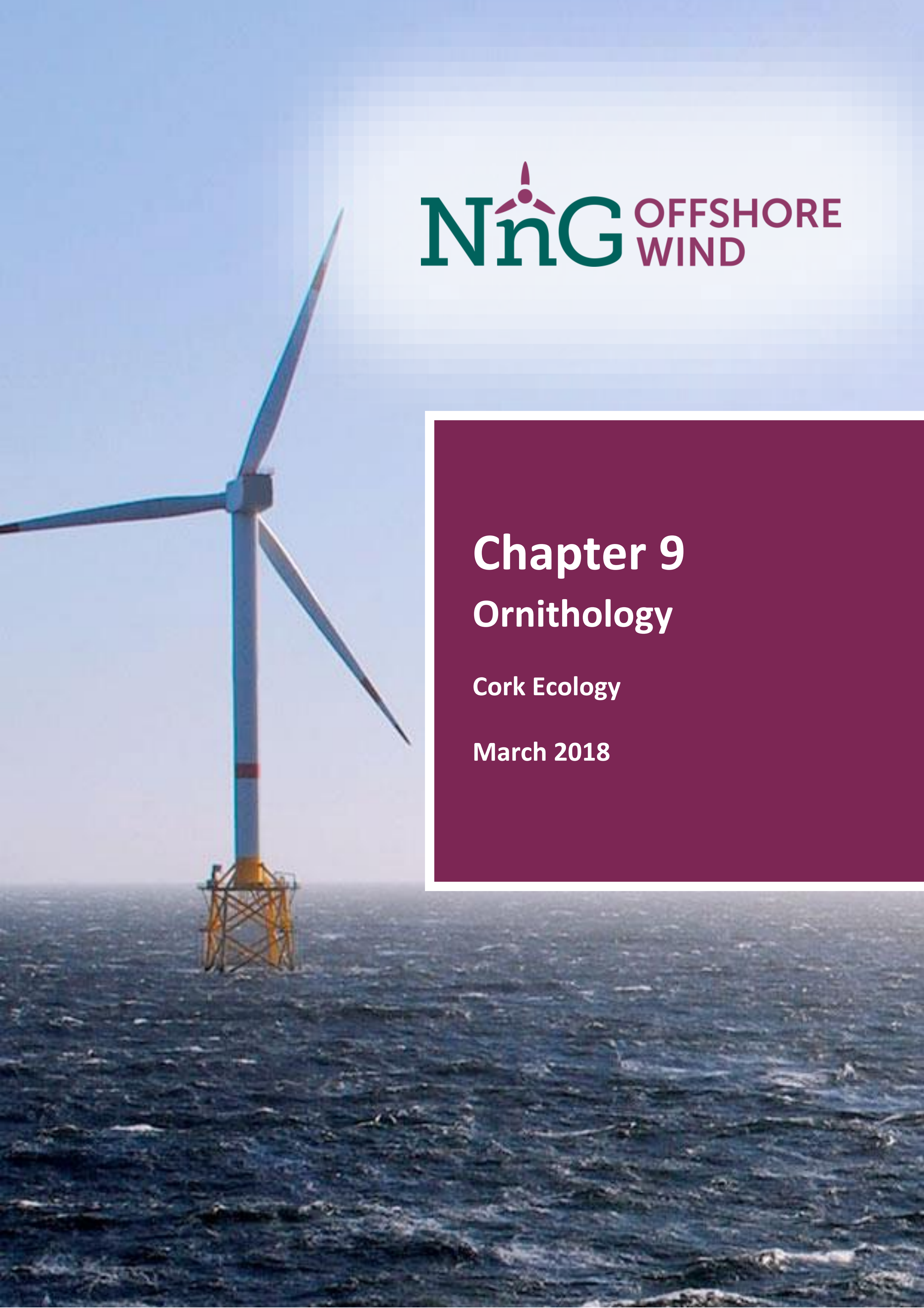

NnG OFFSHORE WIND

# Chapter 9

## Ornithology

**Cork Ecology**

**March 2018**

## Table of Contents



## Table of Figures



## Table of Tables

# 9 Ornithology

## 9.1 Introduction

1. This chapter of the EIA Report presents an assessment of the potential impacts upon ornithology arising from the construction, operation and decommissioning of the Project, as detailed in Chapter 4: Project Description. This chapter has been prepared on behalf of NnGOWL by Cork Ecology with input from Bureau Waardenburg (BW). Acknowledgement is also made to Francis Daunt of the Centre for Ecology and Hydrology (CEH) and Keith Hamer of the University of Leeds for kindly providing tracking data for various species based on tagging studies on the Isle of May, St Abb's Head and the Bass Rock.

2. This chapter is comprised of the following elements:

- A summary of relevant guidance, policy and legislation;
- Details of the data sources used to characterise the study area;
- A summary of the relevant consultations with stakeholders;
- A description of the methodology for assessing the impacts of the Project, including details of the study area and approach to the assessment of potential effects;
- A review of the baseline conditions;
- A description of the worst-case design scenario relevant to ornithology;
- An assessment of the likely effects for the construction, operation and decommissioning phases of the Project, including cumulative and in-combination effects;
- Identification of any further mitigation measures or monitoring requirements in respect of any significant effects;
- A summary of the residual impact assessment determinations taking account of any additional mitigation measures identified.

## 9.2 Guidance, Policy and Legislation

3. The key legislation in relation to birds includes:

- The Council Directive on the Conservation of Wild Birds 2009/147/EC (EU Birds Directive).
- The Council Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora 1992/43/EEC (EU Habitats Directive).
- The Nature Conservation (Scotland) Act 2004 (as amended).
- The Wildlife and Countryside Act 1981 (as amended).
- Conservation (Natural Habitats, etc.) Regulations 1994 (as amended).
- The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017.
- The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017.
- Conservation of Habitats and Species Regulations 2017.

4. The principal guidance documents and information used to inform the assessment of potential impacts on ornithology are as follows:

- Band, W., M. 2012. Using a collision risk model to assess bird collision risks for offshore windfarms. Final version, August 2012. SOSS, The Crown Estate, http://www.bto.org/science/wetland-and-marine/soss/projects;
- Cook, A.S.C.P., Humphreys, E.M., Masden, E.A. and Burton, N.H.K. (2014). The avoidance rates of collision between birds and offshore turbines. BTO Research Report No. 656;

- Cook, A.S.C.P & Robinson, R.A. 2016. Testing sensitivity of metrics of seabird population response to offshore wind farm effects. JNCC Report No. 553. JNCC, Peterborough.
- Freeman, S., Searle, K., Bogdanova, M., Wanless, S. & Daunt, F. 2014. Population dynamics of Forth and Tay breeding seabirds: Review of available models and modelling of key breeding populations. Ref: MSQ-0006. Final Report to Marine Scotland Science.
- Furness R. W., Wade, H. M. and Masden E.A. (2013) Assessing vulnerability of marine bird populations to offshore wind farms. Journal of Environmental Management 119 pp.56-66;
- Furness, R.W. (2015) Non-breeding season populations of seabirds in UK waters: Population sizes for Biologically Defined Minimum Population Scales (BDMPS). Natural England Commissioned Report Number 164. 389 pp;
- IEEM 2010. Guidelines for ecological impact assessment in Britain and Ireland. Marine and Coastal.
- JNCC (2015). Seabird Displacement Impacts from Offshore Wind Farms: report of the MROG Workshop, 6- 7th May 2015. JNCC Report No 568. JNCC Peterborough;
- MacArthur Green. 2014. Bass Rock Gannet PVA. Report to Marine Scotland Science.
- MacArthur Green. (2016) Qualifying impact assessments for selected seabird populations: A review of recent literature and understanding. Report commissioned by Vattenfall, Statkraft and Scottish Power Renewables;
- Marine Scotland. (2014a) Application For Consent Under Section 36 Of The Electricity Act 1989 And Applications For Marine Licences Under The Marine (Scotland) Act 2010 For The Construction And Operation Of The NnG Offshore Windfarm. Marine Scotland's Consideration Of A Proposal Affecting Designated Special Areas Of Conservation ("SACs") Or Special Protection Areas ("SPAs");
- Marine Scotland. (2014c) Population consequences of displacement from proposed offshore wind energy developments for seabirds breeding at Scottish SPAs (CR/2012/03);
- Searle, K., Mobbs, D., Butler, A., Bogdanova, M., Freeman, S., Wanless, S. & Daunt, F. 2014. Population consequences of displacement from proposed offshore wind energy developments for seabirds breeding at Scottish SPAs (CR/2012/03). Final Report to Marine Scotland Science.
- SNH. (2014) Interim Guidance On Apportioning Impacts From Marine Renewable Developments To Breeding Seabird Populations In Special Protection Areas. http://www.snh.gov.uk/docs/A1355703.pdf;
- SNH. (2017) Seasonal Periods for Birds in the Scottish Marine Environment. http://www.snh.gov.uk/docs/A2200567.pdf;
- Statutory Nature Conservation Bodies (SNCB). (2017). Interim Displacement Advice Note. Advice on how to present assessment information on the extent and potential consequences of seabird displacement from Offshore Wind Farm (OWF) developments http://jncc.defra.gov.uk/pdf/Joint_SNCB_Interim_Displacement_AdviceNote_2017.pdf;
- Thaxter, C.B. Lascelles, B. Sugar, K. Cook, A.S.C.P. Roos, S. Bolton, M. Langston, R.H.W. and Burton, N.H.K. (2012). Seabird foraging ranges as a preliminary tool for identifying candidate Marine Protected Areas. Biological Conservation; and
- Wade H.M., Masden. E.A., Jackson, A.C. and Furness, R.W. (2016). Incorporating data uncertainty when estimating potential vulnerability of Scottish seabirds to marine renewable energy developments. Marine Policy 70, 108–113. Available online at doi:10.1016/j.marpol.2016.04.045

## 9.3 Data Sources

5. The assessment considers the potential interaction between the Project (as described in Chapter 4: Project Description) and seabirds.

6. The Project includes the Wind Farm Area, and the Offshore Transmission Works (including the offshore export corridor, up to Mean High Water Springs (MHWS).

7. Baseline characterisation data has been collated combining a thorough desk-based study of extant data supplemented with a series of site-specific surveys. Data was drawn from site surveys, studies commissioned by NnGOWL and existing published datasets.

8. Table 9-1 details the data sources used to inform the baseline characterisation within the study area.

Table 9-1: Data sources used to inform the baseline description.

| Data Source | Study/Data Name | Overview |
|---|---|---|
| **NnGOWL** | Baseline seabird surveys | Monthly boat-based seabird surveys<br>Covered NnG Wind Farm Area and buffer extending out to 8km<br>Covered a 3 year period, from November 2009 – October 2012 |
| **Forth and Tay Offshore Wind Developers Group (FTOWDG)** | Daunt *et al.*, 2011a | GPS tracking of guillemot, razorbill and kittiwake from the Isle of May, Summer 2010 |
| | Daunt *et al.*,2011b | GPS tracking of kittiwake and observations of guillemot trips from Fowlsheugh & St Abb's Head, Summer 2011 |
| **Isle of May tracking data 2012 to 2014[1]** | Data from Francis Daunt, CEH | GPS tracking of guillemot, razorbill and kittiwake from the Isle of May, in the 2012, 2013 and 2014 breeding seasons. |
| **Gannet tracking data 2010 – 2012[2]**<br>**Gannet tracking data 2015 [3]** | Data from Keith Hamer, University of Leeds | GPS data collected by tracking breeding adult and immature gannets from Bass Rock |
| **JNCC Seabird Monitoring Programme** | Seabird 2000 dataset and more recent colony counts | Online database of breeding numbers of seabirds around UK |

[1] Data are owned by NERC Centre for Ecology & Hydrology. Data collection received support from the RSPB, JNCC, SNH and Marine Scotland.

[2] The gannet tagging data from 2010 to 2012 were obtained by Keith Hamer, Ewan Wakefield and Ian Cleasby, funded by NERC Standard Research Grant NE/H007466/1 to Keith Hamer, Stuart Bearhop (University of Exeter) and Stephen Votier (University of Exeter).

[3] The 2015 data were obtained by Keith Hamer, James Grecian and Jude Lane with funding from NERC and DBEIS, with thanks to John Hartley (Hartley Anderson).

## 9.4 Relevant Consultations

9. As part of the EIA process, NnGOWL has undertaken a number of consultations with various statutory and non-statutory stakeholders.

10. An intitial kick-off meeting was held in Aberdeen on 20th January 2017 between MS-LOT and NnGOWL, regarding the approach to scoping and the EIA process.

11. A pre-scoping meeting was held in Battleby on 3rd April 2017 between MS-LOT, MSS, SNH and NnGOWL regarding the approach to scoping and the EIA process, including modelling.

12. A scoping meeting was held in Aberdeen on 13th June 2017 to discuss the NnGOWL Scoping Report and to agree the approach for the EIA Report. Present at the meeting were MS-LOT, MSS, SNH, RSPB and NnGOWL.

13. A meeting was held in Edinburgh on 24th July 2017 between NnGOWL and RSPB to discuss the NnG Scoping Report, and in particular changes in Collision Risk Modelling outputs over the course of the Project design.

14. A formal scoping opinion was requested from MS-LOT, supported by the NnGOWL Scoping Report. In response to NnGOWL's request, MS-LOT issued a Scoping Opinion on 8th September 2017, identifying a number of issues that could not be scoped out of the assessment at this stage following review of the Scoping Report. The issues to be considered further within this EIA in respect of ornithology are summarised in Table 9-2.

15. Ongoing consultation with stakeholders continued post-scoping and responses have been used to develop an appropriate methodology and parameters for assessment. Additional advice received from Marine Scotland after scoping is also summarised in Table 9-2.

Table 9-2: Summary of consultation relating to ornithology.

| Date and consultation phase / type | Consultation and key issues raised | Section where comment addressed |
|---|---|---|
| **8/9/2017– Scoping Opinion – Scottish Ministers** | **Age of survey data**<br>The boat-based survey data for the Original Development EIA remain suitable for providing the baseline survey data for the Revised Development EIA but advise NnG that if their application is delayed this advice may change. | Noted. |
| | **SPAs to be included**<br>The following SPAs/pSPA and qualifying features must be included in the assessment:<br>• Forth Islands SPA – gannet, kittiwake, herring gull, puffin, guillemot, razorbill<br>• Fowlsheugh SPA – kittiwake, herring gull, guillemot, razorbill<br>• Buchan Ness to Collieston Coast SPA and St Abb's Head to Fast Castle SPA should be scoped in due to connectivity. PVAs for these SPAs are required unless the cumulative effects from the Forth and Tay projects are estimated to be less than a reduction in annual adult survival of 0.2%.<br>Impacts are to be considered in relation to the existing colony SPA breeding populations.<br>The reference populations provided by SNH are to be used for the SPAs (see Table 9.8). | Section 9.7.4 |

| Date and consultation phase / type | Consultation and key issues raised | Section where comment addressed |
|---|---|---|
| | **Assessment of Firth of Forth and St Andrews Bay Complex pSPA**<br>Seabird species to be considered in the assessment of Firth of Forth and St Andrews Bay Complex pSPA:<br>Gannet, Kittiwake, Herring gull, Puffin, Razorbill, Guillemot.<br>The assessment carried out for these species at the breeding colony SPAs listed above should also be used for the assessment of the pSPA.<br>A qualitative assessment of potential disturbance or displacement, and collision in relation to little gull, common gull and black-headed gull should be carried out if the turbines overlap with the pSPA. | Section 9.9.2.5 |
| | **Apportioning**<br>The methods that should be used are the SNH apportioning approach and the Apportionment tool being produced for Marine Scotland by CEH (if available).<br>The reference populations provided by SNH are to be used for the SPAs (see Table 9.8).<br>Breeding season:<br>Apportioning impacts between SPA and non-SPA colonies should be done using Seabird 2000 data.<br>Impacts apportioned between SPAs should use most recent colony counts, as provided by SNH.<br>Non-breeding season:<br>The biologically defined minimum population scales (BDMPS) should be used for gannet and kittiwake, using reference populations from Furness (2015).<br>SNH guidance should be used to define the seasons, as follows:<br>Gannet – Autumn (Oct to Nov); Spring (Dec to mid-Mar)<br>Kittiwake – Autumn (Sep to Dec); Spring (Jan to mid-April).<br>For herring gull the updated CRM outputs for the breeding and non-breeding seasons should be presented. If further quantitative assessment is needed, collisions during the non-breeding season should be apportioned across the regional population (a similar method was used previously for Moray Firth wind farms).<br>For guillemot and razorbill, all non-breeding season impacts should be assigned to SPAs as per breeding season. Use of the total SPA population, all ages, and apportioning impacts across age classes based on the PVA stable age structure is recommended. | Sections 9.9.2 and 9.9.4 |
| | **Collision Risk**<br>CRM is required for gannet, herring gull and kittiwake.<br>The nocturnal activity scores of 2 (25%) should be used for herring gull and kittiwake and 1 (0%) for gannet.<br>The mean monthly value should be used, and density of birds in flight values should also have 95% confidence limits presented.<br>Comparison should be made of the proportion of birds at collision height using site specific flight height data and the generic flight height data (Johnson et al. 2014), and any differences between the two should be discussed. | Section 9.9.2.3 |

