20
Hywind	69	Unavailable		
Inch Cape	1,436	2,870	651	Unavailable
Kentish Flats	Unavailable			
Kentish Flats Extension	Unavailable			
Kincardine	22	Unavailable		
Levenmouth demonstration turbine (Fife Energy Park) (Methil)	Unavailable			
Lincs and Lynn and Inner Dowsing	45	34	22	34
London Array	14	20	14	20
Moray East	2,423	1,103	30	168
Moray West	2,808	3,544	184	3,585
Neart na Gaoithe	331	5,492	508	Unavailable
Norfolk Boreas	630	263	1,065	345

Project	Seasonal population estimates for displacement analysis			
	Breeding	Post-breeding	Non-breeding	Pre-breeding
Norfolk Vanguard	879	866	627	924
North Hoyle	Unavailable			
Ormonde	85	Unavailable		
Race Bank	28	42	28	42
Rampion	88	8	156	513
Rhyl Flats		Unavailable		
Robin Rigg	7	Unavailable		
Scroby Sands	Unavailable			
Seagreen Alpha	3,208	Unavailable		
Seagreen Bravo	886	Unavailable		
Sheringham Shoal	106	1,343	211	30
Teesside	16	61	2	20
Thanet	3	0	14	21
Triton Knoll	40	254	855	117
Walney 1&2	Unavailable			
Walney Extension	0	873	3,065	0

Project	Seasonal population estimates for displacement analysis			
	Breeding	Post-breeding	Non-breeding	Pre-breeding
West of Duddon Sands	91	121	152	91
Westermost Rough	Unavailable			

Table 3.12: Population estimates for use in cumulative assessments for razorbill (Tiers 5-6)

Project	Seasonal population estimates for displacement analysis			
	Breeding	Post-breeding	Non-breeding	Pre-breeding
Dudgeon Extension	1,231	3,649	720	272
Galloper Extension (Five Estuaries)	56	0	581	0
Greater Gabbard Extension	0	55	133	500
Gwynt y Môr Extension (Awel y Môr)	Unavailable	Unavailable	Unavailable	Unavailable
Rampion Extension	143	13	262	859
Rampion (Southern Array)	Unavailable			
Sheringham Shoal Extension	240	646	590	148

Puffin

Table 3.13: Population estimates for use in cumulative assessments for puffin (Tiers 1-4)

Project	Seasonal population estimates for displacement analysis	
	Breeding	Non-breeding
Aberdeen European Offshore Wind Deployment Centre	42	82
Barrow	Unavailable	
Beatrice	2,858	2,435
Beatrice Demonstrator	Unavailable	
Blyth Demonstration Project	235	123
Burbo Bank	Unavailable	
Burbo Bank Extension	10	0
Dogger Bank Creyke Beck A	37	295
Dogger Bank Creyke Beck B	102	743
Dogger Bank Teesside A	34	273
Dogger Bank Teesside B	35	329
Dounreay Tri	Unavailable	
Dudgeon	1	3

Project	Seasonal population estimates for displacement analysis	
	Breeding	Non-breeding
East Anglia One	16	32
East Anglia One North	0	0
East Anglia Three	52	142
East Anglia Two	15	0
Erebus	Unavailable	
Galloper	0	1
Greater Gabbard	0	1
Gunfleet Sands I	Unavailable	
Gunfleet Sands II	Unavailable	
Gunfleet Sands III	Unavailable	
Gwynt y Mor	Unavailable	
Hornsea Project One	1,070	1,257
Hornsea Project Two	468	2,039
Hornsea Three	253	127
Hornsea Four	153	353
Humber Gateway	15	10

Project	Seasonal population estimates for displacement analysis	
	Breeding	Non-breeding
Hywind	239	Unavailable
Inch Cape	2,956	2,688
Kentish Flats	Unavailable	
Kentish Flats Extension	Unavailable	
Kincardine	56	Unavailable
Levenmouth demonstration turbine (Fife Energy Park) (Methil)	Unavailable	
Lincs and Lynn and Inner Dowsing	3	6
London Array	0	1
Moray East	2,795	656
Moray West	1115	3966
Neart na Gaoithe	2,562	2,103
Norfolk Boreas	0	23
Norfolk Vanguard	67	112
North Hoyle	Unavailable	
Ormonde	1	Unavailable

Project	Seasonal population estimates for displacement analysis	
	Breeding	Non-breeding
Race Bank	1	10
Rampion	4	0
Rhyl Flats	Unavailable	
Robin Rigg	0	0
Scroby Sands	Unavailable	
Seagreen Alpha	4,254	Unavailable
Seagreen Bravo	8,262	Unavailable
Sheringham Shoal	4	26
Teesside	35	18
Thanet	0	0
Triton Knoll	23	71
Walney 1&2	Unavailable	
Walney Extension	53	119
West of Duddon Sands	61	35
Westermost Rough	Unavailable	

Table 3.14: Population estimates for use in cumulative assessments for puffin (Tiers 5-6)

Project	Seasonal population estimates for displacement analysis	
	Breeding	Non-breeding
Dudgeon Extension	0	22
Galloper Extension (Five Estuaries)	Unavailable	Unavailable
Greater Gabbard Extension	Unavailable	Unavailable
Gwynt y Môr Extension (Awel y Môr)	Unavailable	Unavailable
Rampion Extension	Unavailable	Unavailable
Rampion (Southern Array)	Unavailable	
Sheringham Shoal Extension	0	11

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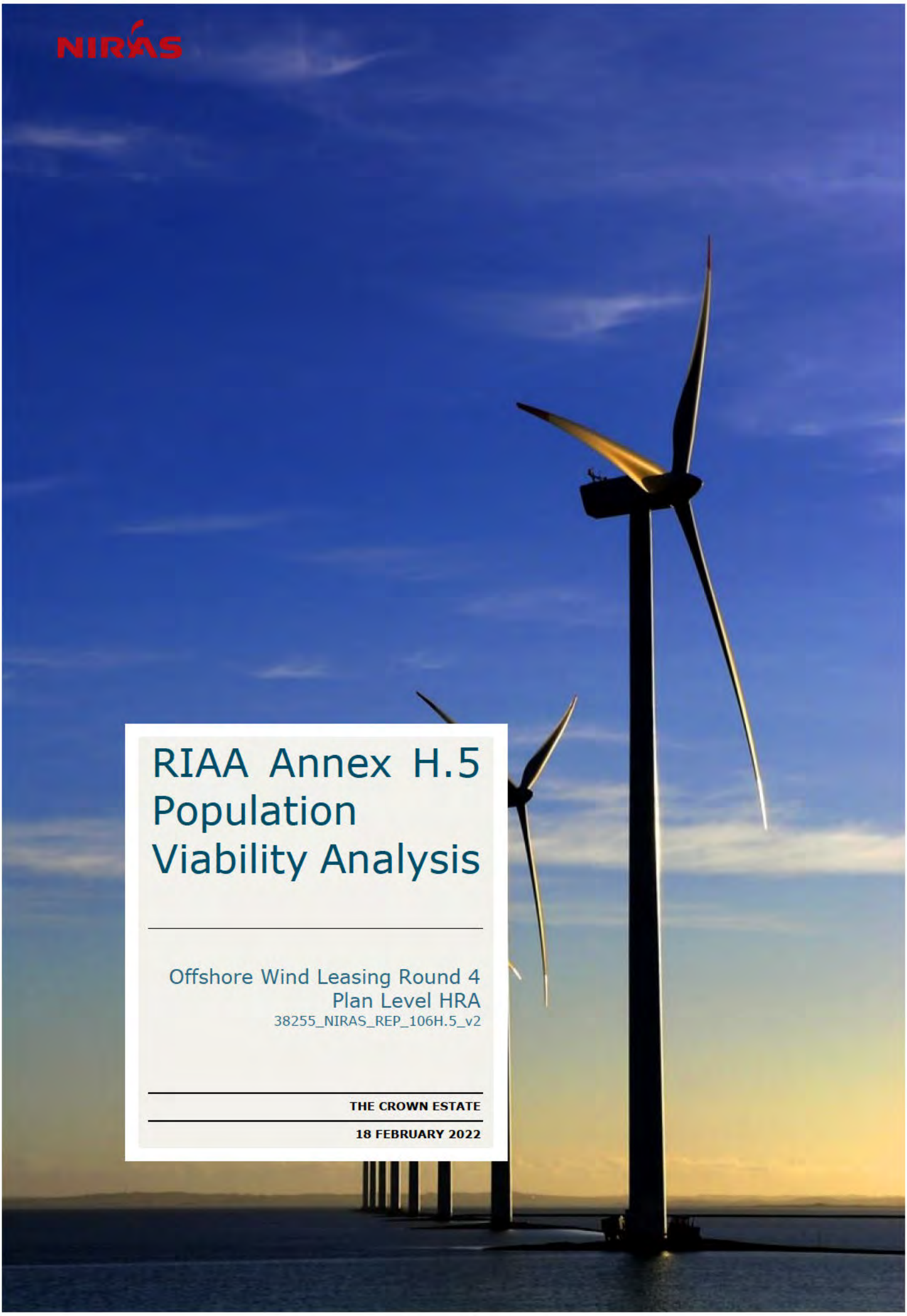
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Offshore Wind Leasing Round 4
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1. Introduction

1.1.1 This annex presents the methodology and results of Population Viability Analysis (PVA) used to inform the Array Assessment (Part 2) in the RIAA.

2. Background

2.1.1 Understanding the effect that the Round 4 Preferred Projects alone and in-combination may have on designated populations will form a key part of the Array Assessment (Part 2) in the RIAA. The preferred approach is to use a Population Viability Analysis (PVA) model which can compare the likely fate of the population both with and without the additional mortality predicted.

2.1.2 In 2019 Natural England published the Natural England Population Viability Analysis (NEPVA) package and online tool (which uses the Shiny app) for carrying out PVA on seabird species under different impact scenarios and at a variety of scales (Searle *et al.,* 2019). Users can run PVA either with the online tool, via a user-friendly Graphical User Interface (GUI) using a standard web browser, or locally in the R statistical software, which allows additional functionality. The NEPVA framework consists of various options which allow users to specify model and species demographic parameters.

2.1.3 The approach to PVA and the parameterisation of the NEPVA model has been discussed and agreed with Natural England, a detailed summary of model options and parameters used is provided in Table 3.1.

3. Methodology

3.1 Basic PVA information

3.1.1 The NEPVA R package (v 4.17) has been used for PVA (see Sub-Annex 1). The package has been run locally in R, to boost efficiency and reproducibility, and uses identical functions to the online tool version. In addition, the user guides associated with this package (Searle *et al.,* 2019; Mobbs *et al.,* 2020) have been followed.

3.1.2 Modelling has been undertaken using the simulation run type. This option simulates future population trajectories based upon specified demographic rates, initial population sizes and scenarios of impact (see Sections 3.2 and 3.3). This option also allows for baseline population forecasts to be generated.

3.1.3 The analysis method in the NEPVA constructs a Leslie matrix based on the model structure and parameters provided by the user. Users must specify whether to include demographic and environmental stochasticity within the model. The inclusion of environmental stochasticity within the models would allow for random variation in factors such as weather to be incorporated. When included the model uses randomly generated values (from a beta distribution) for the probability of survival in each year. The inclusion of demographic stochasticity allows for the models to incorporate random variation in the demographic rates associated with a population. This is included within modelling by generating random values from a binomial distribution for the number of birds surviving (for each age class) and either a binomial or Poisson distribution for the number of chicks fledged. The use of these options allows the model to produce probabilistic outputs for the effect of both types of stochasticity. Both have both been included in the models

undertaken for the RIAA, although demographic uncertainty will only be included where the modelled population comprises more than 100 individuals.