| Date and consultation phase / type | Consultation and key issues raised | Section where comment addressed |
|---|---|---|
| | For kittiwake and gannet, the assessment should assume Option 2 using Johnson et al. (2014) with corrigendum. If sufficient site-specific flight height data are available, outputs using Option 1 should also be presented. Option 2 (at a 98.9% avoidance rate) should be assumed for the PVA.<br>For herring gull, the assessment should present Options 2 and 3 using Johnson et al. (2014) with corrigendum flight height distributions. However, if sufficient site specific flight height data are available, outputs using Option 1 or 4 should also be presented. Option 2 (at a 99% avoidance rate) should be assumed for the PVA.<br>The following avoidance rates should be used:<br>• Gannet – 98.9% (±0.002)<br>• Kittiwake – 98.9% (±0.002)<br>• Herring gull – 99.5% (±0.001) for Option 2, 99.0% (± 0.002) for Option 3<br>The breeding season and non-breeding season months are those described in the SNH advice (Table 9-7).<br>Apportioning between SPAs should follow methods presented in SPA section above. | |
| | **Displacement & Barrier effects**<br>The species to be included are: puffin, guillemot, razorbill and kittiwake.<br>The breeding season months are those described in the SNH advice (Table 9-7).<br>Density estimates should be mean seasonal peaks and include a 2km buffer and should include all birds, both those in flight and on the water.<br>Breeding season:<br>Estimates of displacement should be presented following the SNCB guidance (SNCB 2017).<br>The updated CEH (SeaBORD) model should also be used if available. Outputs from the previous CEH modelling (2014) should be used for context.<br>In addition, a qualitative assessment of displacement impacts on little gull, common gull and black-headed gull should also be included.<br>Non-breeding season:<br>Qualitative assessments should be presented for puffin and kittiwake in the non-breeding season.<br>For guillemot and razorbill, the approach described in the 2017 SNCB guidance should be used. Non-breeding season effects should be assigned to relevant SPAs as per breeding season.<br>A displacement rate of 60% should be used for auks and 30% for kittiwake.<br>A mortality rate from displacement of 2% for puffin and kittiwake (quantitative assessment is for the breeding season only) and 1% for guillemot and razorbill (same rate across breeding and non-breeding seasons) should be applied. The same rates should be used for immatures as for adult birds. | Section 9.9.2.2 |

| Date and consultation phase / type | Consultation and key issues raised | Section where comment addressed |
|---|---|---|
| | Apportioning between SPAs should follow methods presented in SPA section above. | |
| | **Cumulative Impact Assessment**<br>Effects should be considered quantitatively for the wind farm in isolation and in combination with the worst case scenario (for each species) from either Scenario 1:<br>• Seagreen Alpha and Bravo (2014 as consented) or Seagreen (2017 scoping report) and<br>• Inch Cape (2014 as consented) or Inch Cape (2017 scoping report).<br>• Breeding season effects from other wind farms should be considered within the CIA qualitatively.<br>Or Scenario 2:<br>Effects should be considered quantitatively for the wind farm in isolation and in combination with:<br>• Inch Cape (2017 scoping report) and<br>• Seagreen (2017 scoping report) and<br>• Breeding season effects from other wind farms should be considered within the CIA qualitatively.<br>For breeding season, the CIA should consider projects within mean max foraging range of the colony SPA under consideration.<br>For guillemot and razorbill, the CIA should incorporate non-breeding season displacement effects from the Forth and Tay wind farms, apportioning effects as to SPA and non-SPA colonies in the same manner as the breeding season.<br>For gannet and kittiwake, the CIA should estimate non-breeding season collision effects from the Forth and Tay wind farms in isolation, and in combination with the other UK wind farms.<br>For herring gull, if further quantitative assessment is needed, collisions during the non-breeding season from NnGOWL in isolation and in combination with the other Forth and Tay windfarms should be apportioned as outlined in Scoping Opinion. | Section 9.9.4 |
| | **PVA modelling**<br>PVA outputs are required for SPA breeding colonies where the assessed effects exceed a change to the adult annual survival rate of 0.2% and it is considered they are likely to be needed for the following:<br>Forth Islands SPA – gannet, kittiwake, puffin, guillemot, razorbill<br>Fowlsheugh SPA – kittiwake, guillemot, razorbill<br>PVAs should be produced for the estimated effects from the wind farm in isolation, and in combination with the other three Forth & Tay wind farms for:<br>• Guillemot, razorbill, puffin, gannet and kittiwake (effects throughout the year and on all age classes).<br>• For gannet and kittiwake, breeding season effects from the Forth and Tay wind farms combined with the non-breeding season effects from the offshore wind farms in UK waters. | Sections 9.9.2.4 and 9.9.5 |

| Date and consultation phase / type | Consultation and key issues raised | Section where comment addressed |
|---|---|---|
| | For kittiwake, PVAs for the following should also be provided:<br>• Collision effects (throughout the year and on all age classes) in isolation.<br>• Collision effects (throughout the year and on all age classes) in combination with displacement effects (during the breeding season and on all age classes).<br>Stochastic, density independent PVA models should be used and they will need to include the specifications outlined in the Scoping Opinion.<br>The existing matrix-based population models for Forth Islands gannet and puffin populations would still be considered suitable for use in the EIA and HRA for the Revised Development. | |
| **8/9/2017– Scoping Opinion – SNH additional comments** | **Age of survey data**<br>No further baseline survey is required. | Noted. |
| | **Assessment of Firth of Forth and St Andrews Bay Complex pSPA**<br>The following seabird species can be scoped out of the assessment of Firth of Forth and St Andrews Bay Complex pSPA: Common tern, Arctic tern, Shag and Manx shearwater. | Section 9.9.2.5 |
| | **Assessment of non-seabird species**<br>SNH – Non-seabird species were fully considered and addressed in pre-application dialogue and in final assessments for the previous application.<br>In respect of wildfowl and waders these species have been addressed in the Marine Scotland strategic CRM report (Marine Scotland 2014). We confirm that current offshore wind proposals in Scottish waters do not present significant risk to any other bird interests and we do not require any individual developer to submit further information in this regard. | Noted. |
| | **Collision Risk**<br>Annual CRM totals will need to be apportioned between breeding and non-breeding seasons following SNH guidance. For half months the collisions calculated for that month are split equally between breeding and non-breeding period.<br>Collision mortality will need to be apportioned between age classes. We therefore recommend that all adults recorded during survey work are considered as breeding adults.<br>Impacts which occur during the breeding season will need to be apportioned between the breeding colonies (SPA and other) within foraging range of the proposed wind farm, as set out in SNH Guidance (SNH 2014).<br>We advise that assessment of collision mortality in the non-breeding season for herring gull can use the approach agreed for herring gull during the Moray Firth determinations. | Section 9.9.2.3 |

| Date and consultation phase / type | Consultation and key issues raised | Section where comment addressed |
|---|---|---|
| | **Cumulative Impact Assessment**<br>For herring gull, the updated CRM outputs for the breeding and non-breeding seasons should be presented. | Section 9.9.4 |
| **8/9/2017– Scoping Opinion – RSPB additional comments** | **Age of survey data**<br>Updated survey not requested, however, the survey data may not represent an accurate account of seabird usage. This element of uncertainty will need to be taken into account within the assessment. | Noted. |
| | **Assessment of Firth of Forth and St Andrews Bay Complex pSPA**<br>Potential impacts on Firth of Forth and St Andrew's Bay Complex proposed SPA resulting from Cable route requires inclusion in assessment. | Section 9.9.2.5 |
| | **Collision Risk**<br>Lesser black-backed gull & great black-backed gull should also be included in CRM assessment.<br>CRM output for gannet should be presented for basic Band model and a 98% AR in breeding season and a 98.9% AR in non-breeding season.<br>CRM outputs for herring gull, lesser black-backed gull and great black-backed gull should be presented for basic Band model and a 99.5% AR, and for the extended Band model, a 98.9% AR for lesser black-backed gull and great black-backed gull and 99.0% AR for herring gull.<br>Nocturnal activity values as per SNH 2013/14 guidance should be used. | Section 9.9.2.3 |
| | **Displacement & Barrier effects**<br>Species to be included in the assessment:<br>Puffin, razorbill, guillemot, kittiwake.<br>Guidance from SNH should be followed. | Section 9.9.2.2 |
| | **Cumulative Impact Assessment**<br>For the cumulative assessment of non-breeding season collision effects on kittiwake and gannet, a qualitative assessment for non UK sites should also be presented. | Section 9.9.4 |
| | **PVA modelling**<br>Species to be addressed and model population as per SNH advice.<br>Either deterministic or stochastic model.<br>Demographic rates should follow Horswill & Robinson, (2015).<br>Outputs should be presented as either as formula or table to allow for testing a range of mortality input scenarios.<br>Counterfactuals to be presented as per Cook & Robinson, (2016). | Sections 9.9.2.4 and 9.9.5.<br>Appendix 9.8: Population Viability Analysis (PVA) methods and results |
| **21/09/2017** | Email containing a list of offshore wind projects in the North Sea and English Channel for use in the CIA assessment; and also a report and | Section 9.9.4 |

| Date and consultation phase / type | Consultation and key issues raised | Section where comment addressed |
|---|---|---|
| **Post-scoping opinion additional advice from Marine Scotland** | spreadsheet from The Crown Estate for use in the CIA. Comments from SNH on the use of this information were also included. Comments from RSPB to follow if any received. | |
| **11/10/2017**<br>**Post-scoping opinion additional advice from Marine Scotland** | Email containing Collision Risk Modelling spreadsheets from Seagreen and Inch Cape based on the original project applications | Section 9.9.4 and Appendix 9.3: Collision Rate Modelling methods, inputs and results |
| **1/11/2017**<br>**Post-scoping opinion additional advice from Marine Scotland** | Email outlining non-breeding season illustrative example of calculation of non-breeding season impacts to Forth Islands SPA provided by SNH | Section 9.9.4 and Appendix 9.9: Cumulative Impact Assessment additional calculations |
| **7/11/2017**<br>**Post-scoping opinion additional advice from Marine Scotland** | Email outlining delay in availability of outputs from MS seabird apportioning tool project until 2018. MS-LOT advise that the SNH 2 step approach should be used for apportioning as outlined in the recent scoping opinions as the most appropriate method. | Section 9.9.5 |
| **8/11/2017**<br>**Post-scoping opinion additional advice from Marine Scotland** | Email outlining SNH response to Inch Cape queries on the non-breeding season illustrative example provided by SNH and circulated by MS on 1/11/2017 | Section 9.9.4 |
| **30/11/2017**<br>**Post-scoping opinion additional advice from Marine Scotland** | Email outlining correction to the non-breeding season illustrative example provided by SNH and circulated by MS on 1/11/2017 and Forth & Tay Seabird Population Counts - Updated Appendix A(ii): Most recent population counts for the key seabirds and SPAs of relevance to the Forth and Tay offshore wind farm reassessments – gannet, kittiwake, herring gull, guillemot, razorbill and puffin. | Section 9.9.4 |
| **8/12/2017**<br>**Post-scoping opinion additional advice from** | Further correction to Forth & Tay Seabird Population Counts - Updated Appendix A(ii): Most recent population counts for the key seabirds and SPAs of relevance to the Forth and Tay offshore wind farm reassessments – gannet, kittiwake, herring gull, guillemot, razorbill and puffin. | Section 9.9.4 |

| Date and consultation phase / type | Consultation and key issues raised | Section where comment addressed |
|---|---|---|
| Marine Scotland | | |

### 9.4.1 Impacts to be Assessed

16. The Scoping Opinion (Marine Scotland, 2017) highlighted the potential impacts on key species resulting from the Project that are required to be considered in this assessment (Table 9-3). In addition, some other species have also been included, based on numbers recorded on baseline surveys, and on whether they are listed as qualifying interest species for relevant SPAs.

Table 9-3: Potential impacts that have been included in the Project Assessment

| Potential Impact | Reason for scoping in |
|---|---|
| **Construction** | |
| **Impacts of Installation of turbines and Export Cables on the Outer Firth of Forth & St Andrews Bay pSPA** | Although most potential impacts on birds arising during the construction phase of the Project have been scoped out of this EIA Report (Marine Scotland, 2017), part of the Wind Farm Area and the offshore export cable corridor are within the Outer Firth of Forth & St Andrews Bay pSPA. Therefore, MS-LOT will need to address turbine and export cable installation in any new appropriate assessment for the pSPA. An assessment of possible impacts on birds resulting from the installation of turbines and the export cables within the Outer Firth of Forth & St Andrews Bay pSPA is therefore included. |
| **Operation** | |
| **Displacement and barrier effects on the following species:**<br>**Kittiwake, guillemot, razorbill & puffin** | Barrier effects during Operation were concluded to be of Minor significance for puffin in the Original EIA & Addendum.<br>Displacement and barrier effects during Operation were concluded to be not significant for the remaining species in the Original EIA & Addendum.<br>However, these species have been scoped in to the EIA Report for the Project on the basis of numbers of birds recorded within the Development Area in the breeding season, and the presence of SPAs within species mean maximum foraging range of the Project.<br>In addition, kittiwake, guillemot, razorbill and puffin were highlighted as requiring assessment for displacement and barrier effects in the NnG Scoping Opinion (Marine Scotland, 2017). |
| **Collision mortality impacts on the following species:**<br>**Gannet, Arctic skua, great skua, little gull, black-headed gull, common gull, lesser black-backed gull, herring gull, great black-backed gull & kittiwake** | Collision effects during Operation were concluded to be not significant for these species in the Original EIA & Addendum.<br>However, these species have been scoped in to the EIA Report for the Project on the basis of flight heights recorded during baseline surveys, where more than 1% of recorded flight height was within the rotor-swept zone in the Original Application.<br>In addition, gannet, kittiwake, herring gull, lesser black-backed gull and great black-backed gull were highlighted as requiring assessment in the NnG Scoping Opinion (Marine Scotland, 2017). |

| | |
|---|---|
| **Seabird species to be considered in the assessment of Firth of Forth and St Andrews Bay Complex pSPA:**<br>**Gannet, Kittiwake, Herring gull, Puffin, Razorbill, Guillemot, Little gull, black-headed gull and common gull. The remaining qualifying species have been scoped out of the assessment, based on the low numbers recorded within the Project Study Area and on the advice received in the NnG Scoping Opinion (Marine Scotland, 2017)**<br>Impacts to be assessed are displacement and collision impacts on qualifying species pf the pSPA arising from the overlap of the Wind Farm Area with the pSPA. | These species were highlighted as requiring assessment in the NnG Scoping Opinion (Marine Scotland, 2017).<br>Assessment of pSPA also needs to include the offshore export cable corridor, as highlighted by RSPB in the Scoping Opinion (Marine Scotland, 2017). |
| **Combined displacement and collision impacts** | Combined displacement and collision impacts were highlighted as requiring assessment in the NnG Scoping Opinion (Marine Scotland, 2017).<br>Kittiwake was the only species assessed for both displacement and collision impacts so was the only species considered for combined displacement and collision impacts. |
| **Disturbance during Operation and Maintenance activities from helicopters**<br>**All species** | Helicopter use for O & M activities is scoped into the EIA Report for the Project as it may be utilised in future. |
| **Cumulative Impacts** | |
| **Displacement** | Cumulative displacement impacts were highlighted as requiring assessment in the NnG Scoping Opinion (Marine Scotland, 2017).<br>Species assessed were kittiwake, guillemot, razorbill and puffin. |
| **Collision** | Cumulative collision impacts were highlighted as requiring assessment in the NnG Scoping Opinion (Marine Scotland, 2017).<br>Species assessed were gannet and kittiwake. |

17. Other potential impacts and species considered in the Original EIA and Addendum have been scoped out of this assessment, based on the advice received in the recent Scoping Opinion (Marine Scotland, 2017). These potential impacts will therefore not be considered further in this EIA Report.

## 9.5 Impact Assessment Methodology

18. This assessment considers the potential impacts associated with the construction, operation and decommissioning of the Project and the potential effects on ornithology. The impact assessment process and methodology follows the principles and general approach outlined in Chapter 6: EIA Methodology. The methodology and parameters assessed have also taken into account issues identified through consultation with stakeholders as detailed in Section 9.4 and the understanding of baseline conditions informed by the data sources referenced in Section 9.3.

19. The Project Description (Chapter 4) and the project activities for all stages of the project life cycle (construction, operation and decommissioning) have been assessed against the environmental baseline to identify the potential interactions between the Project and the environment. These are known as the potential impacts and are then assessed to determine a level of significance of effect upon the receiving environment.

### 9.5.1 Assessment and Assignment of Significance

20. The sensitivities of bird species are defined by both their potential vulnerability to an impact from the Project, their recoverability and value or importance of the bird species involved. The definitions of terms relating to ornithology are detailed in Table 9-4.

Table 9-4: Definition of terms relating to the environmental value (sensitivity of the receptor) (adapted from Highways Agency et al., 2008)

| Value (sensitivity of the receptor) | Definition |
|---|---|
| **High** | High or very high importance and rarity, international or national scale and limited potential for substitution.<br>Receptor population has very limited tolerance of effect i.e. likely to have limited capacity to absorb change, so a population level effect is likely to occur.<br>Likely to be limited to populations with poor existing conservation status |
| **Medium** | High or medium importance and rarity, regional scale, limited potential for substitution.<br>Receptor population has limited tolerance of effect i.e. a very minor capacity to absorb change so a population level effect possible.<br>Likely to include but not be limited to populations with poor existing conservation status |
| **Low** | Low or medium importance and rarity, local scale.<br>Receptor population has some tolerance of effect i.e. likely to have minor capacity to absorb additional mortality or a reduction in productivity, or habitat loss, so a population level effect unlikely. |
| **Negligible** | Very low importance and rarity, local scale.<br>Receptor population generally tolerant of effect i.e. likely to have moderate capacity to absorb additional mortality or a reduction in productivity, or habitat loss, so a population level effect very unlikely. |

21. The magnitude of impact is defined by a series of factors including the spatial extent of any interaction, the likelihood, duration, frequency and reversibility of a potential impact. The definitions of the levels of magnitude used in this assessment in respect of bird populations are described in Table 9-5. Guide percentages used to determine the magnitude of any effect were based on Regini (2000).

Table 9-5: Definition of terms relating to the magnitude of impacts on bird populations (adapted from Highways Agency et al., 2008)

| Magnitude of impact | Description (adverse effects) | Description (beneficial effects) |
|---|---|---|
| **High** | Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements.<br>Major reduction in the status or productivity of a bird population due to mortality or displacement or disturbance. | Large scale or major improvement or resource quality; extensive restoration or enhancement; major improvement of attribute quality. |
| | Guide: >21% of population affected, >21% change factor in mortality or productivity rate. | |
| **Medium** | Loss of resource, but not adversely affecting integrity of resource; partial loss of/damage to key characteristics, features or elements.<br>Partial reduction in the status or productivity of a bird population due to mortality or displacement or disturbance. | Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality. |
| | Guide: 6-20% of population affected, 6-20% change factor in mortality or productivity rate. | |
| **Low** | Some measurable change in attributes, quality or vulnerability, minor loss of, or alteration to, one (maybe more) key characteristics, features or elements.<br>Small but discernible reduction in the status or productivity of a bird population due to mortality or displacement or disturbance. | Minor benefit to, or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk of negative impact occurring. |
| | Guide: 1-5% of population affected, 1-5% change factor in mortality or productivity rate. | |
| **Negligible** | Very minor loss or detrimental alteration to one or more characteristics, features or elements.<br>Very slight reduction in the status or productivity of a bird population due to mortality or displacement or disturbance. Reduction not detectable or barely discernible, approximating to the “no change” situation. | Very minor benefit to, or positive addition of one or more characteristics, features or elements. |
| | Guide: <1% population affected, <1% change factor in mortality or productivity rate. | |
| **No change** | No loss or alteration or characteristics, features or elements; no observable impact in either direction. | |

22. The magnitude of the impact is correlated against the sensitivity of the receptor to provide a level of significance (Table 9-6). For the purposes of this assessment, effects rated as being of either **Moderate** or **Major** significance are considered **significant** in EIA terms. Any effect that is below moderate is not significant.

Table 9-6: Significance of potential effects

| | | Magnitude | | | |
|---|---|---|---|---|---|
| | | High | Medium | Low | Negligible |
| **Sensitivity** | **High** | Major | Major | Moderate | Minor |
| | **Medium** | Major | Moderate | Minor | Negligible |
| | **Low** | Moderate | Minor | Minor | Negligible |
| | **Negligible** | Minor | Negligible | Negligible | Negligible |

### 9.5.2 Uncertainty and Technical Difficulties Encountered

23. The assessment is based on the best information available at the time of undertaking the Project EIA. The assessment uses site-specific baseline data collected by trained and experienced ESAS observers each month over a period of three years (Section 9.6). The three years of baseline seabird data along with supporting information on the key seabird species over the wider area (e.g. tracking studies and breeding colony counts over a similar time period) provides a robust baseline on which to undertake an assessment.

24. The collision risk modelling that was conducted to help determine the extent and magnitude of any potential collision impact and the associated avoidance rates used in this assessment followed recommended guidance as presented in the Scoping Opinion (Marine Scotland, 2017).

25. Similarly, the displacement assessment followed recommended guidance presented in the Scoping Opinion (Marine Scotland, 2017). Although the revised Marine Scotland displacement model was not available for use at the time of this assessment, the Scoping Opinion recommended the use of the SNCB displacement matrices (SNCB, 2017) as an alternative approach and this was used for the assessment. The use of the three-year peak seasonal mean for the displacement assessment was considered to reduce uncertainty caused by natural variation in bird numbers and distribution between years.

26. There is limited information available on other offshore wind farm developments considered within the cumulative assessment. Where available, information presented within the 2017 scoping document for each project, or information circulated by the developers, has been used. However, where the relevant information is not otherwise available, the assessment is based on information published within the original applications. For Seagreen A and B, there were no population estimates available for the 2 km buffer area around the Wind farm Area.

27. For other, more distant North Sea offshore wind projects, the most conservative published collision estimate was used in the cumulative collision impact assessment, as detailed in Section 9.9.4. This was considered precautionery, as it resulted in a higher number of cumulative collisions being assessed.

28. The assessment used the North Sea BDMPS population estimates for the key SPAs in the vicinity of the Forth and Tay projects as reference populations for the non-breeding season (Furness, 2015), as recommended in the Scoping Opinion (Marine Scotland, 2017). There were some differences between the seasonal breakdowns presented in Furness (2015) and the seasonal breakdowns provided in the Scoping Opinion (Table 9-7), however, the seasonal breakdowns in the Scoping Opinion were followed in this assessment.

29. There is uncertainty over the potential construction schedule of the other, future offshore wind farms. This has a potential effect on the assessment when a population model is used to assess the population level effects arising from cumulative impacts. The worst-case scenario is predicted to arise if all currently planned future projects are included. For the purpose of this assessment this

precautionary assumption has been made. However, there is a high degree of uncertainty that this scenario will occur, as some future projects may not get constructed, or if they do, then the eventual number of turbines used will likely be much lower, due to improvements in turbine technology. It is therefore likely that any cumulative impacts would have a lower population level impact.

30. This assessment is based on the best available information and assessment methods currently available and although there are areas of uncertainty these are recognised within the approaches used for this assessment and a precautionary approach has been taken throughout.

## 9.6 Baseline Survey Methods

31. The methods used to conduct the three years of baseline seabird surveys between November 2009 and October 2012 followed standard COWRIE approved survey methodology (Camphuysen *et al.* 2004). Seabirds (and marine mammals) were recorded using an adaptation of the standard Joint Nature Conservation Committee (JNCC) Seabirds at Sea survey method, which uses line transect methodology (see Webb & Durinck 1992 for further details).

32. Within the Project study area, there are two components; the Wind Farm Area and the surrounding Buffer area, which extends out to 8 km (Figure 9-1). A series of transects running in a north-west to south-easterly direction across the Wind Farm Area and 8 km buffer area and spaced 2 km apart were surveyed each month.

33. Surveys were conducted on the *M.V. Fleur de Lys* in Years 1 and 2, which has a custom-built surveyor platform with an observer eye-height of greater than 5 m, as recommended for ESAS surveys (Webb & Durinck 1992, Camphuysen *et al.* 2004). In Year 3, surveys were conducted onboard *M.V. Eileen May*, which had a survey platform with a similar observer eye-height to the previous survey vessel.

34. Birds were counted ahead of the ship and out to one side of the survey vessel in a 90° arc, with a 300 m transect width, using two surveyors, as per Camphuysen *et al.,* (2004). Three ESAS accredited surveyors were on board for the majority of surveys, apart from between November and March of Year 1, and February of Year 3 when only two ESAS surveyors were on board. At any one time, one surveyor was acting as the primary observer, with a second acting as scribe and secondary observer, while the third surveyor was on a break.

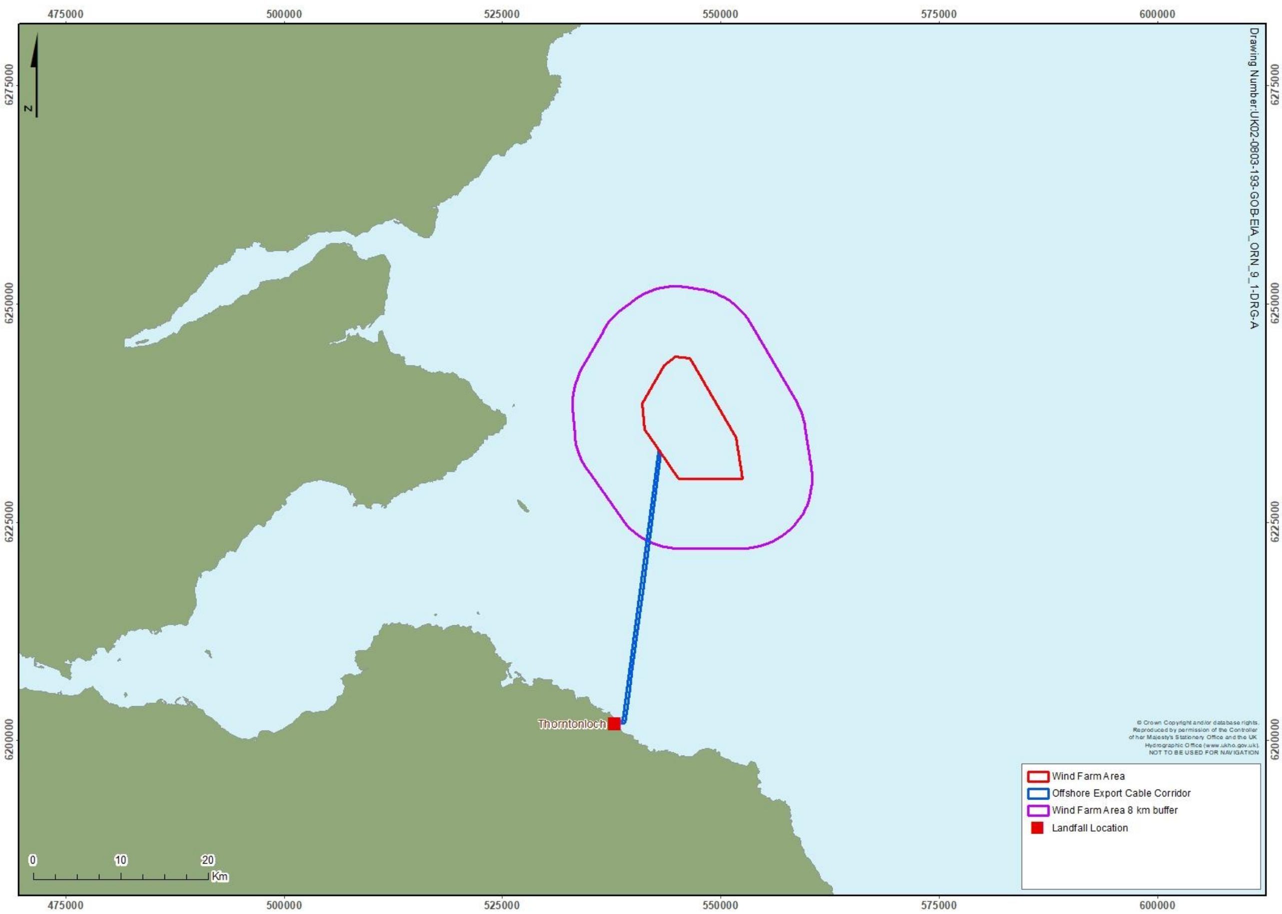


Figure 9-1 Wind Farm Area and 8 km buffer area

35. Binoculars were used to confirm identifications as well as to scan ahead for species such as red-throated divers, which are easily disturbed and take flight at some distance from the approaching vessel. Birds on the water were assigned to distance bands (A = <50 m, B = 51-100 m, C = 101-200 m, D = 201–300 m, E =>300 m), according to their perpendicular distance from the ship's track.

36. A snapshot method was used for flying birds, which considers the ship's speed and prevents overestimation of flying seabird densities. In addition, the estimated height of flying birds was also recorded, to the nearest 5 m. The count interval for surveys was 1 minute intervals, and synchronised GPS recorders were used to record the vessel position every minute. Any marine mammals and uncommon bird species seen on the 'non-survey' side of the vessel were also recorded. All terrestrial bird species seen were also recorded.

37. Environmental conditions such as wind direction and force, sea state, swell height and visibility were recorded every 15 minutes throughout survey days. Surveys were carried out in good weather where possible, to maximise detection rates of birds and marine mammals on the water. Surveys were halted if the sea state exceeded sea state 4, as recommended in Camphuysen (2004).

38. Baseline surveys were conducted by Simon Pinder, Ailsa Reid, Richard Schofield, Caroline Weir, Stuart Murray, Digger Jackson, Ewan Wakefield, Andy Sims, John Clarkson, Tim Sykes, Rachel Coombes, Jon Ford, Paul French, Jonathon Clarke, Bill Aspin, Phil Espin and Chris Rodger. All surveyors were ESAS-accredited.

39. Following completion of each survey, survey datasheets were entered onto a Paradox database using the JNCC Seabirds at Sea Team data-entry program, then printed and manually checked for any errors before the analysis of the data was conducted.

40. These data formed the basis for estimating population sizes and densities of seabirds in the study area. These estimates were derived by applying Distance sampling techniques using Distance 6.0

software. Further details on this technique and associated corrections in relation to the baseline survey data are presented in Appendix 9.1: Population and density estimates of seabirds at Neart na Gaoithe. Distance analysis of ship-based survey data from the period November 2009 to October 2012. Bureau Waardenburg. 2013.

41. The Scottish Ministers, SNH and RSPB concluded in the Scoping Opinion that additional baseline seabird surveys were not required for this application (Marine Scotland, 2017).

# 9.7 Baseline Description

## 9.7.1 Definition of Seasons and Reference Populations

### 9.7.1.1 Definition of Seasons

42. The breakdown of months for the breeding and non-breeding seasons for the key species covered in this assessment followed the Scoping Opinion (Marine Scotland, 2017), and are shown in Table 9-7. Where seasons were split within months e.g. mid-March to September, monthly totals of birds were split 50:50 between each season, as recommended in the Scoping Opinion (Marine Scotland, 2017).