3.1.4 Density dependence is a fundamental feature of any population, affecting all demographic processes that change in response to the number of individuals in a population (i.e. growth, survival and productivity). The alternative to density dependence is density independence. However, for seabird populations, density independence is ecologically implausible as any population exhibiting density independence would grow exponentially. The correct specification of density dependence within a PVA can be difficult with mis-specifications producing models that may be unreliable. To prevent this and to therefore apply a precautionary approach, PVA models for the RIAA have assumed density independence. This is in line with the typical approach applied in assessments for offshore wind farm projects.

3.1.5 The number of matched-pair simulations used in all models was set to 5,000 simulations. A burn-in period of five years was used in modelling.

3.2 Population Sizes and Baseline demographic rates

3.2.1 Table 3.1 summarises the sources of demographic rates and population data required for input into the model and Table 3.2 presents the values used for each PVA model.

Population Sizes

3.2.2 Population sizes have been derived from the most recent population counts at each colony.

Demographic Rates

3.2.3 The NEPVA package allows users to either utilise a number of pre-set demographic parameters or to have the ability to enter custom values. Pre-set demographic parameters are available for fifteen species and represent previously reported national or colony specific demographic rates (JNCC Seabird Monitoring Programme for productivity or Horswill and Robinson (2015) for survival data and age at first breeding). For the RIAA the default values pre-set in the NEPVA package have been used for all demographic parameters, with the exception of productivity. Where available colony specific demographic parameters for the colony under consideration are available these have been used. In the case of productivity, colony-specific values have been sourced from JNCC SMP productivity data using an average over more recent years than that of default colony-specific productivity in NEPVA, allowing a more accurate estimate of current colony productivity trends. If colony-specific demographic parameters were unavailable then other available rates were interrogated to determine which rates are the most appropriate. This included demographic rates available on a regional basis followed by those at a national level. It is indicated in the RIAA where this has been done.

3.2.4 The NEPVA package also allows for users to define different demographic rates for different subpopulations. However, PVA modelling for the RIAA is being conducted for individual colonies and therefore this functionality is not required.

Table 3.1: Parameter values required for modelling and source of parameter information

Parameter type	Parameter required	Selection options	Information required	Values/information used
Species	Region productivity data	Global-colony (if available)	User selected	Most recent colony-level data used where available. Where unavailable, default national productivity rates from Horswill & Robinson (2015) are used Specified "global" for region type and "global" for sector
	Region survival rate	National-colony specific (if available)	User selected	Most recent colony-level data used where available. Where unavailable, default national productivity rates from Horswill & Robinson (2015) are used Specified "national"
	Age at first breeding	Input value	App populates	NEVPA default (colony level where available)
	Brood size (max)	Input value	App populates	
	Is there an upper constraint on productivity?	Yes/no	User selected	"Yes" selected
Population information	Number of sub populations	Demographic rates can be specified for each sub-population	User selected	No sub-populations defined. Parameter set to "1"
	Units for initial pop size	Breeding Ad/ pairs/ Ad+Imm	User selected	Breeding adults

Parameter type	Parameter required	Selection options	Information required	Values/information used
Baseline demographics	Initial pop size	Input value	User defined	Most recent count data available (Seabirds Count SMP data)
	Year (of pop. count)	Input value	User defined	Most recent count data available (Seabirds Count SMP data)
	Ad Prod (mean, +SD)	DD optional - user defined	App populates	Most recent colony-level data used where available. Where unavailable, default national rates from Horswill & Robinson (2015) are used
	Ad Survival (mean, +SD)	DD optional - user defined	App populates	
	Age class x(juv) Prod (mean, +SD)	Optional if known	App populates	
	Age class x(juv) Survival (mean, +SD)	Optional if known	App populates	
Impacts	Number of scenarios	Set value (Plus various options available to select)	User defined	For range predicted by impact assessment; focus on breeding adults, and no application of impacts to subpopulations; random seeds matched for impact scenarios
	Timescale of impact	Input value	User selected	60 years with impact commencing 1 year after initial population year
	Relative or Absolute harvest	One must be selected	User selected	Relative harvest
	Relative	Survival &/ prod rate - annual change	User defined	Impacts on productivity rates to "0" in all cases

Parameter type	Parameter required	Selection options	Information required	Values/information used
	Absolute harvest	Number(per age class lost annually)	User defined	Not used
Outputs	Years from : to	Input value	User defined	60 year operational period
	Target pop size	Optional to assess effect of impact	User defined	Initial pop size – from recent monitoring data
	Extinction threshold		User defined	N/A
	Units for pop size	Breeding Ad/ pairs/ Ad+Imm	User selected	Whole population

Table 3.2: Parameter values used in each PVA. Two mortality estimates per cell denote lower and upper estimates, where available. Survival, maximum brood size and age at first breeding are estimated from NEPVA default National values

Species	Site	Mortality type	Annual mortality from CRM	Annual mortality from displacement	Most recent Population count (breeding adults)	Mean product-ivity	SD product-ivity	Productivity source and years averaged	Mean survival	SD survival	Max Brood size	Age at first breeding
Gannet	Flamborough and Filey Coast SPA	In-combination	288, 290	53.3, 71.1	26,784	0.823	0.038	SMP data: FFC SPA 2009-2019	0.919	0.042	1	5
Gannet	Flamborough and Filey Coast SPA	Alone	7.4, 8.7	2.3, 30.8	26,784	0.823	0.038	SMP data: FFC SPA 2009-2019	0.919	0.042	1	5
Kittiwake	Flamborough and Filey Coast SPA	In-combination	557, 563		103,070	0.722	0.210	SMP data: FFC SPA 2009-2019	0.854	0.077	2	4
Kittiwake	Flamborough and Filey Coast SPA	Alone	37.9, 43.4		103,070	0.722	0.210	SMP data: FFC SPA 2009-2019	0.854	0.077	2	4
Guillemot	Flamborough and Filey Coast SPA	In-combination		520	121,754	0.716	0.076	SMP data: FFC SPA 2009-2019	0.94	0.025	1	6
Guillemot	Flamborough and Filey Coast SPA	Alone		19.1	121,754	0.716	0.076	SMP data: FFC SPA 2009-2019	0.94	0.025	1	6
Puffin	Flamborough and Filey Coast SPA	In-combination		6, 36	3,579	0.617	0.151	SMP data: FFC SPA 2009-2019	0.907	0.083	1	5
Puffin	Flamborough and Filey Coast SPA	Alone		0.5, 4.5	3,579	0.617	0.151	SMP data: FFC SPA 2009-2019	0.907	0.083	1	5

3.3 Impacts

3.3.1 For each feature (population) modelled, the range of impacts predicted in impact assessment was used to specify the modelling scenarios (Table 3.2).

3.3.2 The modelling timescale matches the lease period for Round 4 projects, which will be 60 years.

3.3.3 The "Relative harvest" option was applied.

4. Outputs

4.1.1 The following outputs have been presented to inform assessments in the Array Assessment (Part 2) in the RIAA based on the advice of Natural England to previous offshore wind farm projects (e.g. Natural England, 2018):

- Counterfactual of growth rate
- Counterfactual of final population size
- Model specifications and parameterization

4.1.2 All outputs will be presented for impacts associated with the Plan alone and in-combination with other plans and projects. The results section will discuss the merit of each of these outputs in determining whether Protected Sites will be adversely affected.

5. Results

5.1.1 The following outputs present results of Population Viability Analysis for impacts of Round 4 Preferred Projects alone or in-combination on seabird populations at Flamborough and Filey Coast SPA. Population differences between the baseline (unimpacted) and impact scenarios are reported at five-year intervals from the most recent population count, with impacts commencing the following year and scenarios modelled for 60 years. Scenarios are named with the type of impact (Disp = displacement), and the annual adult bird mortality apportioned to Flamborough and Filey Coast SPA. Population (Pop.) outputs refer to the whole population (adult and immature/juvenile birds).

Gannet

Table 5.1: Results of Population Viability Analysis for impacts of Round 4 Preferred Projects alone on the gannet population at Flamborough and Filey Coast SPA.

Year	Scenario	Years from impact	Pop. size median	Pop. size 2.5% quantile	Pop. size 97.5% quantile	Pop. growth rate median	Pop. growth rate LCI	Pop. growth rate UCI	Counter factual of growth rate median	Counter factual of growth rate LCI	Counter factual of growth rate UCI	Counter factual of pop. size median	Counter factual of pop. size LCI	Counter factual of pop. size UCI
2019	baseline		52993	48748	55869	1.021	0.939	1.076						
2019	CRM 7.4	0	52961	48677	55869	1.020	0.938	1.076	1.000	0.994	1.005	1.000	0.994	1.005
2019	CRM 8.7	0	52962	48721	55860	1.020	0.939	1.076	1.000	0.994	1.005	1.000	0.994	1.005
2019	Disp 2.3	0	52970	48677	55843	1.020	0.938	1.076	1.000	0.995	1.005	1.000	0.995	1.005
2019	Disp 30.8	0	52915	48619	55778	1.019	0.937	1.074	0.999	0.993	1.004	0.999	0.993	1.004
2019	CRM+Disp 9.7	0	52966	48663	55840	1.020	0.937	1.076	1.000	0.994	1.005	1.000	0.994	1.005
2019	CRM+Disp 39.5	0	52898	48667	55741	1.019	0.938	1.074	0.998	0.993	1.004	0.998	0.993	1.004
2024	baseline		57800	48641	66351	1.018	0.989	1.042						
2024	CRM 7.4	5	57677	48526	66256	1.018	0.989	1.042	1.000	0.998	1.002	0.998	0.987	1.009
2024	CRM 8.7	5	57695	48499	66259	1.018	0.989	1.042	1.000	0.998	1.002	0.998	0.987	1.009
2024	Disp 2.3	5	57777	48612	66336	1.018	0.989	1.042	1.000	0.998	1.002	0.999	0.988	1.011
2024	Disp 30.8	5	57354	48165	65793	1.017	0.988	1.040	0.999	0.997	1.001	0.992	0.980	1.003
2024	CRM+Disp 9.7	5	57674	48509	66197	1.018	0.989	1.041	1.000	0.998	1.001	0.997	0.986	1.009
2024	CRM+Disp 39.5	5	57188	48044	65700	1.016	0.987	1.040	0.998	0.996	1.000	0.989	0.978	1.001
2029	baseline		62751	49997	76006	1.017	0.997	1.035						
2029	CRM 7.4	10	62470	49650	75675	1.017	0.996	1.035	1.000	0.998	1.001	0.996	0.981	1.011