Table 9-7: Definitions of breeding and non-breeding season used in this assessment, as provided in the Scoping Opinion (Marine Scotland, 2017)

| Species | Breeding season | Non-breeding season |
|---|---|---|
| **Gannet** | Mid-March to September | Autumn – October and November<br>Spring – December to mid-March |
| **Kittiwake** | Mid-April to August | Autumn - September to December<br>Spring – January to mid-April |
| **Herring gull** | April to August | September to March |
| **Lesser black-backed gull** | Mid-March to August | Not present in significant numbers |
| **Great black-backed gull** | April to August | September to March |
| **Puffin** | April to mid-August | Mid-August to March |
| **Guillemot** | April to mid-August | Mid-August to March |
| **Razorbill** | April to mid-August | Mid-August to March |

### 9.7.1.2 Reference Populations

43. Most recent population counts for the key seabirds and breeding colony SPAs of relevance to this assessment have been taken from Appendix A(ii) of SNH guidance, as provided in the Scoping Opinion (Marine Scotland, 2017) (Table 9-8). For the breeding season, those SPAs within mean maximum foraging range (+1 SD) for each species, based on Thaxter *et al.,*(2012) were used in the assessment. For the non-breeding season, all SPAs listed as relevant for each species were used in the assessment, on the basis that individuals from these SPAs may occur in the Wind Farm Area at this time.

Table 9-8: Most recent population counts for the key seabirds and breeding colony SPAs of relevance to this assessment, as provided in Scoping Opinion (Marine Scotland, 2017)

| Species | SPAs and distance from NnG | SPA Citation population [4] | Most recent counts & year |
|---|---|---|---|
| **Gannet** | Forth Islands (16 km) | 21,600 pairs | 75,259 pairs (2014) |
| **Kittiwake** | Buchan Ness/Collieston Coast (113 km) | 30,452 pairs | 11,482 pairs (2016-17) |
| | Forth Islands (16 km) | 8,400 pairs | 4,663 pairs (2017) |
| | Fowlsheugh (62 km) | 36,350 pairs | 9,655 pairs (2015) |
| | St Abb's Head to Fast Castle (31 km) | 21,170 pairs | 3,334 pairs (2016) |
| | **Total** | **96,372 pairs** | **29,134 pairs** |
| **Herring gull** | Buchan Ness/Collieston Coast (113 km) | 4,292 pairs | 3,115 pairs (2016-17) |
| | Forth Islands (16 km) | 6,600 pairs | 6,580 pairs (2014-17) |
| | Fowlsheugh (62 km) | 3,190 pairs | 125 pairs (2015) |
| | St Abb's Head to Fast Castle (31 km) | 1,160 pairs | 325 pairs (2016) |
| | **Total** | **15,242 pairs** | **10,145 pairs** |
| **Lesser black-backed gull** | Forth Islands (16 km) | 2,920 pairs [1] | 2,571 pairs (2014-16) |
| **Great black-backed gull** | No SPA within mean maximum foraging range | - | 121 pairs Forth Islands in 2015-16. Not SPA. |
| **Puffin** | Forth Islands (16 km) | 14,000 pairs | 45,005 pairs (2009-17) |
| **Guillemot** | Buchan Ness/Collieston Coast (113 km) | 17,280 birds | 33,632 birds (2016-17) |
| | Forth Islands (16 km) | 8,000 birds | 28,786 birds (2017) |
| | Fowlsheugh (62 km) | 56,450 birds | 55,507 birds (2015) |
| | St Abb's Head to Fast Castle (31 km) | 31,750 birds | 36,206 birds (2016) |
| | **Total** | **113,480 birds** | **154,131 birds** |
| **Razorbill** | Forth Islands (16 km) | 2,800 birds | 5,815 birds (2017) |
| | Fowlsheugh (62 km) | 5,800 birds | 7,426 birds (2015) |
| | St Abb's Head to Fast Castle (31km) | 2,180 birds | 2,067 birds (2016) |
| | **Total** | **10,780 birds** | **15,298 birds** |

## 9.7.2 Wind Farm Area

### 9.7.2.1 Results from Site Specific Baseline Surveys for Key Species

44. Within the NnG Wind Farm Area, 22 species of seabird were recorded during Year 1 baseline surveys. The three most frequently recorded species in the Wind Farm Area in Year 1 were gannet, puffin and guillemot, which together accounted for 62.3% of all birds recorded. In Year 2, 16 species were recorded in the Wind Farm Area, with gannet, guillemot and puffin again the three most frequently recorded species. These three species accounted for 77.1% of all birds recorded. In Year 3, 17 species were recorded in the Wind Farm Area, with gannet, guillemot and puffin again the three most frequently recorded species. These three species accounted for 72.9% of all birds recorded.

[4] Stroud *et al.*, 2001

45. There were eight species highlighted for assessment in the Scoping Opinion (Marine Scotland, 2017). Raw numbers of these species recorded in the Wind Farm Area and the Project Study Area during baseline surveys are presented in Table 9-9.

Table 9-9: Raw numbers of the eight key species recorded on baseline surveys in the Project study area in Years 1 to 3 (Raw numbers, all sea states)

| Species | Year One | | Year Two | | Year Three | |
|---|---|---|---|---|---|---|
| | Wind Farm Area | Project Study Area | Wind Farm Area | Project Study Area | Wind Farm Area | Project Study Area |
| **Gannet** | 1,649 | 13,021 | 3,122 | 19,416 | 2,134 | 14,825 |
| **Kittiwake** | 801 | 3,955 | 719 | 4,123 | 838 | 4,300 |
| **Herring gull** | 50 | 1,723 | 58 | 1,433 | 54 | 800 |
| **Lesser black-backed gull** | 10 | 66 | 11 | 195 | 37 | 171 |
| **Great black-backed gull** | 25 | 528 | 20 | 434 | 17 | 225 |
| **Guillemot** | 1,252 | 7,898 | 1,544 | 11,730 | 1,769 | 11,557 |
| **Razorbill** | 596 | 3,980 | 350 | 3,131 | 278 | 1,915 |
| **Puffin** | 1,306 | 11,199 | 1,110 | 6,622 | 1,196 | 5,983 |

46. Species accounts summarising the main findings of the baseline surveys for each of these eight species are presented in Appendix 9.2: Summary of results from baseline surveys for key species considered in this assessment. In addition, summary species accounts are also provided for five additional species (Arctic skua, great skua, little gull, black-headed gull and common gull) which were recorded in low numbers on baseline surveys, but which are included in the collision risk modelling assessment. These five species were included in the assessment on the basis of flight heights recorded during baseline surveys, where more than 1% of recorded flight height were above 27.5m in height.

### 9.7.3 Offshore Export Cable Corridor

47. In addition to the Wind Farm Area, the assessment of the Outer Firth of Forth and St Andrews Bay Complex proposed Special Protection Area (pSPA) should include the Offshore Export Cable Corridor, as highlighted by RSPB in the Scoping Opinion (Marine Scotland, 2017). During construction, the possibility of indirect effects on bird communities resulting from impacts on prey availability may occur.

48. For this reason, a summary of both benthic habitats and fish species likely to occur in the vicinity of the Offshore Export Cable Corridor and the wider area, including the Wind Farm Area is presented below. Further information is available in the Benthic Characterisation Report (Emu Ltd., 2010) (Appendix 7.1).

49. The offshore part of the cable route lies within the ‘deep circalittoral mud’ habitat indicated as characteristic of the outer Forth Estuary and widely distributed in this area. The southern end of the cable route corresponds to deep ‘circalittoral coarse sediment’ and ‘low energy rock’ habitats towards the Thortonloch landfall. All habitats along the cable route option appear to be common throughout the wider region (Emu Ltd., 2010).

50. In conclusion, the subtidal benthic environment was classified as a low energy, deep water (circalittoral) seabed environment within the vicinity of the Project (Emu Ltd., 2010). The dominant sediment type was slightly gravelly sand sediments with small amounts of silt, which was characterised by typical mud and sand fauna comprising infaunal brittlestars, polychaetes and bivalves. Sea bed imagery revealed that this sand habitat was also associated with sea pens and prominent mounds and burrows produced by megafauna. No rare or protected benthic species were recorded from the grab, trawl and video studies (Emu Ltd., 2010).

51. The principal pelagic fish species found in the vicinity of the Wind Farm Area and Offshore Export Cable Corridor are typical of the wider North Sea and include herring *Clupea harengus*, sprat *Sprattus sprattus* and mackerel *Scomber scombrus*. These species are commercially exploited in the wider region (see Chapter 10: Commercial Fisheries for details) and sprat and herring play an important ecological role as principal prey items for several larger fish species, seabirds and marine mammals.

52. Neither the Wind Farm Area nor the Offshore Export Cable Corridor coincide with sprat spawning areas, while herring spawning areas only coincide with the inshore region of the export cable. The Development area does not coincide with spawning areas for mackerel (Ellis *et al.* 2012, Coull *et al.* 1998). Both the Wind Farm Site and Offshore Export Cable Corridor are located in herring, sprat and mackerel nursery areas. The nursey grounds for mackerel in this area are stated as “low intensity”, while the nursey areas for herring are stated as “high intensity.

53. There are also several demersal species found in the vicinity of the Wind Farm Area and Offshore Export Cable Corridor, including sandeels (*Ammodytes* species), which are of particular importance as they occur within the foraging range of many seabirds breeding at colonies in and around the Firth of Forth (Wanless *et al.*, 1998).

## 9.7.4 Special Protection Areas (SPAs)

### 9.7.4.1 Terrestrial SPAs

54. There are four terrestrial SPAs for breeding seabirds that are within mean maximum foraging range of the key seabird species considered in this assessment (Table 9-8). The following site summaries are taken from online iSPA descriptions (JNCC, 2001).

55. The Firth of Forth Islands SPA is located in or near to the Firth of Forth on the east coast of central Scotland. The SPA comprises a number of separate islands or island groups, principally Inchmickery (together with the nearby Cow and Calves) off Edinburgh, Fidra, Lamb and Craigleith together with the Bass Rock off North Berwick, and the much larger Isle of May in the outer part of the Firth. The islands support important numbers of a range of breeding seabirds, in particular terns, auks and gulls. During the breeding season, the area regularly supports important numbers of breeding gannets, razorbills, guillemots, kittiwakes, herring gulls, lesser black-backed gulls, cormorants, shags, fulmars, puffins, common terns, Arctic terns and roseate terns. The seabirds feed outside the SPA in nearby waters, as well as more distantly in the North Sea.

56. Fowlsheugh SPA is located on the east coast of Aberdeenshire in north-east Scotland, overlooking the North Sea. The sheer cliffs, between 30-60 m high, are cut mostly in basalt and conglomerate of Old Red Sandstone age. They form a rock face with diverse structure providing ideal nesting sites for seabirds. The cliffs support major numbers of breeding seabirds, especially gulls and auks. During the breeding season, the area regularly supports important numbers of breeding razorbills, guillemots, kittiwakes, herring gulls and fulmars.The seabirds feed outside the SPA in nearby waters, as well as more distantly in the North Sea.

57. Buchan Ness to Collieston Coast SPA is located on the coast of Aberdeenshire in north-east Scotland. It is a 15 km stretch of south-east facing cliff formed of granite, quartzite and other rocks running to the south of Peterhead, interrupted only by the sandy beach of Cruden Bay. The site is of importance as a nesting area for a number of seabird species (gulls and auks). During the breeding season, the

area regularly supports important numbers of breeding guillemots, kittiwakes, herring gulls, shags and fulmars. These birds feed outside the SPA in the nearby waters, as well as more distantly.

58. St Abb's Head to Fast Castle SPA lies on the coast of Berwickshire in south-east Scotland. It is a 10 km stretch of cliffs comprised of Old Red Sandstone and Silurian rocks, in places reaching over 150 m in height. The cliffs are backed by areas of grassland, open water, flushes and splash zone communities. The site is important for large numbers of breeding seabirds, especially auks and gulls, which feed outside the SPA in surrounding marine areas, as well as further away in the North Sea. During the breeding season, the area regularly supports important numbers of breeding razorbills, guillemots, kittiwakes, herring gulls and shags.

#### 9.7.4.2 Outer Firth of Forth & St Andrews Bay pSPA

59. The following information is based on the SPA Site Selection Document produced in support of the pSPA designation (SNH 2016).

60. The Outer Firth of Forth and St Andrews Bay Complex proposed Special Protection Area (SPA) is a large estuarine/marine site with a total area of 2720.68km$^2$ situated off the south-east coast of Scotland. It consists of the outer sections of the adjacent Firths of Forth and Tay, including St Andrew's Bay, together with adjacent marine waters, to the east of the Isle of May (Table 9-2).

61. The Outer Firth of Forth and St Andrews Bay Complex has been selected to provide protection to important wintering grounds used for feeding, moulting and roosting by eight species of non-breeding inshore waterfowl (divers, grebes and seaduck). This wintering waterfowl assemblage includes the Annex 1 species red-throated diver and Slavonian grebe and over 1% of the biogeographical population of common eiders. Many of these birds migrate to Scotland every year to overwinter or to stop off at as one of their staging posts while on migration. The Firth of Forth is also notable for its concentrations of four species of wintering gulls, including Annex 1 little gulls and large numbers of roosting black-headed, common and herring gulls. In the non-breeding season these together with kittiwakes, guillemots, shags and razorbills contribute to an assemblage of over 40,000 seabirds using the site. The site also encompasses feeding grounds for breeding common terns, Arctic terns and shags nesting at SPA colonies within the site. During the breeding season kittiwakes, gannets, herring gulls, guillemots, puffins, and Manx shearwaters also contribute to a major assemblage of over 100,000 seabirds.

62. The Outer Firth of Forth and St Andrews Bay Complex proposed SPA, lying adjacent to the existing SPAs of the Firth of Forth and the Firth of Tay and Eden Estuary, supports populations of European importance of the following Annex 1 species:

- Red-throated diver;
- Little gull;
- Common tern;
- Arctic tern, and
- Slavonian grebe.

63. It also supports migratory populations of European importance of the following species: eider, Long-tailed duck, common scoter, velvet scoter, goldeneye, red-breasted merganser, gannet, Manx shearwater, shag, kittiwake, guillemot, razorbill puffin, black-headed gull, common gull and herring gull.

64. The area supports a wide variety of both pelagic and demersal fish, including sandeels, and crustaceans, molluscs and marine worms. The abundance of sandeels is of particular importance to colonial seabirds including terns, shags, puffins, razorbills, guillemots and kittiwakes which breed in colonies within and close to the pSPA, including the Isle of May. Gannet also feed on sandeels but are capable of taking a wider range of fish, including larger species such as herring and mackerel. Bass Rock, which is the largest gannet colony in the UK, is also situated in the Firth of Forth. Terns and

kittiwake feed on prey close to the water surface, whereas shags, puffins, razorbills, guillemots and gannet will also pursue prey underwater, in some cases to great depths.

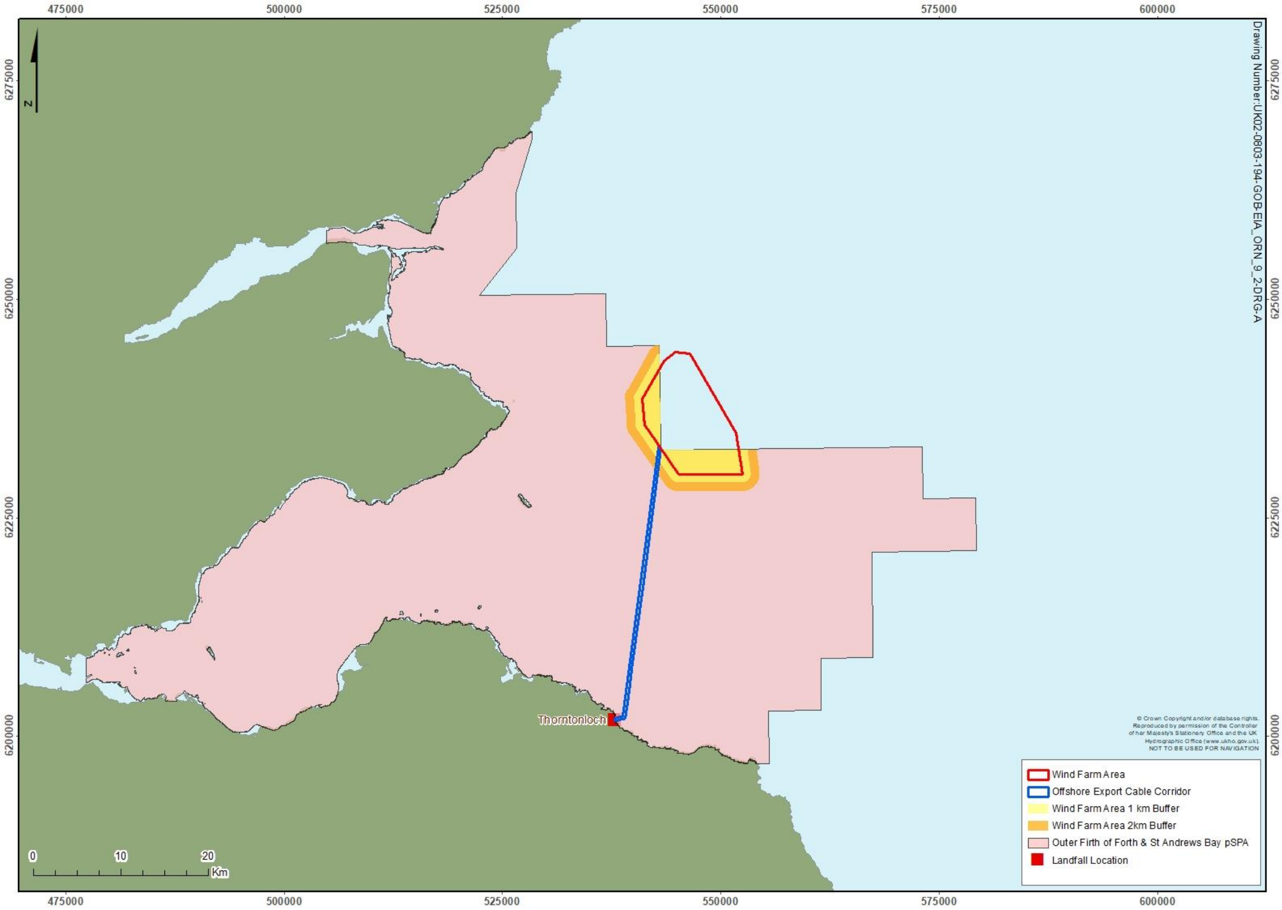


Figure 9-2: Outer Firth of Forth and St Andrews Bay pSPA

### 9.7.5 Development of Baseline Conditions without the Project

65. In the event of the NnG Project not being developed, there would be no change in the baseline conditions in the Wind Farm Area beyond those resulting from drivers such as climatic factors (such as temperature change and subsequent impacts of species' ranges), or human activities such as changes in fishing activities that indirectly affect seabird communities.

66. The numbers of seabirds using and passing through the Wind Farm Area over the next 50 years (the period when it is assumed the Wind Farm could be operational), would reflect changes in local distribution and populations which are driven by these factors.

## 9.8 Design Envelope – Worst Case Design Scenario

67. The Project application is for the construction, operation and decommissioning of an offshore wind farm with a maximum capacity of 450 MW, and a maximum of 54 turbines. The assessment scenarios identified in respect of ornithology have been selected as those having potential to represent the greatest effect on birds, based on the design envelope described in Chapter 4: Project Description.

68. The assessment of potential impacts on birds within this chapter is based on this design envelope, with the development methodology and parameters being based upon the worst case scenario.

69. Key parameters for the worst case scenario for each potential impact are detailed in Table 9-10.

Table 9-10: Design envelope scenario assessed

| Potential Impact | Worst Case Design Scenario | Justification |
|---|---|---|
| **Construction** | | |
| **Disturbance and loss of seabed habitat arising from cable installation** | Two export cables approximately 43 km in length. Cable corridor is approximately 33 km long (site boundary to landfall). Burial depth is maximum of 3m.<br>Maximum 300m spacing between cables. 3x water depth but no less than 70m.<br>Burial method currently unconfirmed, but likely plough/cutting/jetting or rock cover.<br>Installation will require one primary vessel with dynamic positioning and up to three support vessels. Likely vessel speed of 2-3km per day.<br>Installation methods under consideration include:<br>Use of high-pressure pump/jets to cut trenches where sandy conditions exist. Having laid the cable, the trenches will close naturally without backfilling;<br>Use of mechanical cutters or cable ploughs;<br>Laying of cable on the seabed and covering with scour protection, either with rock mattress or over placement with unbound graded rock (where bedrock outcrops at seabed level or thin sediment layer is present over the bedrock). | This is the worst case scenario for disturbance. Final methods for cable trenching will be established following final detailed geotechnical surveys therefore at this stage, none of these potential methods can be excluded. |
| **Operation** | | |
| **Displacement and barrier effects** | Wind farm footprint and 2 km buffer. | A single wind farm footprint and 2 km buffer is the worst case.<br>Variations on the potential design e.g. turbine numbers, are not considered as the assessment uses displacement rates recommended by the Scoping Opinion. |

| Potential Impact | Worst Case Design Scenario | Justification |
|---|---|---|
| **Collision mortality** | Maximum of 54 turbines<br>Minimum air gap of 35m LAT<br>Rotor diameter 167m<br>See Chapter 4: Project Description and Appendix 9.3 for further details of turbine design parameters | The maximum number of modelled collisions occurs due to the maximum number of turbines, therefore this forms the worst case.<br>The air gap will vary across the site and whilst the lowest rotors will be at 35m LAT, it cannot currently be determined how many rotors will be higher. Therefore a precautionary approach has been taken, where it is assumed that all rotors have a minimum air gap of 35m LAT.<br>The maximum rotor diameter under consideration is 167m. |
| **Disturbance during Operation and Maintenance activities from helicopters** | 80 round trips to site anticipated per annum for a small helicopter | If helicopters are used (which is not certain), 80 is considered to be the maximum number of annual trips therefore this is considered to be the worst case scenario for disturbance. |
| **Cumulative Effects** | | |
| **Cumulative displacement impacts** | For NnG and Inch Cape, worst case scenario taken as birds displaced from Wind Farm Area and 2 km buffer.<br>For Seagreen A & B, no figures available for 2 km buffer, so worst case was birds displaced from Wind Farm Area only. | This was recommended approach in Scoping Opinion (Marine Scotland, 2017). |
| | **Scenario One:**<br>NnG with proposed updated designs for Seagreen and Inch Cape<br>**NnG:**<br>2017 worst-case design scenario (54 turbines) (as above)<br>**Seagreen Phase 1:**<br>120 turbines<br>Minimum rotor height of 29.8m LAT<br>Rotor diameter 167m<br>**Inch Cape:**<br>40 turbines<br>Minimum rotor height of 30.5m LAT<br>Rotor diameter 250m<br>See Appendix 9.3 for further details of turbine design parameters. | NnG 2017 worst-case design scenario (54 turbines) (as above).<br>Seagreen 2017 – maximum turbine numbers (120) within Seagreen revised design were used. These are assumed for a scenario with lowest individual turbine capacity. Currently the lowest turbine capacity likely to be used would be an 8MW machine, therefore the parameters of a known 8MW were the basis for the assessment. Minimum air gap was provided by Seagreen. Air gaps will vary and in some cases will be higher, so this is a precautionary approach.<br>Inch Cape – a comparison of CRM outputs was undertaken for turbine numbers/parameters provided by ICOL. The worst case was using a theoretical maximum rotor |

| Potential Impact | Worst Case Design Scenario | Justification |
|---|---|---|
| | | diameter of 250m (far larger than anything available or present or in the near future). Such a large generator would use the lowest number of turbines in ICOL's range i.e. 40.<br>Minimum air gap was provided by Inch Cape. Air gaps will vary and in some cases will be higher, so this is a precautionary approach. |
| | **Scenario Two:**<br>NnG with consented designs for Inch Cape and Seagreen<br>**NnG:**<br>2017 worst-case design scenario (54 turbines) (as above)<br>**Seagreen:**<br>Maximum of 75 turbines per project (consented)<br>Minimum rotor height of 29.8m LAT<br>Rotor diameter 167 m<br>**Inch Cape:**<br>Maximum of 110 turbines (consented)<br>Minimum rotor height of 27 m LAT<br>Rotor diameter 172 m<br>See Appendix 9.3 for further details of turbine design parameters. | NnG 2017 worst-case design scenario (54 turbines) (as above).<br>For Inch Cape and Seagreen, 2014 scenarios were assessed as these were the worst case designs for the existing consents. It is considered highly unlikely that these projects will be built to this extent, therefore they are considered to be precautionary and unrealistic. |
| **Collision impacts from other UK OWF projects** | For kittiwake collision impacts in the non-breeding season, NnG 2017 & 2014 consents for Inch Cape & Seagreen A & B were considered, along with collision estimates for UK offshore wind farms in North Sea. For gannet collision impacts, projects in the English Channel were also included.<br>In addition, all four 2017 proposed projects, together with UK offshore wind farms in North Sea (and English Channel for gannet) – see Section 9.9.4. | This was recommended approach in Scoping Opinion (Marine Scotland, 2017). |

## 9.8.1 Embedded Mitigation

70. Mitigation measures that have been identified and adopted into the Project design as the design envelope has evolved and that are relevant to ornithology are set out in Table 9-11. In the event that further mitigation is required that cannot be embedded into the Project, this has been included as additional mitigation and is set out in Section 9.10.

Table 9-11: Embedded mitigation relating to ornithology

| Design Parameter | Embedded Mitigation |
|---|---|
| **Operation** | |
| **Number of turbines** | The number of turbines was reduced from a maximum of 125 at the time of the Original Application to a maximum of 90 at the time of the addendum and 75 for the Original Consents. The reduced turbine numbers and increased spacing was anticipated to reduce the risk of collision, displacement and barrier effects on birds.<br>The design evolution of the Project has continued and the number of turbines has been further reduced to a maximum of 54 turbines for the Project EIA Report. |
| **Rotor height** | Increasing the turbine rotor height reduces the risk of collision for a number of seabirds, many of which rarely fly above about 25 m but occur regularly at around 20 m. Therefore an increase in turbine height can cause a reduction in the number of predicted collisions.<br>Minimum rotor height was increased from 26m above LAT in the Original Application to 30.5m above LAT in the Addendum. The design evolution of the Project has continued and the minimum rotor height has been further increased to a minimum rotor height of 35m above LAT and the assessments are on this basis. |

## 9.9 Impact Assessment

71. Based on the requirements set out in the Scoping Opinion (Marine Scotland, 2017), the impact assessment focuses only on the operational phase of the Project, with the exception of construction phase impacts on the the Outer Firth of Forth & St Andrews Bay pSPA which are considered in the following section. Currently, impacts on birds resulting from decommissioning activities are expected to be no greater than those during the construction phase. Decommissioning impacts are considered to be covered under Construction Phase Impacts below, with no further assessment required.

### 9.9.1 Construction Phase Impacts

72. Although most of the potential impacts on birds arising during the construction phase of the Project have been scoped out of this EIA Report (Marine Scotland, 2017), part of the Wind Farm Area and the offshore export cable corridor are within the Outer Firth of Forth & St Andrews Bay pSPA (Table 9-2). Therefore, MS-LOT will need to address turbine and export cable installation in any new appropriate assessment for the pSPA, as highlighted in the Scoping Opinion (Marine Scotland, 2017). An assessment of possible impacts on birds resulting from the installation of turbines and the export cables within the Outer Firth of Forth & St Andrews Bay pSPA is therefore included.

#### 9.9.1.1 Impacts of Installation of Turbines and Export Cables on the Outer Firth of Forth & St Andrews Bay pSPA

73. In their response to the Scoping Opinion (Marine Scotland, 2017), SNH considered that cable installation would not result in any significant amount of permanent habitat loss and were satisfied that the scoping report adequately addressed the potential cable impacts for each of the Forth & Tay wind farms and the liklihood of significant effects arising on ornithological receptors. SNH stated that any habitats or prey disturbed during the cable laying should not take long to recover and that they did not consider that cable installation would give rise to any significant amount of permanent habitat loss.

74. In their response to the scoping process, the RSPB accepted that potential impacts on the pSPA from the export cabling from the Forth & Tay wind farms and NnG turbine array could be small, however they did not agree that this necessarily meant they would be insignificant. RSPB considered it necessary that further information be provided to inform the requirements of the Birds & Habitats Directive. The RSPB suggested that information on the scale and longevity of the potential effect on the supporting habitats needed to be presented as part of the assessment.

75. In conclusion, the Scoping Opinion stated that "In order to inform the appropriate assessment ("AA") for the pSPA, NnGOWL should consider the footprint of the wind turbines and also the cable route in relation to the qualifying interests and conservation objective regarding habitat deterioration."

76. Details of the turbines and Offshore Export Cables and Cable Corridor are presented in Table 9-10. Further details are presented in Chapter 4: Project Description.

77. The export cable installation methods to be adopted will ultimately be dependent on the ground conditions along the export cable route. Final decisions will be made following further detailed geotechnical investigations and engineerign design work. Given the length of the proposed Export Cable Route Corridor a combination of methodologies may be required to bury the cable in different sections of the route. Seabed conditions or protection issues may require the cable to be protected by scour protection instead of, or in addition to, burial. It is estimated that up to 15% of the export cable route could require additional cable protection.

78. As highlighted in the Scoping Opinion (Marine Scotland, 2017), the existing consents, as previously issued for the Originally Consented Project, require the submission, for approval, of a cable installation plan (or cable lay strategy). The cable installation plan will detail how the final cable routing takes account of environmental sensitivities, including pSPA features of interest, and will also include a cable burial risk assessment so will provide details of the location of any required cable protection material. NnGOWL would expect a similar requirement in the consents issued for the Project.

79. The scoping report (NnGOWL, 2017) concluded that there will be no likely adverse significant effects on the benthic communities in the vicinity of the turbines or the Offshore Export Cable Corridor as a result of seabed sediment disturbances and re-deposition during construction. This view was shared by the Scottish Ministers who agreed that impacts on benthic habitats could be scoped out of this EIA Report. Impacts on fish and shellfish habitats arising from construction were also scoped out (with the exception of particle motion effects) on the basis that there would be no likely significant effects.

#### 9.9.1.2 Direct impacts on birds

80. Direct habitat loss impacts during construction on birds are considered to be of negligible magnitude due to the very localised and short-term effects of such habitat loss, effectively representing a very slight change to baseline conditions. Therefore, direct habitat loss during construction on birds during all seasons is evaluated as a negligible impact, with any effects predicted to lie within the limits of natural variation of a dynamic seabed ecosystem.

#### 9.9.1.3 Indirect impacts on birds

81. During construction, there is the potential for indirect effects on bird communities resulting from impacts on prey availability to occur. Within the Wind Farm Area that overlaps with the pSPA site boundary, there is the potential for the loss of habitat arising from the physical presence of the turbines. The possible loss of seabed habitat due to the physical presence of the turbines will occur on the seabed at each of the turbine locations. The scour protection around each turbine is estimated to be up to 1,200m$^2$. If each turbine foundation impacts an area of 1,200m$^2$ then there is the potential for a maximum loss of 64,800m$^2$ (0.064 km$^2$) of seabed habitat. In addition, there is the possibility that an Offshore Substation Platform will be situated within the pSPA, which would remove

a further 2,400m$^2$ of seabed habitat. The total potential area of seabed habitat lost would therefore be 67,200m$^2$ (0.0672 km$^2$).

82. This assessment is based on the worst-case scenario that all 54 turbines will be within the pSPA. However, approximately 68% of the Wind Farm Area is outwith the pSPA and therefore approximately 68% of the turbines will occur outwith the pSPA boundary and have no physical impact on the pSPA. It is therefore assumed that the potential habitat lost from turbine installation will be 68% less than 67,200m$^2$, which means that approximately 21,504m$^2$ (0.021504 km$^2$) of seabed habitat could be lost. The potential loss of 0.021504 km$^2$ of seabed habitat out of a total pSPA area of 2,720.68 km$^2$ is 0.0008% of the physical habitat within the pSPA.