Year	Scenario	Years from impact	Pop. size median	Pop. size 2.5% quantile	Pop. size 97.5% quantile	Pop. growth rate median	Pop. growth rate LCI	Pop. growth rate UCI	Counter factual of growth rate median	Counter factual of growth rate LCI	Counter factual of growth rate UCI	Counter factual of pop. size median	Counter factual of pop. size LCI	Counter factual of pop. size UCI
2029	CRM 8.7	10	62462	49600	75675	1.017	0.996	1.035	1.000	0.998	1.001	0.996	0.981	1.011
2029	Disp 2.3	10	62619	49769	75705	1.017	0.996	1.035	1.000	0.999	1.001	0.999	0.984	1.014
2029	Disp 30.8	10	61813	49154	74878	1.016	0.995	1.034	0.999	0.997	1.000	0.985	0.970	0.999
2029	CRM+Disp 9.7	10	62429	49643	75460	1.017	0.996	1.035	1.000	0.998	1.001	0.995	0.980	1.010
2029	CRM+Disp 39.5	10	61499	48934	74530	1.016	0.995	1.033	0.998	0.997	1.000	0.981	0.966	0.996
2034	baseline		68387	52728	86449	1.017	1.001	1.032						
2034	CRM 7.4	15	68050	52389	85811	1.017	1.001	1.032	1.000	0.999	1.001	0.995	0.977	1.013
2034	CRM 8.7	15	67934	52324	85859	1.017	1.000	1.032	1.000	0.999	1.001	0.994	0.976	1.012
2034	Disp 2.3	15	68325	52560	85995	1.017	1.001	1.032	1.000	0.999	1.001	0.998	0.981	1.017
2034	Disp 30.8	15	66902	51382	84533	1.016	0.999	1.031	0.999	0.998	1.000	0.978	0.961	0.996
2034	CRM+Disp 9.7	15	67908	52305	85649	1.017	1.000	1.032	1.000	0.998	1.001	0.993	0.976	1.011
2034	CRM+Disp 39.5	15	66521	51117	84101	1.016	0.999	1.031	0.998	0.997	0.999	0.972	0.955	0.990
2039	baseline		74636	55343	97904	1.017	1.003	1.031						
2039	CRM 7.4	20	74015	55041	97047	1.017	1.003	1.030	1.000	0.999	1.001	0.993	0.973	1.013
2039	CRM 8.7	20	74046	55002	97087	1.017	1.003	1.030	1.000	0.999	1.001	0.992	0.973	1.012
2039	Disp 2.3	20	74372	55375	97418	1.017	1.003	1.030	1.000	0.999	1.001	0.998	0.978	1.018
2039	Disp 30.8	20	72461	53772	95066	1.016	1.002	1.029	0.999	0.998	1.000	0.971	0.953	0.991
2039	CRM+Disp 9.7	20	73872	54720	96749	1.017	1.003	1.030	1.000	0.999	1.001	0.991	0.971	1.011

Year	Scenario	Years from impact	Pop. size median	Pop. size 2.5% quantile	Pop. size 97.5% quantile	Pop. growth rate median	Pop. growth rate LCI	Pop. growth rate UCI	Counter factual of growth rate median	Counter factual of growth rate LCI	Counter factual of growth rate UCI	Counter factual of pop. size median	Counter factual of pop. size LCI	Counter factual of pop. size UCI
2039	CRM+Disp 39.5	20	71866	53350	94376	1.016	1.001	1.029	0.998	0.997	0.999	0.964	0.944	0.983
2044	baseline		81141	58762	110023	1.017	1.005	1.029						
2044	CRM 7.4	25	80420	58216	109028	1.017	1.004	1.029	1.000	0.999	1.001	0.991	0.970	1.013
2044	CRM 8.7	25	80396	57938	109034	1.017	1.004	1.029	1.000	0.999	1.000	0.990	0.969	1.012
2044	Disp 2.3	25	80990	58501	109828	1.017	1.005	1.029	1.000	0.999	1.001	0.998	0.976	1.019
2044	Disp 30.8	25	78317	56786	106205	1.016	1.003	1.028	0.999	0.998	0.999	0.965	0.944	0.986
2044	CRM+Disp 9.7	25	80247	58025	108835	1.017	1.004	1.029	1.000	0.999	1.000	0.989	0.967	1.010
2044	CRM+Disp 39.5	25	77523	55938	105097	1.016	1.003	1.028	0.998	0.997	0.999	0.955	0.934	0.977
2049	baseline		88601	61715	122731	1.017	1.006	1.028						
2049	CRM 7.4	30	87472	60844	121708	1.017	1.005	1.028	1.000	0.999	1.000	0.989	0.967	1.013
2049	CRM 8.7	30	87436	60851	121461	1.017	1.005	1.028	1.000	0.999	1.000	0.988	0.965	1.011
2049	Disp 2.3	30	88278	61583	122642	1.017	1.006	1.028	1.000	0.999	1.001	0.997	0.974	1.020
2049	Disp 30.8	30	84836	59044	117740	1.016	1.004	1.027	0.999	0.998	0.999	0.958	0.936	0.981
2049	CRM+Disp 9.7	30	87349	60825	121243	1.017	1.005	1.028	1.000	0.999	1.000	0.987	0.964	1.010
2049	CRM+Disp 39.5	30	83705	58305	116613	1.016	1.004	1.026	0.998	0.997	0.999	0.947	0.925	0.969
2054	baseline		96523	65475	136773	1.017	1.006	1.027						
2054	CRM 7.4	35	95267	64622	135241	1.017	1.006	1.027	1.000	0.999	1.000	0.988	0.964	1.012
2054	CRM 8.7	35	95249	64352	135074	1.017	1.006	1.027	1.000	0.999	1.000	0.986	0.963	1.010
2054	Disp 2.3	35	95987	65177	136317	1.017	1.006	1.027	1.000	0.999	1.001	0.996	0.972	1.022

Year	Scenario	Years from impact	Pop. size median	Pop. size 2.5% quantile	Pop. size 97.5% quantile	Pop. growth rate median	Pop. growth rate LCI	Pop. growth rate UCI	Counter factual of growth rate median	Counter factual of growth rate LCI	Counter factual of growth rate UCI	Counter factual of pop. size median	Counter factual of pop. size LCI	Counter factual of pop. size UCI
2054	Disp 30.8	35	91703	62246	129895	1.016	1.005	1.026	0.999	0.998	0.999	0.952	0.928	0.975
2054	CRM+Disp 9.7	35	94886	64445	134765	1.017	1.006	1.027	1.000	0.999	1.000	0.984	0.960	1.010
2054	CRM+Disp 39.5	35	90353	61287	128837	1.016	1.005	1.026	0.998	0.998	0.999	0.938	0.915	0.962
2059	baseline		105348	68834	153091	1.017	1.007	1.027						
2059	CRM 7.4	40	103952	68088	150898	1.017	1.007	1.026	1.000	0.999	1.000	0.986	0.962	1.012
2059	CRM 8.7	40	103721	67557	150955	1.017	1.006	1.026	1.000	0.999	1.000	0.984	0.959	1.010
2059	Disp 2.3	40	104918	68725	152480	1.017	1.007	1.027	1.000	0.999	1.001	0.995	0.970	1.022
2059	Disp 30.8	40	99488	65219	144524	1.016	1.006	1.025	0.999	0.998	0.999	0.945	0.921	0.970
2059	CRM+Disp 9.7	40	103461	67461	150169	1.017	1.006	1.026	1.000	0.999	1.000	0.982	0.957	1.008
2059	CRM+Disp 39.5	40	97969	63871	142788	1.016	1.005	1.025	0.998	0.998	0.999	0.930	0.906	0.954
2064	baseline		114617	72582	171628	1.017	1.007	1.026						
2064	CRM 7.4	45	112900	71443	168502	1.017	1.007	1.026	1.000	0.999	1.000	0.985	0.959	1.011
2064	CRM 8.7	45	112692	71437	169146	1.017	1.007	1.026	1.000	0.999	1.000	0.982	0.956	1.008
2064	Disp 2.3	45	114123	72332	170812	1.017	1.007	1.026	1.000	0.999	1.000	0.995	0.968	1.023
2064	Disp 30.8	45	107591	67750	160792	1.016	1.006	1.025	0.999	0.998	0.999	0.939	0.914	0.965
2064	CRM+Disp 9.7	45	112279	71550	167733	1.017	1.007	1.026	1.000	0.999	1.000	0.980	0.954	1.006
2064	CRM+Disp 39.5	45	105668	66891	158344	1.016	1.006	1.025	0.998	0.998	0.999	0.922	0.897	0.947
2069	baseline		124590	78418	189434	1.017	1.008	1.026						

Year	Scenario	Years from impact	Pop. size median	Pop. size 2.5% quantile	Pop. size 97.5% quantile	Pop. growth rate median	Pop. growth rate LCI	Pop. growth rate UCI	Counter factual of growth rate median	Counter factual of growth rate LCI	Counter factual of growth rate UCI	Counter factual of pop. size median	Counter factual of pop. size LCI	Counter factual of pop. size UCI
2069	CRM 7.4	50	122578	76960	186265	1.017	1.008	1.025	1.000	0.999	1.000	0.983	0.956	1.011
2069	CRM 8.7	50	122150	76470	185821	1.017	1.008	1.025	1.000	0.999	1.000	0.981	0.953	1.008
2069	Disp 2.3	50	123802	77525	188008	1.017	1.008	1.026	1.000	0.999	1.000	0.995	0.967	1.024
2069	Disp 30.8	50	116264	72726	177087	1.016	1.007	1.024	0.999	0.998	0.999	0.932	0.907	0.959
2069	CRM+Disp 9.7	50	121727	76395	185453	1.017	1.008	1.025	1.000	0.999	1.000	0.978	0.951	1.005
2069	CRM+Disp 39.5	50	113823	71258	173454	1.016	1.006	1.024	0.998	0.998	0.999	0.914	0.888	0.940
2074	baseline		135767	84544	212212	1.017	1.009	1.025						
2074	CRM 7.4	55	133387	83099	208621	1.017	1.008	1.025	1.000	0.999	1.000	0.981	0.954	1.010
2074	CRM 8.7	55	132999	82450	208191	1.017	1.008	1.025	1.000	0.999	1.000	0.978	0.952	1.006
2074	Disp 2.3	55	135057	84303	211822	1.017	1.009	1.025	1.000	0.999	1.000	0.994	0.966	1.025
2074	Disp 30.8	55	125694	77973	196972	1.016	1.007	1.024	0.999	0.998	0.999	0.926	0.900	0.953
2074	CRM+Disp 9.7	55	132355	82502	207747	1.017	1.008	1.025	1.000	0.999	1.000	0.976	0.948	1.004
2074	CRM+Disp 39.5	55	123147	76444	193595	1.016	1.007	1.024	0.998	0.998	0.999	0.906	0.880	0.932
2079	baseline		147564	90317	236622	1.017	1.009	1.025						
2079	CRM 7.4	60	144531	88414	232111	1.017	1.009	1.025	1.000	0.999	1.000	0.980	0.952	1.008
2079	CRM 8.7	60	144096	87857	231766	1.017	1.009	1.025	1.000	0.999	1.000	0.976	0.949	1.004
2079	Disp 2.3	60	146579	89625	236661	1.017	1.009	1.025	1.000	0.999	1.000	0.993	0.965	1.024
2079	Disp 30.8	60	135739	82677	218487	1.016	1.008	1.024	0.999	0.998	0.999	0.919	0.893	0.947
2079	CRM+Disp 9.7	60	143682	88158	231125	1.017	1.009	1.025	1.000	0.999	1.000	0.974	0.945	1.002

Year	Scenario	Years from impact	Pop. size median	Pop. size 2.5% quantile	Pop. size 97.5% quantile	Pop. growth rate median	Pop. growth rate LCI	Pop. growth rate UCI	Counter factual of growth rate median	Counter factual of growth rate LCI	Counter factual of growth rate UCI	Counter factual of pop. size median	Counter factual of pop. size LCI	Counter factual of pop. size UCI
2079	CRM+Disp 39.5	60	132520	81145	212917	1.015	1.007	1.023	0.998	0.998	0.999	0.898	0.872	0.925

Table 5.2: Results of Population Viability Analysis for impacts of Round 4 Preferred Projects in-combination with other OWF developments on the gannet population at Flamborough and Filey Coast SPA