83. It is concluded that the very small area of seabed habitat lost within the pSPA as a result of turbine installation will not cause a significant effect on benthic habitats within the pSPA and therefore will not result in indirect impacts on seabirds. No further assessment on the potential loss of habitat has been undertaken.

84. As summarised in Section 9.7.3, all habitats along the cable route option appear to be common throughout the wider region, indicating that there will be no significant effect on habitat diversity at the regional level as a result of the construction of the wind farm (Emu Ltd., 2010).

85. The assessment considered all birds of all sensitivities in all seasons. Indirect disturbance impacts during turbine installation or export cable installation on birds via impacts on fish prey were considered to be of negligible magnitude. As noted above, any such effects have been identified as not giving rise to likely significant effects at scoping. Any impacts in relation to installation of turbines or the Offshore Export Cables are very small in relation to seabird species foraging ranges, and are short-term and reversible. As a result it is considered highly unlikely that seabird communities would be affected given the absence of any significant effects on benthos or fish species.

86. Any such impact is therefore considered to represent no more than a short-term, slight change from baseline conditions, with any effects to lie within the limits of natural variation. Indirect impacts on seabird populations from the surrounding Outer Forth and St Andrews Bay pSPA arising from turbine or the export cable installation have therefore been evaluated as negligible. The significance of any impacts is therefore assessed to be **minor** at worst, and the potential indirect impact from habitat loss or disturbance during installation of turbines and the Expoprt Cable on seabirds is not significant.

## 9.9.2 Operational Phase Impacts

87. Impacts predicted to occur during the operational phase of the Project are presented below and based on the requirements set out in the Scoping Opinion (Marine Scotland, 2017).

### 9.9.2.1 Displacement and barrier effects

88. Displacement and barrier effects have been considered together in this assessment, as recommended by the SNCBs (SNCB 2017). Depending on the season and species involved, different methods have been applied during the assessment; these are outlined further below.

89. Displacement and barrier effects in the breeding and non-breeding seasons have been assessed for the following species, based on numbers of these species recorded in the Wind Farm Area during the baseline surveys and following the recommendations set out in the Scoping Opinion (Marine Scotland, 2017):

- Kittiwake;
- Puffin;
- Guillemot; and
- Razorbill.

90. The definition of breeding season for each species followed advice in the Scoping Opinion (Table 9-7) (Marine Scotland, 2017). The assessment of displacement and barrier effects in the breeding season followed the recent SNCB guidance (2017). In addition, the original CEH displacement modelling (2014) was also used as a basis for running a comparative assessment of breeding season effects for kittiwake, puffin, guillemot and razorbill.

91. The SNCB guidance (2017) states that a proportion of birds recorded within offshore wind farms may be passing through, and are therefore more likely to be affected by barrier effects, rather than displacement from the offshore wind farm, and that this is more likely to be the case for flying birds. However, the guidance concludes that there is currently not enough evidence to separate these impacts out and apportion to the two groups. In accordance with the guidance, this assessment assumes that total numbers of birds on site (flying and on water) are subject to displacement impacts.

92. Displacement impacts were assessed based on the overall mean seasonal peak numbers of birds (averaged over three years of baseline surveys) in the development footprint and 2 km buffer, as specified in the guidance. Mean seasonal peak population estimates were calculated by summing the highest monthly population estimate for the relevant season in years 1 to 3 and dividing by the number of years. Breeding seasons were determined using the seasonal breakdown provided by SNH (Table 9-7). Where a month was split across a season (e.g. mid-April to August), the monthly population estimate was split equally between the breeding and non-breeding season, as recommended in the Scoping Opinion (Marine Scotland, 2017). Where appropriate, the non-breeding season was further broken down into autumn and spring periods to allow comparison with non-breeding season seabird populations calculated in a recent review (Furness, 2015), as recommended in the Scoping Opinion (Marine Scotland, 2017).

93. For kittiwake, the ratio of different age classes recorded on surveys was used to estimate the number of adult birds present in each season. Due to the difficulty in aging guillemots, razorbills and puffins at sea, age ratios were assigned using the proportions from the stable age structure used in the PVA, as recommended in the Scoping Opinion (Marine Scotland, 2017).

94. For each species, a range of potential displacement is presented (in 10% intervals from 0% to 100%), based on the mean seasonal peak estimated numbers from baseline surveys as matrix tables. Values are presented for the Wind Farm Area and the Wind Farm Area plus a 2 km buffer, as recommended in the SNCB guidance (2017).

95. Mortality of adult birds displaced from the development site (plus buffer) was considered in this assessment. Reduction in productivity of breeding birds was not considered in the assessment, as recommended in the SNCB guidance, due to the lack of empirical evidence on the consequence of displacement to seabirds. Mortality of displaced birds was presented in 1% intervals between 1 and 5%, and 10% intervals between 10% and 100%. The rate of displacement and mortality used in the assessment was based on available published evidence and also on the recommendations set out in the Scoping Opinion (Marine Scotland, 2017). Displacement and mortality matrices for species covered in this assessment are presented in Appendix 9.4: Displacemet matrices for NnG and other projects included in the Cumulative Impact Assessment.

96. A comparison of mortality estimates between the SNCB displacement guidance (2017) and the CEH displacement model (Searle et al.2014) is also presented for each species considered in the displacement assessment. Depending on the species, there are differences between the SNCB guidance and the CEH displacement model, for example in terms of the displacement rates used, and the size of the buffer around the Wind Farm Area. These differences are highlighted in the text.

97. A recent review estimated species-specific non-breeding season seabird populations at biologically defined minimum population scales (BDMPS) to enable the apportioning of potential impacts of marine renewable developments during the non-breeding season (Furness, 2015). This review also included estimates of the numbers of adult and immature birds originating from each individual UK

SPA population in the non-breeding season, as required for HRA. Where appropriate, this information has been reproduced here and used to inform the assessment.

98. In the non-breeding season, displacement effects on kittiwake and puffin were considered by using the matrix approach as outlined in the recent SNCB guidance (2017) and non-breeding season seabird populations from Furness (2015). This provides a more informative means to assess potential displacement effects rather than using a purely qualitative approach.

99. For guillemot and razorbill, displacement effects in the non-breeding season were assessed using the recent SNCB guidance (2017) only, as the original CEH displacement modelling (2014) did not include the non-breeding season. Advice received in the Scoping Opinion (Marine Scotland, 2017) stated that for these two species, non-breeding season effects should be compared against relevant breeding season reference SPA populations. Although this was recognised in the Scoping Opinion as being highly precautionary due to the non-breeding season dispersal of these species, it was considered that using reference populations based on BDMPS could underestimate impacts, due to e.g. guillemots returning to their colony during this period (Marine Scotland, 2017). Both reference populations are presented in the assessment text.

### 9.9.2.2 Displacement and barrier effect results

#### *9.9.2.2.1 Gannet*

100. Although it was documented in the Scoping Opinion that both SNH and RSPB agreed that gannet did not need to be considered in the displacement assessment (Marine Scotland, 2017), the potential impact from barrier effects caused by offshore wind farms in the breeding season has been assessed qualitatively here, using evidence from published studies.

101. The potential effect that an offshore wind farm acting as a barrier would have on flight distances and times depends on how far the destination areas lie beyond the barrier. The results from tagging studies on gannets breeding on the Bass Rock show that they forage over a considerable area of the northern North Sea; commonly travelling distances in excess of 150 km from the colony and sometimes up to three times this distance (Appendix 9.7: GPS tracking maps for breeding gannets from Bass Rock). The mean maximum distances recorded from tagged gannets from the Bass Rock varies between years, depending on food availability, but ranges from between 170 km and 363 km (Hamer *et al.,* 2000; Hamer *et al.,* 2011). It is therefore reasonable to assume that likely destinations of gannet flights potentially affected by barrier effects due to the Project will be at a wide range of distances beyond the Wind Farm Area, and commonly many tens of kilometres beyond.

102. Studies on foraging gannets have shown that they are capable of extending foraging distances in response to distribution of prey, suggesting that birds would easily absorb the minor increases in flight distances that a barrier could cause (Hamer *et al.,* 2007; Hamer *et al*., 2011). On this basis, gannets appear to have a low sensitivity to barrier effects. This species was rated as having a low sensitivity to barrier effects by Maclean *et al.* (2009) and Langston (2010). In addition, a review by Furness and Wade (2012) concluded that gannets use a wide range of habitats over a large area, usually with a relatively wide range of prey species, and therefore have a high flexibility of habitat use.

103. Appendix 9.7 presents maps of gannets tracked from the Bass Rock in the breeding season in 2010, 2011, 2012 and 2015. Birds tagged in the 2010 to 2012 breeding seasons were all breeding adults from the Bass Rock colony, while birds tagged in the 2015 breeding season were breeding adults and non-breeding immature birds. This gannet data was made available by Keith Hamer of the University of Leeds.

104. The maps demonstrate that adult birds travel a considerable distance from the Bass Rock colony, and are therefore unlikely to be significantly affected by potential barrier effects arising from the Project.

105. It is concluded that barrier impacts caused by NnG will have no effect on gannets from the breeding SPA population within mean maximum foraging range in the breeding season. The sensitivity of gannets to barrier effects is assessed as negligible and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

#### *9.9.2.2.2 Kittiwake*

106. Monthly peak estimated numbers of kittiwakes in the Wind Farm Area and buffers (Appendix 9.2: Table 5) in the breeding season (mid-April to August), autumn (September to December) and spring (January to mid-April) for Years 1 to 3 were averaged to get the three-year mean peak per season (Table 9-12). Where peak numbers occurred in different months within the same season across different years, the peak month was used. This was repeated for 1 km and 2 km buffers around the Wind Farm Area.

Table 9-12: Seasonal three-year mean peak estimated numbers of kittiwakes in the Wind Farm Area (plus 1 km and 2 km buffers)

| Year | Wind Farm Area | | |
|---|---|---|---|
| | Breeding | Autumn | Spring |
| Year 1 | 83 | 2,211 | 4 |
| Year 2 | 1,451 | 837 | 152 |
| Year 3 | 3,783 | 146 | 117 |
| 3-year mean peak | 1,772 | 1,065 | 91 |
| | Wind Farm Area + 1 km buffer | | |
| | Breeding | Autumn | Spring |
| Year 1 | 407 | 2,513 | 10 |
| Year 2 | 1,641 | 882 | 185 |
| Year 3 | 3,903 | 191 | 135 |
| 3-year mean peak | 1,984 | 1,195 | 110 |
| | Wind Farm Area + 2 km buffer | | |
| | Breeding | Autumn | Spring |
| Year 1 | 620 | 4,440 | 10 |
| Year 2 | 1,708 | 936 | 222 |
| Year 3 | 4,165 | 672 | 185 |
| 3-year mean peak | 2,164 | 2,016 | 139 |

107. Based on advice in the Scoping Opinion (Marine Scotland, 2017), it was assumed that there will be 30% displacement of kittiwakes from the Wind Farm Area (and buffer areas) in the breeding and non-breeding seasons.

108. Populations at SPAs for breeding kittiwakes of relevance to this assessment are presented in Table 9-8. In the breeding season, the mean maximum foraging range of breeding kittiwakes is 60.0 ± 23.3 km, based on a sample size of six birds (Thaxter *et al.,* 2012). Based on this, three SPAs for breeding kittiwakes (Forth Islands, Fowlsheugh and St Abb's Head to Fast Castle) are within mean maximum

foraging range + 1 SD of the Project (Appendix 9.2: Figure 18). These three SPAs have therefore been used as the SPA reference population for this assessment in the breeding season. For the non-breeding season, the Buchan Ness to Collieston Coast SPA was also included.

109. The UK breeding population of kittiwakes has declined over the last 25 years. At the time of designation, Forth Islands SPA held 8,400 pairs of kittiwakes, but in 2017 the breeding population was 4,663 pairs (Table 9-8). Similarly, the breeding population at St Abb's Head to Fast Castle SPA was 21,170 pairs at the time of designation, with 3,334 pairs in 2016. The breeding population at Fowlsheugh SPA has also declined, from 36,650 pairs at the time of designation, to 9,655 pairs in 2015. Based on figures provided by SNH in the Scoping Opinion (Marine Scotland, 2017), the most recent total combined breeding population estimate for these three SPAs is therefore 17,652 pairs (Table 9-8).

110. Kittiwake is also listed as a qualifying interest for the Outer Firth of Forth & St Andrews Bay pSPA in the breeding and non-breeding seasons (SNH 2016).

*Breeding season (Mid-April to August)*

111. Assuming 30% of all kittiwakes were displaced from the Wind Farm Area during the breeding season (Marine Scotland, 2017), this would affect an estimated 532 birds (Table 9-13), increasing to 595 birds including the 1 km buffer, and 649 birds including the 2 km buffer. However, this estimate includes non-breeding immature birds, as well as breeding adults. During the breeding period (mid-April to August), 6.8% of aged kittiwakes were immature birds (Appendix 9.2: Table 5). This percentage was applied to the estimated numbers of displaced kittiwakes in the breeding season to estimate the maximum number of adults potentially displaced (equating to 496 adults in the Wind Farm Area, increasing to 554 adults including the 1 km buffer, and 605 adults including the 2 km buffer) (Table 9-13).

Table 9-13: Summary of kittiwake displacement for the Wind Farm Area and surrounding buffer areas in the breeding season

| Displacement | Breeding adults | Immature birds | Total number of birds |
|---|---|---|---|
| **Wind Farm Area** | 496 | 36 | 532 |
| **Wind Farm Area + 1 km** | 554 | 41 | 595 |
| **Wind Farm Area + 2 km** | 605 | 44 | 649 |

112. Based on advice received on mortality rates in the Scoping Opinion (Marine Scotland, 2017), a mortality rate of 2% of all kittiwakes displaced was assumed during the breeding season (from the Wind Farm Area (10 adults and one immature bird), Wind Farm Area and 1 km buffer (11 adults and one immature bird) and Wind Farm Area and 2 km buffer (12 adults and one immature bird) (Table 9-14). A mortality of 12 adult kittiwakes corresponds to a maximum of 0.03% of the SPA population within mean maximum foraging range (17,652 pairs), for the Wind Farm Area and 2 km buffer (Marine Scotland, 2017).

Table 9-14: Summary of kittiwake displacement mortality for the Wind Farm Area and surrounding buffer areas in the breeding season

| Displacement mortality | Breeding adults | Immature birds | Total number of birds | % of SPA population (adults) |
|---|---|---|---|---|
| **Wind Farm Area** | 10 | 1 | 11 | 0.03 |
| **Wind Farm Area + 1 km** | 11 | 1 | 12 | 0.03 |
| **Wind Farm Area + 2 km** | 12 | 1 | 13 | 0.03 |

113. In comparison, the CEH displacement model (Searle *et al.*, 2014) estimated that the change in the annual adult kittiwake survival rate for the Forth Islands SPA for NnG alone would be -1.04%, based on the homogeneous prey distribution scenario, and -1.08%, based on the heterogeneous prey distribution scenario (Table 9-15).

114. Similarly, for Fowlsheugh SPA, the change in the annual adult survival rates for the NnG project alone were estimated as -0.12% based on the homogeneous prey distribution scenario, and +0.06%, based on the heterogeneous prey distribution scenario.

115. For the St Abb's Head to Fast Castle SPA, the change in the annual adult survival rates for the NnG project alone were estimated as -0.05% based on the homogeneous prey distribution scenario, and -0.14%, based on the heterogeneous prey distribution scenario.

116. The estimated number of adult birds involved was calculated by dividing these survival rates by 100, and then multiplying by the relevant SPA population (Table 9-15). Based on the most recent population counts for these three SPAs (17,652 pairs, or 35,304 individuals), the estimated change in adult survival rates correspond to a mortality of 123 adult kittiwakes based on the homogeneous prey distribution scenario, or 98 adult kittiwakes based on the heterogeneous prey distribution scenario.