Year	Scenario	Years from impact	Pop. size median	Pop. size 2.5% quantile	Pop. size 97.5% quantile	Pop. growth rate median	Pop. growth rate LCI	Pop. growth rate UCI	Counter factual of growth rate median	Counter factual of growth rate LCI	Counter factual of growth rate UCI	Counter factual of pop. size median	Counter factual of pop. size LCI	Counter factual of pop. size UCI
2019	baseline		52993	48748	55869	1.021	0.939	1.076						
2019	CRM 288	0	52294	48020	55169	1.007	0.925	1.063	0.987	0.981	0.992	0.987	0.981	0.992
2019	CRM 290	0	52289	48051	55160	1.007	0.926	1.063	0.987	0.981	0.992	0.987	0.981	0.992
2019	Disp 53.3	0	52865	48647	55732	1.018	0.937	1.074	0.998	0.992	1.003	0.998	0.992	1.003
2019	Disp 71.1	0	52808	48524	55688	1.017	0.935	1.073	0.997	0.991	1.002	0.997	0.991	1.002
2019	CRM+Disp 341.3	0	52159	47935	55041	1.005	0.923	1.060	0.985	0.979	0.990	0.985	0.979	0.990
2019	CRM+Disp 361.1	0	52118	47861	54974	1.004	0.922	1.059	0.984	0.978	0.989	0.984	0.978	0.989
2024	baseline		57800	48641	66351	1.018	0.989	1.042						
2024	CRM 288	5	53515	44842	61504	1.005	0.976	1.029	0.987	0.985	0.989	0.926	0.914	0.936
2024	CRM 290	5	53489	44839	61447	1.005	0.976	1.029	0.987	0.985	0.989	0.925	0.913	0.936
2024	Disp 53.3	5	57013	47951	65450	1.016	0.987	1.039	0.998	0.996	1.000	0.986	0.975	0.997
2024	Disp 71.1	5	56748	47667	65159	1.015	0.986	1.039	0.997	0.995	0.999	0.981	0.970	0.992
2024	CRM+Disp 341.3	5	52751	44165	60608	1.003	0.973	1.026	0.985	0.983	0.987	0.912	0.901	0.923
2024	CRM+Disp 361.1	5	52464	43990	60428	1.002	0.973	1.026	0.984	0.982	0.986	0.908	0.896	0.918
2029	baseline		62751	49997	76006	1.017	0.997	1.035						
2029	CRM 288	10	54419	43065	66054	1.004	0.983	1.022	0.987	0.986	0.989	0.868	0.854	0.881
2029	CRM 290	10	54419	43005	65984	1.004	0.983	1.022	0.987	0.986	0.989	0.867	0.852	0.881
2029	Disp 53.3	10	61099	48568	73916	1.015	0.994	1.033	0.998	0.996	0.999	0.974	0.960	0.990

Year	Scenario	Years from impact	Pop. size median	Pop. size 2.5% quantile	Pop. size 97.5% quantile	Pop. growth rate median	Pop. growth rate LCI	Pop. growth rate UCI	Counter factual of growth rate median	Counter factual of growth rate LCI	Counter factual of growth rate UCI	Counter factual of pop. size median	Counter factual of pop. size LCI	Counter factual of pop. size UCI
2029	Disp 71.1	10	60587	48073	73443	1.014	0.993	1.032	0.997	0.995	0.998	0.966	0.951	0.980
2029	CRM+Disp 341.3	10	52986	41897	64261	1.002	0.981	1.020	0.985	0.983	0.986	0.845	0.831	0.859
2029	CRM+Disp 361.1	10	52510	41530	63766	1.001	0.980	1.019	0.984	0.982	0.985	0.837	0.823	0.851
2034	baseline		68387	52728	86449	1.017	1.001	1.032						
2034	CRM 288	15	55661	42652	70547	1.004	0.988	1.019	0.987	0.986	0.988	0.814	0.798	0.829
2034	CRM 290	15	55526	42503	70494	1.004	0.988	1.019	0.987	0.986	0.988	0.812	0.797	0.828
2034	Disp 53.3	15	65903	50555	83176	1.015	0.998	1.030	0.998	0.997	0.999	0.963	0.946	0.980
2034	Disp 71.1	15	65056	49953	82160	1.014	0.998	1.029	0.997	0.996	0.998	0.951	0.934	0.968
2034	CRM+Disp 341.3	15	53584	40901	67869	1.002	0.985	1.017	0.985	0.984	0.986	0.783	0.767	0.798
2034	CRM+Disp 361.1	15	52802	40348	66893	1.001	0.984	1.016	0.984	0.983	0.985	0.772	0.756	0.787
2039	baseline		74636	55343	97904	1.017	1.003	1.031						
2039	CRM 288	20	56928	42075	74852	1.004	0.990	1.018	0.987	0.986	0.988	0.763	0.746	0.779
2039	CRM 290	20	56744	41816	74761	1.004	0.990	1.018	0.987	0.986	0.988	0.761	0.745	0.778
2039	Disp 53.3	20	71001	52569	93074	1.015	1.001	1.028	0.998	0.997	0.999	0.951	0.932	0.971
2039	Disp 71.1	20	69745	51670	91785	1.014	1.000	1.028	0.997	0.996	0.998	0.936	0.917	0.955
2039	CRM+Disp 341.3	20	54143	39924	71261	1.002	0.988	1.015	0.985	0.984	0.986	0.725	0.710	0.741
2039	CRM+Disp 361.1	20	53098	39150	69970	1.001	0.987	1.014	0.984	0.983	0.985	0.712	0.696	0.727
2044	baseline		81141	58762	110023	1.017	1.005	1.029						

Year	Scenario	Years from impact	Pop. size median	Pop. size 2.5% quantile	Pop. size 97.5% quantile	Pop. growth rate median	Pop. growth rate LCI	Pop. growth rate UCI	Counter factual of growth rate median	Counter factual of growth rate LCI	Counter factual of growth rate UCI	Counter factual of pop. size median	Counter factual of pop. size LCI	Counter factual of pop. size UCI
2044	CRM 288	25	58050	41743	78865	1.004	0.992	1.016	0.987	0.986	0.988	0.715	0.698	0.732
2044	CRM 290	25	57950	41667	78947	1.004	0.992	1.016	0.987	0.986	0.988	0.714	0.697	0.730
2044	Disp 53.3	25	76305	55118	103379	1.015	1.002	1.027	0.998	0.997	0.998	0.940	0.920	0.961
2044	Disp 71.1	25	74756	54008	101256	1.014	1.002	1.026	0.997	0.996	0.998	0.921	0.901	0.942
2044	CRM+Disp 341.3	25	54521	39039	74383	1.002	0.989	1.014	0.985	0.984	0.986	0.672	0.655	0.688
2044	CRM+Disp 361.1	25	53237	38382	72432	1.001	0.988	1.013	0.984	0.983	0.985	0.656	0.640	0.672
2049	baseline		88601	61715	122731	1.017	1.006	1.028						
2049	CRM 288	30	59357	41117	82920	1.004	0.993	1.015	0.987	0.986	0.988	0.671	0.653	0.687
2049	CRM 290	30	59183	41017	82768	1.004	0.992	1.015	0.987	0.986	0.988	0.669	0.651	0.686
2049	Disp 53.3	30	82261	57363	114552	1.015	1.003	1.026	0.998	0.997	0.998	0.929	0.907	0.952
2049	Disp 71.1	30	80229	55683	111343	1.014	1.002	1.025	0.997	0.996	0.998	0.907	0.885	0.928
2049	CRM+Disp 341.3	30	55115	37912	77333	1.002	0.990	1.013	0.985	0.984	0.986	0.622	0.606	0.639
2049	CRM+Disp 361.1	30	53604	37229	74780	1.001	0.989	1.012	0.984	0.983	0.985	0.605	0.589	0.621
2054	baseline		96523	65475	136773	1.017	1.006	1.027						
2054	CRM 288	35	60617	40815	86345	1.004	0.993	1.014	0.987	0.986	0.988	0.629	0.612	0.646
2054	CRM 290	35	60436	40942	86346	1.004	0.993	1.014	0.987	0.986	0.988	0.627	0.610	0.643
2054	Disp 53.3	35	88597	60039	125578	1.015	1.004	1.025	0.998	0.997	0.998	0.918	0.895	0.941
2054	Disp 71.1	35	86022	58278	121907	1.014	1.003	1.024	0.997	0.996	0.998	0.892	0.869	0.915
2054	CRM+Disp 341.3	35	55556	37400	79346	1.002	0.991	1.012	0.985	0.984	0.986	0.576	0.560	0.592

Year	Scenario	Years from impact	Pop. size median	Pop. size 2.5% quantile	Pop. size 97.5% quantile	Pop. growth rate median	Pop. growth rate LCI	Pop. growth rate UCI	Counter factual of growth rate median	Counter factual of growth rate LCI	Counter factual of growth rate UCI	Counter factual of pop. size median	Counter factual of pop. size LCI	Counter factual of pop. size UCI
2054	CRM+Disp 361.1	35	53855	36223	76962	1.001	0.990	1.011	0.984	0.983	0.985	0.558	0.542	0.574
2059	baseline		105348	68834	153091	1.017	1.007	1.027						
2059	CRM 288	40	62098	40239	90663	1.004	0.994	1.014	0.987	0.986	0.988	0.590	0.572	0.606
2059	CRM 290	40	61872	40063	90449	1.004	0.994	1.014	0.987	0.986	0.988	0.587	0.570	0.604
2059	Disp 53.3	40	95656	62302	138489	1.015	1.004	1.024	0.998	0.997	0.998	0.907	0.884	0.932
2059	Disp 71.1	40	92573	60444	134483	1.014	1.004	1.023	0.997	0.996	0.997	0.878	0.855	0.902
2059	CRM+Disp 341.3	40	56271	36405	82348	1.002	0.991	1.011	0.985	0.984	0.986	0.534	0.518	0.550
2059	CRM+Disp 361.1	40	54180	35222	79451	1.001	0.991	1.010	0.984	0.983	0.985	0.515	0.499	0.530
2064	baseline		114617	72582	171628	1.017	1.007	1.026						
2064	CRM 288	45	63293	39715	95431	1.004	0.994	1.013	0.987	0.987	0.988	0.553	0.535	0.569
2064	CRM 290	45	63029	39662	94929	1.004	0.994	1.013	0.987	0.986	0.988	0.550	0.534	0.566
2064	Disp 53.3	45	102837	65338	153786	1.015	1.005	1.024	0.998	0.997	0.998	0.897	0.873	0.921
2064	Disp 71.1	45	99226	62562	148356	1.014	1.004	1.023	0.997	0.996	0.997	0.864	0.840	0.889
2064	CRM+Disp 341.3	45	56750	35649	85457	1.002	0.992	1.011	0.985	0.984	0.985	0.495	0.479	0.510
2064	CRM+Disp 361.1	45	54431	34121	82146	1.001	0.991	1.010	0.984	0.983	0.985	0.475	0.459	0.489
2069	baseline		124590	78418	189434	1.017	1.008	1.026						
2069	CRM 288	50	64605	40178	98513	1.004	0.995	1.013	0.987	0.987	0.988	0.518	0.501	0.534
2069	CRM 290	50	64352	40018	98377	1.004	0.995	1.013	0.987	0.986	0.988	0.516	0.499	0.532
2069	Disp 53.3	50	110408	69209	167883	1.015	1.006	1.023	0.998	0.997	0.998	0.886	0.861	0.911