Table 9-15: Summary of annual kittiwake displacement mortality for SPAs in foraging range of NnG, as presented in the CEH displacement model (Searle *et al.*, 2014)

| SPA | Change in annual adult survival | | SPA population | Estimated number of adults | |
|---|---|---|---|---|---|
| | Homogeneous [5] | Heterogeneous [5] | | Homogeneous | Heterogeneous |
| **Forth Islands** | -1.04 | -1.08 | 4,663 pairs | -97 | -101 |
| **Fowlsheugh** | -0.12 | +0.06 | 9,655 pairs | -23 | +12 |
| **St Abb's Head to Fast Castle** | -0.05 | -0.14 | 3,334 pairs | -3 | -9 |
| **Total** | - | - | 17,652 pairs | -123 adults | -98 adults |

117. A worst-case annual estimated mortality of 123 adult kittiwakes corresponds to a maximum of 0.3% of the SPA breeding population within mean maximum foraging range (17,652 pairs), from displacement effects from NnG and a 1 km buffer. This demonstrates that if adult kittiwake mortality from displacement was to occur at this level, the impact would not be significant at the SPA population level.

118. However, this is an annual estimate, based on the homogeneous prey distribution scenario, which is considered highly unrealistic, an assumed 40% displacement rate, as well as several other

[5] Figures from Table 3.2, Searle *et al.* (2014)

assumptions including the behaviour of seabirds in response to wind farms (including habituation) and the effects of adult body mass change on subsequent survival, which are detailed in the final report for the displacement model (Searle *et al.*, 2014).

119. Searle *et al.* (2014) also concluded that model outputs are very sensitive to some parameters. The total amount of prey is the most prominent of these, and the report concluded that small changes in this value can have very substantial effects on the model output. The barrier and displacement rates, which were agreed by the Steering Committee, are also important parameters in determining the magnitude of the response to the wind farm (and the exploratory analyses, which used different scenarios for barrier and displacement rates, suggest that this is indeed the case).

120. One of the largest sources of uncertainty in the CEH displacement modelling was the translation of adult body mass into subsequent survival over the remainder of the year (Searle *et al.*, 2014).

121. Available evidence from existing operational projects indicates that kittiwake displacement is not likely to occur and as such, it is considered that a displacement rate of 30% as used in this assessment, (or 40% as used for NnG in the CEH displacement model), represents a highly precautionary assumption.

122. Results from monitoring at operational offshore wind farms indicate that kittiwakes are not likely to be displaced.  Typically, studies at existing offshore wind farms show either no significant change or small increases in kittiwake numbers compared to pre-construction numbers.  For example, analysis of five years of post-construction monitoring data at the Robin Rigg OWF suggested that there was no change in kittiwake flight behaviour in response to the presence of the turbines.  Kittiwakes were recorded in flight within the Robin Rigg OWF during operation (although no kittiwakes were recorded at turbine rotor height (35-125 m) within the site).

123. Although monitoring showed that numbers of kittiwakes on the sea decreased within the Robin Rigg OWF during the construction phase, this reduction was not statistically significant (Walls *et al*., 2013a, 2013b).  During operation, modelled kittiwake abundance across the study area was largest within and immediately east and west of the Robin Rigg OWF, providing clear evidence that kittiwakes had not been displaced from the Robin Rigg OWF during operation (Nelson *et al.,* 2015).

124. A review of avoidance behaviour recorded at operational wind farm projects in Denmark, Germany, the Netherlands, Belgium and the UK by Krijgsveld (2014), noted that three out of five studies reported kittiwakes as being indifferent to offshore wind farms, and readily entering them (OWEZ, PAWP, Blighbank).  At Thorntonbank (B), results indicated that kittiwakes were positively attracted to the wind farm (Vanermen et al. 2013).  Only one project (Alpha Ventus), where kittiwakes were numerous, reported a strong decline in numbers, suggesting possible avoidance (Mendel et al. 2014). However, although these studies are indicative, only results from the OWEZ wind farm reported by Leopold et al. (2011) were significant for this species.

125. Post construction monitoring of kittiwakes at the OWEZ wind farm showed statistically significant attraction to the offshore wind farm during one survey with non-significant results (neither attraction or avoidance) for a further four surveys (Leopold et al., 2011).  This study also found no behavioural evidence of gulls (including kittiwake) being displaced, with birds regularly seen flying through and sitting on the sea within the wind farm as well as resting on built infrastructure.  The authors concluded that “kittiwakes seemed mostly indifferent to the wind farm” and that there was “hardly any effect of the wind farm on their distribution” (Leopold et al., 2011).

126. At Horns Rev, Denmark, selectivity indices were significantly higher for the wind farm area during operation compared with the baseline period (Diersche and Garthe, 2006).  By contrast, the compared selectivity indices for the baseline and construction periods showed that kittiwake numbers were significantly lower during the construction phase both in the wind farm and in a zone that comprised the wind farm plus a 4 km area surrounding the wind farm (Christensen et al., 2003).

127. Post-construction monitoring at Arklow Bank, Ireland reported an increase in kittiwake numbers compared to baseline numbers, concentrated within ca. 10 km of the turbine array (Barton et al., 2009). The overall increase in kittiwake numbers and their proximity to the turbines was positively associated but not significantly so (Barton et al., 2009).

128. Results of radar and visual studies indicate that flying gulls in general are not deflected around or away from offshore wind farms. At Horns Rev, it was noted that “marked behavioural reactions to the wind farm and single turbines were not observed in gull and tern species” (Christensen and Hounisen, 2005), although the proportion of 15-minute time units that kittiwakes were recorded flying between two turbines was slightly lower when one and both were active compared to when both were inactive, indicating that operational turbines may have insignificant barrier effect on kittiwakes (Petersen et al., 2006). Summarising the barrier effect of wind farms on seabird species occurring in German marine areas, kittiwakes were categorised as ‘commonly flying through wind farms’ (Diersche and Garthe, 2006).

129. A recent study conducted at the operational Westermost Rough Offshore Wind Farm in July 2017, investigated evidence of displacement for kittiwakes and auks within the wind farm (APEM 2017). This report is presented in Appendix 9.5: Westermost Rough Displacement Study.

130. A series of three high resolution digital still aerial surveys of the Westermost Rough Offshore Wind Farm (WROWF) and its surrounding 8 km buffer were carried out in July 2017. Surveys were conducted to compare distributions of kittiwakes and auks inside and outside the wind farm during the breeding season. Westermost Rough is approximately 35 km from the Flamborough Head and Bempton Cliffs SPA, and is therefore within mean maximum foraging range of breeding kittiwakes from this colony. The wind farm covers an area of 35 km$^2$ with a capacity of approximately 210 MW, and was fully commissioned in 2015. The wind farm comprises 35 turbines spaced approximately 1 km apart, each with a turbine height of 177 m, hub height of 102 m and rotor diameter of 154 m. Westermost Rough therefore has a comparable design to NnG, in terms of the size of turbines and spacing between turbines. Older wind farms have smaller turbines with lower rotors which are considerably closer together.

131. Kittiwake distribution within the Westermost Rough wind farm and surrounding study area in July 2017 is presented in Figure 9-3, Figure 9-4 and Figure 9-5 below.

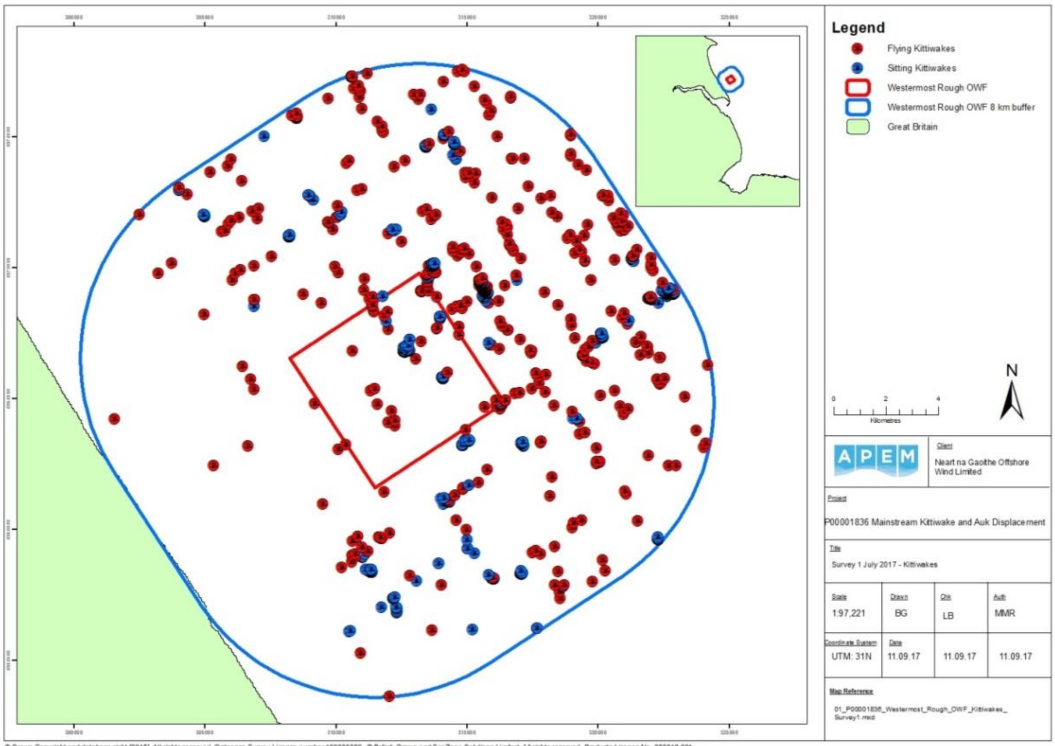




Figure 9-3: Distribution of kittiwakes recorded in the WROWF and 8 km buffer during Survey 1, July 2017

132. On all three surveys, kittiwakes were recorded in flight and on the water within the wind farm, indicating that birds were not displaced by the presence of the operational turbines.

133. While these figures show a lower number of kittiwakes in more inshore waters compared to further offshore, the distribution of kittiwakes within the wind farm compared to the surrounding area is similar on each survey.

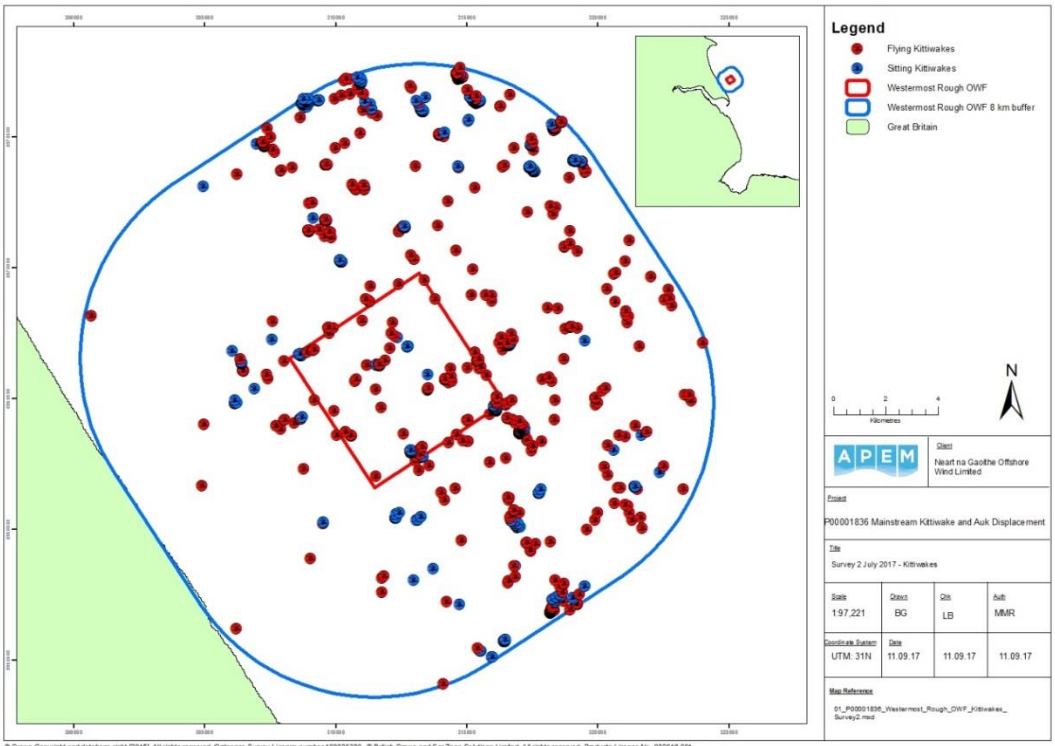




Figure 9-4: Distribution of kittiwakes recorded in the WROWF and 8 km buffer during Survey 2, July 2017

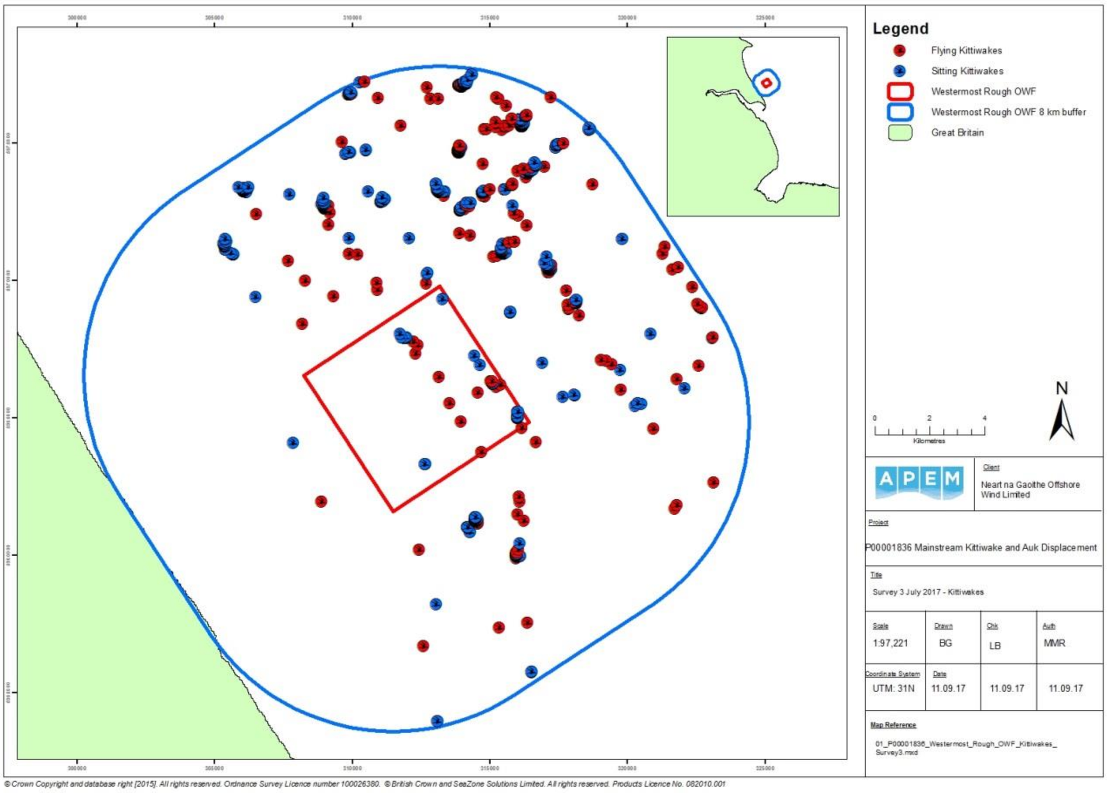


Figure 9-5: Distribution of kittiwakes recorded in the WROWF and 8 km buffer during Survey 3, July 2017

134. The study concluded that there was no evidence of displacement for kittiwakes based on mean densities calculated for the wind farm and compared with mean densities in the surrounding 8km buffer zone. There were variations in kittiwake densities between buffers but this was not statistically significant, potentially due in part to the large between-survey variability in kittiwake densities.

135. The advice provided by SNH in the Scoping Opinion (Marine Scotland, 2017) was that kittiwake did not need to be considered for displacement effects, as the data available from post construction monitoring indicates no significant avoidance behaviour by this species.

136. It was also considered that 2% mortality following displacement was a precautionary estimate, and that the actual mortality rate as a direct result of displacement would be lower than this.