Year	Scenario	Years from impact	Pop. size median	Pop. size 2.5% quantile	Pop. size 97.5% quantile	Pop. growth rate median	Pop. growth rate LCI	Pop. growth rate UCI	Counter factual of growth rate median	Counter factual of growth rate LCI	Counter factual of growth rate UCI	Counter factual of pop. size median	Counter factual of pop. size LCI	Counter factual of pop. size UCI
2069	Disp 71.1	50	106028	66610	161808	1.014	1.005	1.023	0.997	0.996	0.997	0.851	0.826	0.875
2069	CRM+Disp 341.3	50	57052	35626	87848	1.002	0.993	1.010	0.985	0.984	0.985	0.458	0.443	0.473
2069	CRM+Disp 361.1	50	54514	33998	83627	1.001	0.992	1.009	0.984	0.983	0.985	0.438	0.423	0.452
2074	baseline		135767	84544	212212	1.017	1.009	1.025						
2074	CRM 288	55	66069	40731	103993	1.004	0.996	1.012	0.987	0.987	0.988	0.486	0.470	0.502
2074	CRM 290	55	65667	40331	103614	1.004	0.996	1.012	0.987	0.987	0.988	0.483	0.468	0.499
2074	Disp 53.3	55	119106	73891	186744	1.015	1.006	1.023	0.998	0.997	0.998	0.876	0.850	0.901
2074	Disp 71.1	55	113820	70641	178639	1.014	1.006	1.022	0.997	0.996	0.997	0.837	0.812	0.862
2074	CRM+Disp 341.3	55	57657	35482	91109	1.002	0.993	1.010	0.985	0.984	0.985	0.425	0.410	0.439
2074	CRM+Disp 361.1	55	54894	33834	86441	1.001	0.992	1.009	0.984	0.983	0.985	0.404	0.389	0.417
2079	baseline		147564	90317	236622	1.017	1.009	1.025						
2079	CRM 288	60	67178	40578	108404	1.004	0.996	1.012	0.987	0.987	0.988	0.455	0.440	0.471
2079	CRM 290	60	66818	40612	108769	1.004	0.996	1.012	0.987	0.987	0.988	0.453	0.437	0.468
2079	Disp 53.3	60	127872	77936	204992	1.015	1.007	1.023	0.998	0.997	0.998	0.865	0.839	0.891
2079	Disp 71.1	60	121820	74235	196869	1.014	1.006	1.022	0.997	0.996	0.997	0.824	0.799	0.849
2079	CRM+Disp 341.3	60	58143	34887	94120	1.002	0.994	1.010	0.985	0.984	0.985	0.393	0.379	0.407
2079	CRM+Disp 361.1	60	54926	33292	89151	1.001	0.993	1.009	0.984	0.983	0.984	0.372	0.359	0.385

Kittiwake

Table 5.3: Results of Population Viability Analysis for impacts of Round 4 Preferred Projects alone on the kittiwake at Flamborough and Filey Coast SPA

Year	Scenario	Years from impact	Pop. size median	Pop. size 2.5% quantile	Pop. size 97.5% quantile	Pop. growth rate median	Pop. growth rate LCI	Pop. growth rate UCI	Counter factual of growth rate median	Counter factual of growth rate LCI	Counter factual of growth rate UCI	Counter factual of pop. size median	Counter factual of pop. size LCI	Counter factual of pop. size UCI
2018	baseline		215699	183155	248597	1.020	0.866	1.175						
2018	CRM 37.9	0	215583	183118	248390	1.019	0.866	1.174	1.000	0.996	1.003	1.000	0.996	1.003
2018	CRM 43.4	0	215612	183014	248277	1.019	0.865	1.174	1.000	0.996	1.003	1.000	0.996	1.003
2023	baseline		238153	168512	315659	1.020	0.963	1.069						
2023	CRM 37.9	5	237614	167890	314973	1.020	0.962	1.069	1.000	0.998	1.001	0.997	0.990	1.005
2023	CRM 43.4	5	237443	167824	314660	1.019	0.962	1.068	0.999	0.998	1.001	0.997	0.990	1.004
2028	baseline		260280	166912	383508	1.019	0.979	1.056						
2028	CRM 37.9	10	259137	166038	381946	1.019	0.978	1.055	1.000	0.999	1.000	0.995	0.986	1.004
2028	CRM 43.4	10	259035	165886	381647	1.019	0.978	1.055	0.999	0.999	1.000	0.994	0.985	1.004
2033	baseline		286898	167722	461263	1.019	0.986	1.050						
2033	CRM 37.9	15	284615	166706	459169	1.019	0.985	1.050	1.000	0.999	1.000	0.993	0.982	1.004
2033	CRM 43.4	15	284658	166266	458550	1.019	0.985	1.050	0.999	0.999	1.000	0.992	0.981	1.003
2038	baseline		313665	171849	551187	1.019	0.990	1.047						
2038	CRM 37.9	20	310770	170338	546566	1.018	0.990	1.046	1.000	0.999	1.000	0.991	0.978	1.003
2038	CRM 43.4	20	310334	170420	545210	1.018	0.990	1.046	0.999	0.999	1.000	0.989	0.977	1.002
2043	baseline		343592	179655	647903	1.019	0.994	1.044						
2043	CRM 37.9	25	339482	176356	644841	1.018	0.993	1.044	1.000	0.999	1.000	0.989	0.975	1.002
2043	CRM 43.4	25	339202	176267	642210	1.018	0.993	1.044	0.999	0.999	1.000	0.987	0.973	1.000
2048	baseline		379836	179614	756043	1.019	0.995	1.042						

Year	Scenario	Years from impact	Pop. size median	Pop. size 2.5% quantile	Pop. size 97.5% quantile	Pop. growth rate median	Pop. growth rate LCI	Pop. growth rate UCI	Counter factual of growth rate median	Counter factual of growth rate LCI	Counter factual of growth rate UCI	Counter factual of pop. size median	Counter factual of pop. size LCI	Counter factual of pop. size UCI
2048	CRM 37.9	30	375568	177480	747726	1.019	0.994	1.042	1.000	0.999	1.000	0.987	0.972	1.001
2048	CRM 43.4	30	373957	176534	743385	1.019	0.994	1.041	0.999	0.999	1.000	0.985	0.970	0.999
2053	baseline		418919	190333	860404	1.019	0.997	1.040						
2053	CRM 37.9	35	412354	186925	848633	1.019	0.997	1.039	1.000	0.999	1.000	0.984	0.969	0.999
2053	CRM 43.4	35	411440	186866	846306	1.019	0.997	1.039	1.000	0.999	1.000	0.982	0.967	0.997
2058	baseline		460529	201499	1001147	1.019	0.999	1.039						
2058	CRM 37.9	40	452900	198064	982620	1.019	0.998	1.038	1.000	0.999	1.000	0.982	0.966	0.998
2058	CRM 43.4	40	451540	197529	978129	1.019	0.998	1.038	1.000	0.999	1.000	0.980	0.964	0.995
2063	baseline		507190	210839	1157087	1.019	1.000	1.038						
2063	CRM 37.9	45	497128	206386	1137692	1.019	0.999	1.037	1.000	0.999	1.000	0.980	0.964	0.996
2063	CRM 43.4	45	495392	205133	1131970	1.019	0.999	1.037	1.000	0.999	1.000	0.977	0.961	0.994
2068	baseline		555153	216025	1326005	1.019	1.000	1.037						
2068	CRM 37.9	50	543469	211427	1299369	1.019	1.000	1.036	1.000	0.999	1.000	0.978	0.961	0.994
2068	CRM 43.4	50	541372	208910	1298844	1.019	1.000	1.036	1.000	0.999	1.000	0.975	0.958	0.992
2073	baseline		608505	229523	1528652	1.019	1.001	1.036						
2073	CRM 37.9	55	594911	223219	1485398	1.019	1.001	1.035	1.000	0.999	1.000	0.976	0.958	0.993
2073	CRM 43.4	55	593889	222299	1488725	1.019	1.001	1.035	1.000	0.999	1.000	0.973	0.955	0.990
2078	baseline		668649	243321	1747176	1.019	1.002	1.035						
2078	CRM 37.9	60	650317	235522	1701621	1.019	1.002	1.035	1.000	0.999	1.000	0.974	0.956	0.991
2078	CRM 43.4	60	647591	234650	1690925	1.019	1.002	1.035	0.999	0.999	1.000	0.970	0.952	0.988

Table 5.4: Results of Population Viability Analysis for impacts of Round 4 Preferred Projects in-combination with other OWF developments on the kittiwake population at Flamborough and Filey Coast SPA

Year	Scenario	Years from impact	Pop. size median	Pop. size 2.5% quantile	Pop. size 97.5% quantile	Pop. growth rate median	Pop. growth rate LCI	Pop. growth rate UCI	Counter factual of growth rate median	Counter factual of growth rate LCI	Counter factual of growth rate UCI	Counter factual of pop. size median	Counter factual of pop. size LCI	Counter factual of pop. size UCI
2018	baseline		215699	183155	248597	1.020	0.866	1.175						
2018	CRM 557	0	214330	181949	246794	1.013	0.860	1.167	0.994	0.990	0.997	0.994	0.990	0.997
2018	CRM 563	0	214298	181799	246790	1.013	0.859	1.167	0.994	0.990	0.997	0.994	0.990	0.997
2023	baseline		238153	168512	315659	1.020	0.963	1.069						
2023	CRM 557	5	229235	161559	303968	1.013	0.956	1.062	0.994	0.992	0.995	0.962	0.955	0.969
2023	CRM 563	5	229192	161791	303891	1.013	0.956	1.062	0.994	0.992	0.995	0.962	0.954	0.969
2028	baseline		260280	166912	383508	1.019	0.979	1.056						
2028	CRM 557	10	242553	154867	357909	1.013	0.972	1.049	0.994	0.993	0.994	0.932	0.922	0.941
2028	CRM 563	10	242337	155004	358022	1.012	0.972	1.049	0.994	0.993	0.994	0.931	0.922	0.940
2033	baseline		286898	167722	461263	1.019	0.986	1.050						
2033	CRM 557	15	258904	151178	417878	1.013	0.979	1.043	0.994	0.993	0.994	0.902	0.891	0.912
2033	CRM 563	15	258492	150596	417183	1.013	0.979	1.043	0.994	0.993	0.994	0.901	0.890	0.912
2038	baseline		313665	171849	551187	1.019	0.990	1.047						
2038	CRM 557	20	273980	149836	484156	1.012	0.984	1.040	0.994	0.993	0.994	0.874	0.862	0.885
2038	CRM 563	20	273610	149819	481575	1.012	0.984	1.040	0.994	0.993	0.994	0.872	0.860	0.884
2043	baseline		343592	179655	647903	1.019	0.994	1.044						
2043	CRM 557	25	290629	151046	551923	1.012	0.987	1.038	0.994	0.993	0.994	0.846	0.834	0.858
2043	CRM 563	25	290187	150295	551745	1.012	0.987	1.038	0.994	0.993	0.994	0.845	0.832	0.856
2048	baseline		379836	179614	756043	1.019	0.995	1.042						
2048	CRM 557	30	311231	146599	620703	1.013	0.988	1.035	0.994	0.993	0.994	0.820	0.806	0.832
2048	CRM 563	30	310804	146493	618409	1.012	0.988	1.035	0.994	0.993	0.994	0.818	0.804	0.830

Year	Scenario	Years from impact	Pop. size median	Pop. size 2.5% quantile	Pop. size 97.5% quantile	Pop. growth rate median	Pop. growth rate LCI	Pop. growth rate UCI	Counter factual of growth rate median	Counter factual of growth rate LCI	Counter factual of growth rate UCI	Counter factual of pop. size median	Counter factual of pop. size LCI	Counter factual of pop. size UCI
2053	baseline		418919	190333	860404	1.019	0.997	1.040						
2053	CRM 557	35	332743	150239	685311	1.013	0.991	1.033	0.994	0.993	0.994	0.794	0.780	0.806
2053	CRM 563	35	331599	149992	683343	1.013	0.990	1.033	0.994	0.993	0.994	0.792	0.778	0.804
2058	baseline		460529	201499	1001147	1.019	0.999	1.039						
2058	CRM 557	40	353580	153719	770836	1.013	0.992	1.032	0.994	0.993	0.994	0.769	0.755	0.781
2058	CRM 563	40	352932	153735	769177	1.013	0.992	1.032	0.994	0.993	0.994	0.766	0.752	0.779
2063	baseline		507190	210839	1157087	1.019	1.000	1.038						
2063	CRM 557	45	376411	156982	864286	1.013	0.994	1.031	0.994	0.993	0.994	0.744	0.730	0.757
2063	CRM 563	45	376482	155844	860970	1.013	0.993	1.031	0.994	0.993	0.994	0.742	0.728	0.754
2068	baseline		555153	216025	1326005	1.019	1.000	1.037						
2068	CRM 557	50	400216	154395	958277	1.013	0.994	1.030	0.994	0.993	0.994	0.721	0.707	0.734
2068	CRM 563	50	398273	154424	957690	1.012	0.994	1.030	0.994	0.993	0.994	0.718	0.704	0.731
2073	baseline		608505	229523	1528652	1.019	1.001	1.036						
2073	CRM 557	55	425559	159381	1069923	1.013	0.995	1.029	0.994	0.993	0.994	0.698	0.684	0.711
2073	CRM 563	55	423547	158965	1064661	1.012	0.995	1.029	0.994	0.993	0.994	0.695	0.681	0.708
2078	baseline		668649	243321	1747176	1.019	1.002	1.035						
2078	CRM 557	60	451458	163657	1184677	1.013	0.996	1.029	0.994	0.993	0.994	0.676	0.661	0.688
2078	CRM 563	60	449214	162577	1181166	1.012	0.996	1.029	0.994	0.993	0.994	0.673	0.659	0.686

Guillemot

Table 5.5: Results of Population Viability Analysis for impacts of Round 4 Preferred Projects alone on the guillemot at Flamborough and Filey Coast SPA

Year	Scenario	Years from impact	Pop. size median	Pop. size 2.5% quantile	Pop. size 97.5% quantile	Pop. growth rate median	Pop. growth rate LCI	Pop. growth rate UCI	Counter factual of growth rate median	Counter factual of growth rate LCI	Counter factual of growth rate UCI	Counter factual of pop. size median	Counter factual of pop. size LCI	Counter factual of pop. size UCI
2018	baseline		255259	237733	270894	1.039	0.968	1.103						
2018	Disp 19.1	0	255220	237578	270785	1.039	0.967	1.103	1.000	0.998	1.002	1.000	0.998	1.002
2023	baseline		309061	270063	346750	1.039	1.016	1.059						
2023	Disp 19.1	5	308662	269844	346226	1.039	1.016	1.059	1.000	0.999	1.001	0.999	0.995	1.003
2028	baseline		374073	313243	439577	1.039	1.022	1.054						
2028	Disp 19.1	10	373334	312639	438478	1.039	1.022	1.054	1.000	0.999	1.000	0.998	0.992	1.004
2033	baseline		453860	367116	552099	1.039	1.025	1.052						
2033	Disp 19.1	15	452450	366034	550487	1.039	1.025	1.052	1.000	0.999	1.000	0.997	0.991	1.004
2038	baseline		549656	432703	684554	1.039	1.027	1.050						
2038	Disp 19.1	20	548204	431187	681008	1.039	1.027	1.050	1.000	0.999	1.000	0.996	0.989	1.003
2043	baseline		665345	513328	850026	1.039	1.029	1.049						
2043	Disp 19.1	25	662018	510409	845768	1.039	1.029	1.049	1.000	1.000	1.000	0.995	0.988	1.003
2048	baseline		807381	608991	1053450	1.039	1.030	1.048						
2048	Disp 19.1	30	802752	605633	1048153	1.039	1.030	1.048	1.000	1.000	1.000	0.995	0.987	1.002
2053	baseline		979359	721024	1310840	1.039	1.030	1.048						
2053	Disp 19.1	35	973124	716842	1301259	1.039	1.030	1.047	1.000	1.000	1.000	0.994	0.986	1.002
2058	baseline		1185207	848594	1615498	1.039	1.031	1.047						
2058	Disp 19.1	40	1176867	842641	1600933	1.039	1.031	1.047	1.000	1.000	1.000	0.993	0.985	1.001
2063	baseline		1436965	1021651	1985878	1.039	1.031	1.046						

Year	Scenario	Years from impact	Pop. size median	Pop. size 2.5% quantile	Pop. size 97.5% quantile	Pop. growth rate median	Pop. growth rate LCI	Pop. growth rate UCI	Counter factual of growth rate median	Counter factual of growth rate LCI	Counter factual of growth rate UCI	Counter factual of pop. size median	Counter factual of pop. size LCI	Counter factual of pop. size UCI
2063	Disp 19.1	45	1424482	1011731	1967846	1.039	1.031	1.046	1.000	1.000	1.000	0.992	0.983	1.000
2068	baseline		1733159	1201147	2467644	1.039	1.032	1.046						
2068	Disp 19.1	50	1717346	1190278	2442344	1.039	1.031	1.046	1.000	1.000	1.000	0.991	0.982	1.000
2073	baseline		2102581	1432914	3023851	1.039	1.032	1.046						
2073	Disp 19.1	55	2079792	1420831	3005485	1.039	1.032	1.046	1.000	1.000	1.000	0.990	0.981	0.999
2078	baseline		2540785	1714544	3765601	1.039	1.032	1.046						
2078	Disp 19.1	60	2514237	1700419	3724244	1.039	1.032	1.046	1.000	1.000	1.000	0.989	0.980	0.998

Table 5.6: Results of Population Viability Analysis for impacts of Round 4 Preferred Projects in-combination with other OWF developments on the guillemot population at Flamborough and Filey Coast SPA

Year	Scenario	Years from impact	Pop. size median	Pop. size 2.5% quantile	Pop. size 97.5% quantile	Pop. growth rate median	Pop. growth rate LCI	Pop. growth rate UCI	Counter factual of growth rate median	Counter factual of growth rate LCI	Counter factual of growth rate UCI	Counter factual of pop. size median	Counter factual of pop. size LCI	Counter factual of pop. size UCI
2018	baseline		255259	237733	270894	1.039	0.968	1.103						
2018	Disp 520	0	254066	236455	269545	1.035	0.963	1.098	0.995	0.993	0.997	0.995	0.993	0.997
2023	baseline		309061	270063	346750	1.039	1.016	1.059						
2023	Disp 520	5	300210	261951	336992	1.034	1.011	1.054	0.995	0.994	0.996	0.972	0.967	0.976
2028	baseline		374073	313243	439577	1.039	1.022	1.054						
2028	Disp 520	10	354735	297026	417170	1.034	1.017	1.049	0.995	0.995	0.996	0.948	0.943	0.954
2033	baseline		453860	367116	552099	1.039	1.025	1.052						
2033	Disp 520	15	420473	339739	511573	1.034	1.020	1.047	0.995	0.995	0.996	0.926	0.920	0.932
2038	baseline		549656	432703	684554	1.039	1.027	1.050						
2038	Disp 520	20	497165	391469	618632	1.034	1.022	1.045	0.995	0.995	0.996	0.904	0.897	0.910
2043	baseline		665345	513328	850026	1.039	1.029	1.049						
2043	Disp 520	25	586907	452745	750314	1.034	1.024	1.044	0.995	0.995	0.995	0.882	0.875	0.889
2048	baseline		807381	608991	1053450	1.039	1.030	1.048						
2048	Disp 520	30	694688	523309	907409	1.034	1.025	1.043	0.995	0.995	0.995	0.861	0.854	0.868
2053	baseline		979359	721024	1310840	1.039	1.030	1.048						
2053	Disp 520	35	823125	603308	1103090	1.034	1.025	1.043	0.995	0.995	0.995	0.841	0.833	0.848
2058	baseline		1185207	848594	1615498	1.039	1.031	1.047						
2058	Disp 520	40	972544	695977	1328107	1.034	1.026	1.042	0.995	0.995	0.995	0.821	0.813	0.828
2063	baseline		1436965	1021651	1985878	1.039	1.031	1.046						
2063	Disp 520	45	1150245	817026	1595149	1.034	1.026	1.042	0.995	0.995	0.995	0.801	0.794	0.808
2068	baseline		1733159	1201147	2467644	1.039	1.032	1.046						

Year	Scenario	Years from impact	Pop. size median	Pop. size 2.5% quantile	Pop. size 97.5% quantile	Pop. growth rate median	Pop. growth rate LCI	Pop. growth rate UCI	Counter factual of growth rate median	Counter factual of growth rate LCI	Counter factual of growth rate UCI	Counter factual of pop. size median	Counter factual of pop. size LCI	Counter factual of pop. size UCI
2068	Disp 520	50	1353846	941124	1930352	1.034	1.027	1.041	0.995	0.995	0.995	0.782	0.775	0.789
2073	baseline		2102581	1432914	3023851	1.039	1.032	1.046						
2073	Disp 520	55	1602848	1091502	2317599	1.034	1.027	1.041	0.995	0.995	0.995	0.763	0.756	0.771
2078	baseline		2540785	1714544	3765601	1.039	1.032	1.046						
2078	Disp 520	60	1893806	1276050	2801661	1.034	1.027	1.041	0.995	0.995	0.995	0.745	0.738	0.752

Puffin

Table 5.7: Results of Population Viability Analysis for impacts of Round 4 Preferred Projects alone on the puffin population at Flamborough and Filey Coast SPA

Year	Scenario	Years from impact	Pop. size median	Pop. size 2.5% quantile	Pop. size 97.5% quantile	Pop. growth rate median	Pop. growth rate LCI	Pop. growth rate UCI	Counter factual of growth rate median	Counter factual of growth rate LCI	Counter factual of growth rate UCI	Counter factual of pop. size median	Counter factual of pop. size LCI	Counter factual of pop. size UCI
2019	baseline		6748	5557	7640	0.984	0.810	1.114						
2019	Disp 0.5	0	6744	5552	7644	0.983	0.809	1.114	1.000	0.983	1.017	1.000	0.983	1.017
2019	Disp 4.5	0	6737	5532	7642	0.982	0.806	1.114	0.999	0.982	1.015	0.999	0.982	1.015
2024	baseline		6095	3912	8186	0.981	0.911	1.030						
2024	Disp 0.5	5	6085	3918	8192	0.980	0.911	1.030	1.000	0.993	1.006	0.999	0.961	1.038
2024	Disp 4.5	5	6041	3877	8119	0.979	0.909	1.029	0.999	0.992	1.005	0.991	0.953	1.029
2029	baseline		5404	3036	8153	0.979	0.929	1.016						
2029	Disp 0.5	10	5386	3042	8151	0.978	0.929	1.016	1.000	0.995	1.005	0.999	0.946	1.051
2029	Disp 4.5	10	5308	2991	8093	0.977	0.927	1.015	0.998	0.994	1.003	0.983	0.934	1.035
2034	baseline		4806	2530	8107	0.978	0.940	1.011						
2034	Disp 0.5	15	4797	2528	8073	0.978	0.940	1.010	1.000	0.996	1.004	0.998	0.933	1.064
2034	Disp 4.5	15	4681	2468	7883	0.976	0.938	1.009	0.999	0.994	1.002	0.977	0.914	1.039
2039	baseline		4278	2135	7760	0.978	0.946	1.006						
2039	Disp 0.5	20	4277	2095	7845	0.978	0.945	1.006	1.000	0.996	1.003	0.997	0.923	1.074
2039	Disp 4.5	20	4140	2031	7603	0.976	0.944	1.005	0.998	0.995	1.002	0.969	0.897	1.045
2044	baseline		3821	1747	7573	0.978	0.949	1.004						
2044	Disp 0.5	25	3804	1744	7539	0.978	0.949	1.004	1.000	0.996	1.003	0.996	0.910	1.086
2044	Disp 4.5	25	3668	1675	7301	0.976	0.947	1.002	0.999	0.995	1.002	0.962	0.880	1.050
2049	baseline		3431	1473	7158	0.978	0.952	1.001						

Year	Scenario	Years from impact	Pop. size median	Pop. size 2.5% quantile	Pop. size 97.5% quantile	Pop. growth rate median	Pop. growth rate LCI	Pop. growth rate UCI	Counter factual of growth rate median	Counter factual of growth rate LCI	Counter factual of growth rate UCI	Counter factual of pop. size median	Counter factual of pop. size LCI	Counter factual of pop. size UCI
2049	Disp 0.5	30	3421	1458	7118	0.978	0.951	1.001	1.000	0.996	1.003	0.995	0.897	1.099
2049	Disp 4.5	30	3276	1378	6876	0.976	0.950	1.000	0.998	0.995	1.002	0.954	0.862	1.058
2054	baseline		3058	1196	6709	0.978	0.953	0.999						
2054	Disp 0.5	35	3036	1201	6631	0.978	0.953	0.999	1.000	0.997	1.003	0.994	0.887	1.111
2054	Disp 4.5	35	2894	1131	6313	0.976	0.951	0.998	0.998	0.995	1.002	0.946	0.847	1.059
2059	baseline		2749	988	6395	0.978	0.954	0.998						
2059	Disp 0.5	40	2704	979	6312	0.978	0.954	0.998	1.000	0.997	1.003	0.994	0.878	1.124
2059	Disp 4.5	40	2570	942	6100	0.976	0.953	0.997	0.999	0.995	1.002	0.940	0.831	1.065
2064	baseline		2440	815	5877	0.978	0.955	0.997						
2064	Disp 0.5	45	2408	815	5937	0.977	0.955	0.997	1.000	0.997	1.003	0.993	0.866	1.139
2064	Disp 4.5	45	2279	774	5587	0.976	0.954	0.996	0.999	0.996	1.002	0.934	0.814	1.072
2069	baseline		2173	697	5580	0.978	0.956	0.996						
2069	Disp 0.5	50	2155	695	5587	0.978	0.956	0.996	1.000	0.997	1.003	0.991	0.855	1.154
2069	Disp 4.5	50	2011	660	5125	0.976	0.955	0.994	0.999	0.996	1.001	0.927	0.798	1.077
2074	baseline		1939	613	5293	0.978	0.958	0.995						
2074	Disp 0.5	55	1924	615	5330	0.978	0.958	0.996	1.000	0.997	1.003	0.990	0.842	1.168
2074	Disp 4.5	55	1777	566	4941	0.976	0.956	0.994	0.999	0.996	1.001	0.920	0.778	1.083
2079	baseline		1724	516	5032	0.978	0.958	0.995						
2079	Disp 0.5	60	1702	513	4986	0.977	0.958	0.995	1.000	0.997	1.003	0.991	0.829	1.178
2079	Disp 4.5	60	1580	472	4583	0.976	0.957	0.993	0.998	0.996	1.001	0.912	0.762	1.090

Table 5.8: Results of Population Viability Analysis for impacts of Round 4 Preferred Projects in-combination with other OWF developments on the puffin population at Flamborough and Filey Coast SPA

Year	Scenario	Years from impact	Pop. size median	Pop. size 2.5% quantile	Pop. size 97.5% quantile	Pop. growth rate median	Pop. growth rate LCI	Pop. growth rate UCI	Counter factual of growth rate median	Counter factual of growth rate LCI	Counter factual of growth rate UCI	Counter factual of pop. size median	Counter factual of pop. size LCI	Counter factual of pop. size UCI
2019	baseline		6748	5557	7640	0.984	0.810	1.114						
2019	Disp 6	0	6730	5538	7626	0.981	0.807	1.112	0.998	0.982	1.015	0.998	0.982	1.015
2019	Disp 36	0	6666	5465	7556	0.972	0.797	1.102	0.988	0.971	1.004	0.988	0.971	1.004
2024	baseline		6095	3912	8186	0.981	0.911	1.030						
2024	Disp 6	5	6013	3875	8092	0.978	0.909	1.028	0.998	0.992	1.004	0.988	0.950	1.026
2024	Disp 36	5	5676	3613	7636	0.969	0.899	1.018	0.988	0.981	0.994	0.931	0.892	0.967
2029	baseline		5404	3036	8153	0.979	0.929	1.016						
2029	Disp 6	10	5282	2971	7983	0.977	0.927	1.014	0.998	0.993	1.003	0.978	0.927	1.031
2029	Disp 36	10	4724	2652	7231	0.967	0.917	1.005	0.988	0.983	0.993	0.876	0.828	0.924
2034	baseline		4806	2530	8107	0.978	0.940	1.011						
2034	Disp 6	15	4660	2471	7848	0.976	0.938	1.008	0.998	0.994	1.002	0.968	0.907	1.034
2034	Disp 36	15	3971	2065	6786	0.966	0.928	0.999	0.988	0.984	0.992	0.826	0.767	0.881
2039	baseline		4278	2135	7760	0.978	0.946	1.006						
2039	Disp 6	20	4101	2024	7510	0.976	0.944	1.004	0.998	0.994	1.002	0.958	0.886	1.034
2039	Disp 36	20	3333	1618	6150	0.966	0.934	0.995	0.988	0.984	0.992	0.779	0.716	0.840
2044	baseline		3821	1747	7573	0.978	0.949	1.004						
2044	Disp 6	25	3626	1659	7218	0.976	0.947	1.002	0.998	0.995	1.001	0.949	0.867	1.036
2044	Disp 36	25	2797	1247	5607	0.966	0.937	0.992	0.988	0.984	0.992	0.733	0.665	0.803
2049	baseline		3431	1473	7158	0.978	0.952	1.001						
2049	Disp 6	30	3222	1362	6779	0.976	0.949	1.000	0.998	0.995	1.001	0.939	0.850	1.037
2049	Disp 36	30	2367	988	5019	0.966	0.939	0.990	0.988	0.985	0.991	0.690	0.617	0.767

Year	Scenario	Years from impact	Pop. size median	Pop. size 2.5% quantile	Pop. size 97.5% quantile	Pop. growth rate median	Pop. growth rate LCI	Pop. growth rate UCI	Counter factual of growth rate median	Counter factual of growth rate LCI	Counter factual of growth rate UCI	Counter factual of pop. size median	Counter factual of pop. size LCI	Counter factual of pop. size UCI
2054	baseline		3058	1196	6709	0.978	0.953	0.999						
2054	Disp 6	35	2837	1114	6281	0.976	0.951	0.998	0.998	0.995	1.001	0.930	0.830	1.038
2054	Disp 36	35	1978	763	4419	0.966	0.941	0.988	0.988	0.985	0.991	0.650	0.574	0.730
2059	baseline		2749	988	6395	0.978	0.954	0.998						
2059	Disp 6	40	2508	919	5972	0.976	0.952	0.997	0.998	0.995	1.001	0.922	0.810	1.038
2059	Disp 36	40	1673	586	3975	0.966	0.942	0.987	0.988	0.985	0.991	0.612	0.530	0.699
2064	baseline		2440	815	5877	0.978	0.955	0.997						
2064	Disp 6	45	2210	749	5403	0.976	0.953	0.995	0.998	0.995	1.001	0.912	0.793	1.045
2064	Disp 36	45	1405	470	3492	0.966	0.943	0.985	0.988	0.985	0.991	0.577	0.492	0.670
2069	baseline		2173	697	5580	0.978	0.956	0.996						
2069	Disp 6	50	1950	649	5005	0.976	0.955	0.994	0.998	0.995	1.001	0.904	0.773	1.044
2069	Disp 36	50	1176	373	3114	0.966	0.945	0.985	0.988	0.985	0.991	0.544	0.455	0.639
2074	baseline		1939	613	5293	0.978	0.958	0.995						
2074	Disp 6	55	1729	547	4791	0.976	0.956	0.994	0.998	0.995	1.001	0.893	0.760	1.049
2074	Disp 36	55	994	310	2782	0.966	0.946	0.984	0.988	0.985	0.991	0.513	0.420	0.611
2079	baseline		1724	516	5032	0.978	0.958	0.995						
2079	Disp 6	60	1517	470	4415	0.976	0.957	0.993	0.998	0.995	1.001	0.884	0.743	1.053
2079	Disp 36	60	831	248	2493	0.966	0.947	0.984	0.988	0.985	0.991	0.483	0.386	0.589

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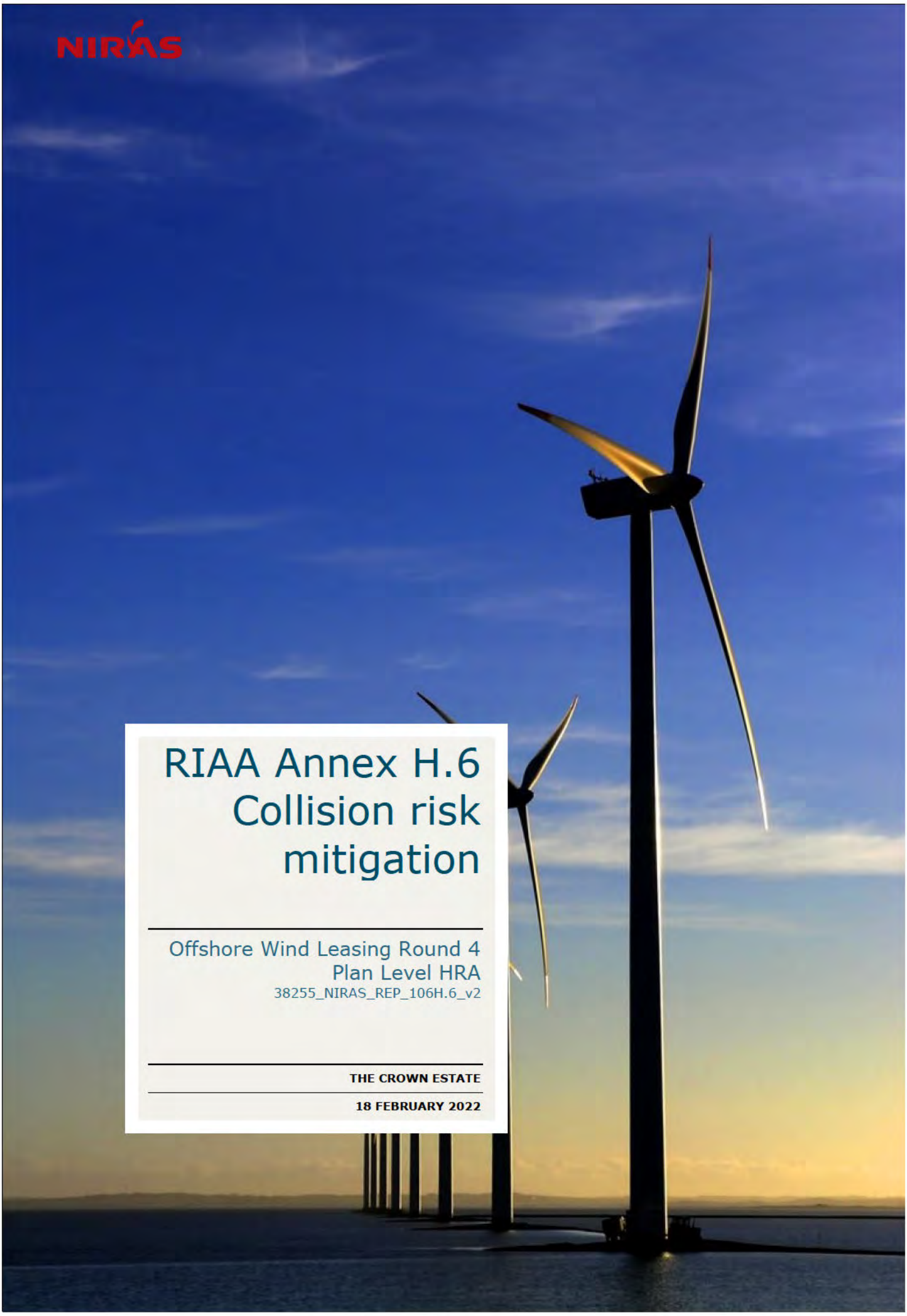
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Sub-Annex 1. NEPVA R code

1.1 R function used to run PVA per feature (species/site)

H.1.1. The following R function from the NEPVA package was used to run PVA per feature (species/site). Results from Section 6 can be reproduced using this code and the feature values in Table 3.2

```
nepva.simplescenarios(
model.envstoch = "betagamma", # env stochasticity from beta distribution
model.demostoch = TRUE, # model demographic stochasticity?
model.dd = "nodd", # density independence
model.prodmax = TRUE, # productivity rates constrained to be <= maximum brood size?
mbs = p_row$mbs, # maximum brood size
afb = p_row$afb, # age at first breeding
npop = 1, # number of populations
nscen = length(impact_name_list), # number of impact scenarios
sim.n = 5000, sim.seed = 1898, nburn = 5, # n simulations, seed number and n burn
demobase.specify.as.params = FALSE, # empirical values for prod and surv rather than estimate?
demobase.splitpops = FALSE, # different demographic rates for each subpopulation?
demobase.splitimmat = TRUE, # different demographic rates specified for immatures?
demobase.prod = data.frame(Mean=p_row$mn_base_prod, SD = p_row$sd_base_prod), #
baseline productivity mean and SD
demobase.survadult = data.frame(Mean =  p_row$mn_base_adsurv, SD =
p_row$sd_base_adsurv), # baseline survival mean and SD
demobase.survimmat = imm_surv, # baseline survival mean and SD for different immature ages
inipop.years = as.numeric(p_row$yr), # year when initial count was made
inipop.inputformat = "breeding.adults", # initial population size entered as breeding adults
inipop.vals = p_row$Count_BrAd, # initial population value
impacts.relative = TRUE, # specify relative impacts (% change in population from impact)
impacts.splitimmat = FALSE, # different impacts specified for immatures?
impacts.year.start = as.numeric(p_row$yr)+1, # impact starts year after last count
impacts.year.end = as.numeric(p_row$yr)+61, # impact ends after 60 years
impacts.splitpops = FALSE, # different impact rates for each subpopulation?
impacts.scennames = impact_name_list, # naming impact for reference
impacts.prod.mean = 0, # No impacts on productivity
impacts.survadult.mean = impact_mean_list,# impacts on adult survival
impacts.provideses = FALSE, # Are SEs provided for impacts?
impacts.prod.se = 0, # SE for productivity impact
impacts.survadult.se = 0, # SE for survival impact
output.agetype = "whole.population", # output population as whole population
output.year.end = as.numeric(p_row$yr)+61, #when to end model
output.year.start = as.numeric(p_row$yr), # when to start model report from
output.popsize.target = NULL, # don't set output pop target
output.popsize.qe = NULL,# don't set output extinction risk target
silent = TRUE, # suppress progress text, plots
changetablenames = TRUE) # match shiny table names
```



RIAA Annex H.6 Collision risk mitigation

Offshore Wind Leasing Round 4
Plan Level HRA

38255_NIRAS_REP_106H.6_v2

THE CROWN ESTATE

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1. Introduction

1.1.1 Collision risk modelling has been undertaken to determine the likely impact of the Round 4 Plan on seabirds, including with respect to the breeding kittiwake population that is an interest feature of the Flamborough and Filey Coast SPA. The collision risk modelling is described in Annex H.2 and the apportioning of the predicted collision rates for kittiwake to the Flamborough and Filey Coast SPA is described in Annex H.3.

1.1.2 Collision risk modelling and apportioning indicates that the Round 4 Plan alone could lead to kittiwake mortality in the range 37.9-108.0 collisions /annum, with an impact in the range 37.9-43.4 considered most likely. An impact of this magnitude represents 0.25-0.29% of the baseline mortality of the Flamborough and Filey Coast SPA kittiwake population (51,535 pairs). An upper annual collision risk estimate of 94.3-108.0 collisions/annum represents an increase in baseline mortality of 0.63-0.72%. Using these upper estimates of collision mortality, the predicted in-combination impact rises to 613.3-627 collisions/annum from the 557-563 in-combination totals calculated using the most likely impact from the Round 4 Plan.

1.1.3 In recent project applications, Natural England has advised that the breeding kittiwake interest feature of the Flamborough and Filey Coast SPA has a conservation objective to restore its population and that predicted impacts of this magnitude would be unsustainable. In light of this advice and of recent decisions on project applications for offshore wind farms in the southern North Sea, options for mitigating the risk have been explored.

1.1.4 It is possible to amend the design of a wind farm to reduce its collision risk. Collision rates are actually related to the total swept area of the wind farm, and particularly that component of the swept areas that intersects with the heights above sea level at which birds fly. Larger turbines tend to have a relatively lower interaction with birds (as more of the swept area sits above their flight height distribution) and some wind farms have sought to mitigate collision rates through the exclusion of smaller turbine options from their design (Rochdale) envelope.

1.1.5 A further option is to reduce interaction with birds by raising the hub height of turbines, which then increases the air gap between the lower rotor tip and the sea surface. As this air gap increases the collision rate will reduce due to the skewed distribution of bird flight heights which is biased towards lower heights. Compared to other methods this option can be specified at Plan level without reducing capacity, although it is not necessarily clear how big an air gap a specific project can accommodate without knowledge of water depths etc. Recent projects in the southern North Sea have included airgaps between 30-40m (and in some cases higher) and so the beneficial impact of raising hub heights to generate air gaps of up to 45m has been explored.

1.1.6 Although some collision mortality is predicted from all Preferred Projects during the non-breeding season, the large majority of collision mortality arises during the breeding season from Preferred Projects 1, 2 and 3, which are within foraging range of the colony at the Flamborough and Filey Coast SPA. Consequently, the exploration of mitigation focusses on these Preferred Projects.

2. Methodology

2.1.1 Collision risk modelling has been undertaken using the turbine parameters as provided by the Round 4 developers of Preferred Projects 1, 2 and 3 these are described in detail in Annex H.2 and summarised in Table 2.1. With the exception of hub height, these parameters remain identical throughout the modelling presented in this report.

Table 2.1: Wind farm and turbine parameters used for collision risk modelling

Parameter	Preferred Project		
	1	2	3
Wind farm			
Latitude (degrees)	54.62	54.52	53.57
No. of turbines	150	150	107
Tidal offset (m)	-	-	-
Turbine			
No. of blades	3	3	3
Average rotation speed (rpm)	13.9	13.9	9.4
Rotor radius (m)	82	82	110
Hub height (m)	106	106	150
Max blade width (m)	5.5	5.5	7.7
Average pitch (°)	3	3	3
Monthly proportion of time operational (all months) (%)	92	92	91.9

2.1.2 The minimum rotor height at Preferred Projects 1 and 2, as proposed by the associated developer is 24m. At Preferred Project 3, the minimum rotor height is 40m.

2.1.3 The collision risk estimates for kittiwake at Flamborough and Filey Coast SPA calculated using the parameters provided by the Round 4 Preferred Project developers for Preferred Projects 1, 2 and 3 and the apportioning approach in the RIAA are summarised in Table 2.2.

Table 2.2: Collision risk estimates for kittiwake apportioned to the Flamborough & Filey Coast SPA based on the turbine scenarios provided by the Preferred Project developers.

Band (2012) Model Option	Nocturnal activity factor	Flight speed	Avoidance rate (%)	Breeding			Post-breeding	Pre-breeding	Total	Baseline mortality (%)
				PP1	PP2	PP3	All projects	All projects		
Option 2	2	13.1	98.9	45.6	34.2	8.5	3	2.9	94.3	0.63
			99.0	41.5	31.1	7.8	2.8	2.6	85.8	0.57
		8.71	98.9	35	26.3	6.3	2.3	2.2	72.1	0.48
			99.0	31.8	23.9	5.7	2.1	2	65.6	0.44
	3	13.1	98.9	51.8	38.9	9.7	3.9	3.8	108.0	0.72
			99.0	47.1	35.3	8.8	3.5	3.4	98.2	0.65
		8.71	98.9	39.7	29.8	7.2	3	2.9	82.6	0.55
			99.0	36.1	27.1	6.5	2.7	2.6	75.1	0.5
Option 3	2	13.1	98	21.7	16.3	2.7	1.4	1.3	43.4	0.29
		8.71	98	19	14.2	2.3	1.2	1.2	37.9	0.25
	3	13.1	98	24.6	18.5	3.1	1.8	1.7	49.6	0.33
		8.71	98	21.5	16.2	2.6	1.6	1.5	43.4	0.29

3. Mitigation scenarios

3.1.1 The maximum predicted collision rate for kittiwake, based on the adoption of the most conservative assumptions in all cases, is 108 individual birds per annum. This is considered to be overly cautious, with the impact more likely to be in the range 37.9-43.4 birds per annum, however, the higher value has been used for the purposes of demonstrating the effects of mitigation.

3.1.2 To explore how increasing the air gap reduced the predicted collision rate for the Round 4 Plan, collision risk modelling has been conducted or kittiwake using minimum rotor heights of 25m, 30m, 35m, 40m and 45m (above mean sea level). Note, that in most cases this will only apply to Preferred Projects 1 and 2, as Preferred Project 3 already has an air gap of 40m and this has not been reduced in these calculations (Table 3.1).

Table 3.1: Predicted kittiwake collision rates for Preferred Projects 1, 2 and 3 at different lower tip heights

Lower tip height (m)			Breeding season			Post-breeding season	Pre-breeding season	Total	Baseline mortality (%)
PP1	PP2	PP3	PP1	PP2	PP3	All projects	All projects		
24	24	40	51.8	38.9	9.7	3.9	3.8	108.0	0.72
25	25	40	47.1	35.3	9.9	3.5	3.4	99.1	0.66
30	30	40	29.2	21.9	9.9	2.3	2.2	65.4	0.43
35	35	40	18.0	13.5	9.9	1.5	1.5	44.5	0.30
40	40	40	11.1	8.4	9.9	1.1	1.0	31.5	0.21
45	45	45	6.9	5.1	6.0	0.7	0.6	19.3	0.13

3.1.3 Although reducing the air gap of turbines is targeted at mitigating kittiwake collisions, substantial benefits are expected for gannet and lesser black-backed gull. To explore this the same changes to lower tip heights shown in Table 3.1 were modelled for in collision risk estimates for gannet apportioned to the Flamborough & Filey Coast SPA. The most realistic worst case scenario, as calculated in the RIAA, is considered to be 7.4-8.7 individual birds per annum; however, the maximum predicted collision rate, based on the adoption of the most conservative assumptions in all cases, is 20.2 individual birds per annum (as shown in Table 3.2). This is arrived at using a nocturnal activity factor of two, a flight speed of 14.9 and an avoidance rate of 98.9 under Band (2012) model option two. This parameter combination is used to estimate collision impacts under different lower tip heights in Table 3.2 although is considered to be an over-estimate based upon overly conservative assumptions.

Table 3.2: Predicted gannet collision rates for Preferred Projects 1, 2 and 3 at different lower tip heights

Lower tip height (m)			Breeding season			Post-breeding season	Pre-breeding season	Total	Baseline mortality (%)
PP1	PP2	PP3	PP1	PP2	PP3	All projects	All projects		
24	24	40	11.2	6.5	2	0.1	0.3	20.2	1.47
25	25	40	10.1	5.9	2	0.1	0.3	18.4	1.34
30	30	40	6	3.5	2	0.1	0.2	11.7	0.85
35	35	40	3.6	2.1	2	0	0.1	7.8	0.57
40	40	40	2.1	1.2	2	0	0.1	5.4	0.39
45	45	45	1.2	0.7	1.2	0	0	3.2	0.23

4. Conclusions

4.1.1 It can be seen that increasing the lower tip height of turbines dramatically reduces predicted kittiwake collision rates. A 50% reduction can be achieved, for example by raising the lower tip height of Preferred Projects 1 and 2 by about 10m.

4.1.2 A proportionate change in collision rate arising from increasing hub height would also be seen in the other collision rates predicted in Table 3.1. So, a predicted rate of 37.9 – 43.4 collisions/annum would reduce to approximately 11.0 – 12.5 collisions/annum.

4.1.3 In addition, the collision risk for gannet has been shown to be similarly reduced, demonstrating the benefit of increasing the lower tip height of turbines for other species.