137. There have been a series of tracking studies on kittiwakes breeding on the Isle of May, Fowlsheugh and St Abb's Head in recent years, undertaken by CEH. In the 2010 breeding season, a study conducted for FTOWDG indicated that kittiwakes from the Isle of May use both coastal and offshore areas, with a mean maximum range of 42 ± 31 km and a maximum of 150 km (Daunt *et al*., 2011a). This was based on a sample size of 36 tagged kittiwakes, and a total of 91 trips from the breeding colony. It can be seen from the plot of 2010 activity that the tagged kittiwakes were widespread in the 2010 breeding season, and that while they occurred within the Wind Farm Area, they were also recorded over a wide area north and east of the Isle of May (Appendix 9.6: GPS tracking maps for kittiwake, guillemot and razorbill from CEH tagging studies), with fewer tracks inshore of the Isle of May.

138. Analysis of at-sea distributions of kittiwakes using kernel density estimations found that the Wind Farm Area did not overlap to any great extent with the core area used by foraging kittiwakes from the Isle of May (50% kernels), but was within the overall area used by tagged foraging kittiwakes in 2010 (90% kernels). The core area of use (50% kernels) was estimated to cover an area of 1,947 $km^2$, while the overall area of active use (90% kernels) was estimated at 3,993 $km^2$ (Daunt *et al.,* 2011a). For comparison, the total area of the Wind Farm Area is 105 $km^2$.

139. Similar tracking studies were repeated in May and June 2011 at kittiwake breeding colonies at Fowlsheugh (35 birds, 93 trips) and St Abb's Head (25 birds, 70 trips) (Daunt *et al.,* 2011b). In the 2011 breeding season, foraging trips from Fowlsheugh were concentrated in a north-easterly to south-easterly direction, with a mean maximum foraging range of 35 ± 33 km, and a maximum foraging range of 141 km recorded (excluding one outlier of 415 km) (Appendix 9.6). Foraging range from St Abb's Head was similar (mean maximum range of 32 ± 25 km; maximum 108 km), but overall distribution was more focussed, in a south-easterly direction (Daunt *et al.,* 2011b) (Appendix 9.6). No tagged kittiwakes from the Fowlsheugh or St Abb's Head breeding colonies were recorded within the Wind farm Area during the 2011 breeding season, suggesting that the Wind Farm Area is not a key foraging area for birds from either of these breeding colonies.

140. Similar tracking studies were repeated by CEH in the breeding seasons of 2012 (17 tagged birds), 2013 (22 tagged birds) and 2014 (11 tagged birds). In the 2012 breeding season, the majority of recorded activity was south-west of the Wind Farm Area, to the north and east of the Isle of May, although some birds travelled through and well beyond the Wind Farm Area (Appendix 9.6). Kittiwakes were less widespread in the 2013 breeding season, based on the recorded track data, but again, most tagged birds travelled north and east of the Isle of May colony (Appendix 9.6). Activity within the Wind Farm Area was not higher than elsewhere within the tracking activity. In the 2014 breeding season, fewer tagged birds were recorded in the Wind Farm Area, although the sample size of tagged birds was slightly lower than previous years (11 tagged birds) (Appendix 9.6).

141. The main conclusion that can be drawn from these studies is that kittiwakes are clearly capable of travelling and foraging over considerable distances during the breeding season (Daunt *et al.,* 2011a). It is therefore considered that should kittiwakes be partially displaced from the Wind Farm Area following construction of the wind farm (which is considered unlikely based on available evidence), any impact on breeding success of these displaced birds is not likely to be significant.

142. It is concluded that displacement mortality impacts at NnG will have no effect on the breeding SPA populations of kittiwakes within mean maximum foraging range in the breeding season. The sensitivity of kittiwakes to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

*Autumn period of non-breeding season (September to December)*

143. Assuming 30% of all kittiwakes were displaced from the Wind Farm Area during the autumn period of the non-breeding season, this would affect an estimated 320 birds (Table 9-16), increasing to 359 birds including the 1 km buffer and 605 birds including the 2 km buffer.

144. A total of 43.1% of the kittiwakes aged on baseline surveys undertaken during the autumn period of the non-breeding season (September to December), were immature birds (Appendix 9.2: Table 5). Based on this figure, an estimated 182 adult and 138 immature kittiwakes may be displaced from the Wind Farm Area during the autumn period of the non-breeding season. This would increase to an estimated 204 adults and 155 immature kittiwakes displaced from the Wind Farm Area and 1 km buffer area, and 344 adult and 261 immature kittiwakes displaced from the Wind Farm Area and 2 km buffer area during the autumn period of the non-breeding season (Table 9-16).

Table 9-16: Summary of kittiwake displacement for the Wind Farm Area and surrounding buffer areas in the autumn period of the non-breeding season

| Displacement | Adults | Immature birds | Total number of birds |
|---|---|---|---|
| **Wind Farm Area** | 182 | 138 | 320 |
| **Wind Farm Area + 1 km** | 204 | 155 | 359 |
| **Wind Farm Area + 2 km** | 344 | 261 | 605 |

145. Based on advice in the Scoping Opinion (Marine Scotland, 2017), a mortality rate of 2% was assumed for all kittiwakes displaced from the Wind Farm Area (6 birds), or Wind Farm Area and 1 km buffer (7 birds), or Wind Farm Area and 2 km buffer (12 birds) during the autumn part of the non-breeding season (Table 9-17).

Table 9-17: Summary of kittiwake displacement mortality for the Wind Farm Area and surrounding buffer areas in the autumn period of the non-breeding season

| Displacement mortality | Adults | Immature birds | Total number of birds | % of SPA population |
|---|---|---|---|---|
| **Wind Farm Area** | 3 | 3 | 6 | 0.01 |
| **Wind Farm Area + 1 km** | 4 | 3 | 7 | 0.01 |
| **Wind Farm Area + 2 km** | 7 | 5 | 12 | 0.02 |

146. This is considered an over-estimate, as outside of the breeding season kittiwakes are no longer limited in their foraging range by having to return to the nest. As birds are free to forage over a wider area, any displacement effects (should they occur) are considerably less likely to have any mortality impact.

147. The total number of kittiwakes (adults and immature birds) estimated to occur in the UK waters of the North Sea in the autumn period (August to December) is 829,937 birds (Furness, 2015). Of this population, an estimated 432,129 kittiwakes (adults and immature birds) are considered to be from UK breeding colonies. If a maximum mortality of 12 kittiwakes resulted from displacement from the Wind Farm Area and 2 km buffer, this would affect 0.003% of the North Sea population from UK breeding colonies (432,129 adults and immature birds) in the autumn period of the non-breeding season.

148. Estimated numbers of adult and immature kittiwakes from the four key SPAs for kittiwakes considered in this assessment (Table 9-8) in the UK waters of the North Sea in the autumn period (August to December) are shown in Table 9-18 (Furness, 2015).

Table 9-18: Estimated numbers of adult and immature kittiwakes from the four key SPAs in the UK waters of the North Sea in the autumn period of the non-breeding season (Furness, 2015)

| SPA | Autumn North Sea | | |
|---|---|---|---|
| | Adult | Immature | Total |
| **Buchan Ness to Collieston Coast** | 15,050 | 8,830 | 23,880 |
| **Fowlsheugh** | 11,204 | 6,573 | 17,778 |
| **Forth Islands** | 3,720 | 2,182 | 5,902 |
| **St Abb's Head to Fast Castle** | 4,084 | 2,396 | 6,479 |
| **Combined total** | 34,058 | 19,981 | 54,039 |

149. If a mortality of up to 12 kittiwakes occurred as a result of displacement from the Wind Farm Area and 2 km buffer in the autumn period of the non-breeding season, this would affect 0.02% of the North Sea population from the four key SPAs (54,039 adults and immature birds) (Furness, 2015) (Table 9-17).

150. For the surviving displaced birds, there would be minimal impact from displacement, as foraging birds would be able to find food outside of the Wind Farm Area and 2 km buffer. In addition, based on evidence from other operational projects, kittiwakes are not predicted to be susceptible to displacement.

151. It is concluded that displacement mortality impacts at NnG will have no effect on kittiwakes from the four key SPA populations in the autumn period of the non-breeding season. The sensitivity of kittiwakes to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

*Spring part of non-breeding season (January to mid-April)*

152. Assuming 30% of all kittiwakes were displaced from the Wind Farm Area during the spring period of the non-breeding season, this would affect an estimated 27 birds (Table 9-19), increasing to 33 birds including the 1 km buffer and 42 birds including the 2 km buffer.

153. A total of 20.8% of the kittiwakes aged on baseline surveys during the spring period of the non-breeding season (January to mid-April), were immature birds (Appendix 9.2: Table 5). Based on this figure, an estimated 21 adult and six immature kittiwakes may be displaced from the Wind Farm Area during the spring period of the non-breeding season. This would increase to an estimated 26 adult and seven immature kittiwakes displaced from the Wind Farm Area and 1 km buffer area, or 33 adult and nine immature kittiwakes displaced from the Wind Farm Area and 2 km buffer area during the spring period of the non-breeding season (Table 9-19). As discussed above, this is considered precautionary.

Table 9-19: Summary of kittiwake displacement for the Wind Farm Area and surrounding buffer areas in the spring period of the non-breeding season

| Displacement | Adults | Immature birds | Total number of birds |
|---|---|---|---|
| **Wind Farm Area** | 21 | 6 | 27 |
| **Wind Farm Area + 1 km** | 26 | 7 | 33 |
| **Wind Farm Area + 2 km** | 33 | 9 | 42 |

154. Based on advice in the Scoping Opinion (Marine Scotland, 2017), assuming a 2% mortality rate of all kittiwakes displaced from the Wind Farm Area (one bird), or Wind Farm Area and 1 km buffer (one bird), or Wind Farm Area and 2 km buffer (one bird) during the spring period of the non-breeding season would result (Table 9-20).

Table 9-20: Summary of kittiwake displacement mortality for the Wind Farm Area and surrounding buffer areas in the spring period of the non-breeding season

| Displacement mortality | Adults | Immature birds | Total number of birds | % of SPA population |
|---|---|---|---|---|
| **Wind Farm Area** | 1 | 0 | 1 | 0.002 |
| **Wind Farm Area + 1 km** | 1 | 0 | 1 | 0.002 |
| **Wind Farm Area + 2 km** | 1 | 0 | 1 | 0.002 |

155. The total number of kittiwakes (adults and immature birds) estimated to occur in the UK waters of the North Sea in the spring period (January to April) is 627,816 birds (Furness, 2015). Of this population, an estimated 389,392 kittiwakes (adults and immature birds) are considered to be from UK breeding colonies. If one kittiwake was to die as a result of displacement from the Wind Farm Area and 2 km buffer, this would affect 0.0003% of the North Sea population from UK breeding colonies (389,392 adults and immature birds), in the spring period of the non-breeding season.

156. Estimated numbers of adult and immature kittiwakes from the four key SPAs for kittiwakes (Table 9-8) considered in this assessment in the UK waters of the North Sea in the spring period (January to April) are shown in Table 9-21 (Furness, 2015).

Table 9-21: Estimated numbers of adult and immature kittiwakes from the four key SPAs in the UK waters of the North Sea in the spring period of the non-breeding season (Furness, 2015)

| SPA | Spring North Sea | | |
|---|---|---|---|
| | Adult | Immature | Total |
| **Buchan Ness to Collieston Coast** | 15,050 | 6,622 | 21,673 |
| **Fowlsheugh** | 11,204 | 4,930 | 16,134 |
| **Forth Islands** | 3,720 | 1,637 | 5,357 |
| **St Abb's Head to Fast Castle** | 4,084 | 1,797 | 5,880 |
| **Combined total** | 34,058 | 14,986 | 49,044 |

157. If one adult kittiwake was to suffer mortality as a result of displacement from the Wind Farm Area and 2 km buffer during the spring period of the non-breeding season, this would affect 0.002% of the North Sea population from the four key SPAs (49,044 adults and immature birds) (Furness, 2015).

158. For the surviving displaced birds, there would be minimal impact from displacement, as foraging birds would be able to find food outside of the Wind Farm Area and 2 km buffer. In addition, based on evidence from other operational projects, kittiwakes are not predicted to be susceptible to displacement.

159. It is concluded that displacement mortality impacts at NnG will have no effect on kittiwakes from the four key SPA populations in the spring period of the non-breeding season. The sensitivity of kittiwakes

to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

*Assessment of displacement mortality throughout the year*

160. Predicted kittiwake mortality as a result of displacement in the Wind Farm Area and 2 km buffer for all seasons as calculated above, was summed for the whole year (Table 9-22).

Table 9-22: Estimated kittiwake mortality (adult and immature birds) from the Wind Farm Area and 2 km buffer on the key breeding SPAs in the UK waters of the North Sea throughout the year

| Season | Wind Farm Area | | Wind Farm Area + 2 km buffer | |
|---|---|---|---|---|
| | No of birds | % of SPA population | No of birds | % of SPA population |
| **Breeding season** | 10 adults | 0.03 | 12 adults | 0.03 |
| **Autumn period** | 6 | 0.01 | 12 | 0.02 |
| **Spring period** | 1 | 0.002 | 1 | 0.002 |
| **Total** | 17 birds | 0.04% | 25 birds | 0.05% |

161. Based on the seasonal mortality estimates and an assumed displacement rate of 30%, a total mortality of 17 kittiwakes was estimated based on 2% mortality, if displacement impacts are confined to the Wind Farm Area. This represents an estimated 0.04% of the SPA population, based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015).

162. If displacement impacts occur over the Wind Farm Area and a surrounding 2 km buffer, then an estimated mortality of 25 kittiwakes would occur as a result of displacement impacts. This represents an estimated 0.05% of the SPA population, based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015).

163. However, available evidence from existing wind farm projects as outlined above, indicates that a mortality rate of 2% is precautionary, as is the displacement rate of 30% used in the assessment. Therefore, it is concluded that displacement mortality impacts at NnG will have no effect on kittiwakes from the four key SPA populations throughout the year. The sensitivity of kittiwakes to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

### *9.9.2.2.3 Guillemot*

164. Monthly peak estimated numbers of guillemots in the Wind Farm Area (Appendix 9.2: Table 13) in the breeding season (April to mid-August) and non-breeding season (mid-August to March) for Years 1 to 3 were averaged to provide a three-year mean peak per season (Table 9-23). Where peak numbers occurred in different months within the same season across different years, the peak month was used. This was repeated for 1 km and 2 km buffers around the Wind Farm Area.

165. Based on the Scoping Opinion (Marine Scotland, 2017), it was assumed that there would be a 60% displacement of guillemots from the Wind Farm Area (and buffer areas) in the breeding and non-breeding seasons.

Table 9-23: Seasonal three-year mean peak estimated numbers of guillemots in the Wind Farm Area (plus 1 km and 2 km buffers)

| Year | Wind Farm Area | | Wind Farm Area + 1km buffer | | Wind Farm Area + 2km buffer | |
|---|---|---|---|---|---|---|
| | Breeding | Non-breeding | Breeding | Non-breeding | Breeding | Non-breeding |
| **Year 1** | 387 | 7,020 | 542 | 9,491 | 924 | 11,174 |
| **Year 2** | 3,789 | 2,222 | 4,100 | 3,839 | 4,323 | 7,140 |
| **Year 3** | 2,429 | 2,429 | 3,446 | 3,446 | 4,541 | 4,541 |
| **3-year mean peak** | 2,202 | 3,890 | 2,696 | 5,592 | 4,894 | 7,618 |

166. Populations at SPAs for breeding guillemots of relevance to this assessment are presented in Table 9-8. In the breeding season, the mean maximum foraging range of breeding guillemots is 84.2 ± 50.1 km, based on a sample size of five birds (Thaxter et al., 2012). Based on this, four SPAs for breeding guillemots (Buchan Ness to Collieston Coast, Forth Islands, Fowlsheugh and St Abb's Head to Fast Castle) are within mean maximum foraging range + 1 SD of the Project (Appendix 9.2: Figure 47**).** These four SPAs have therefore been used as the SPA reference population for this assessment in the breeding and non-breeding seasons.

167. Numbers of guillemots at the Buchan Ness to Collieston Coast SPA have increased from 17,820 birds at the time of designation to 33,632 birds in 2016/2017 (Table 9-8). Numbers of guillemots at the Forth Islands SPA have also increased, from 8,000 birds at the time of designation, to 28,786 birds in 2017. Over the same period, the breeding population at Fowlsheugh SPA has declined slightly, from 56,450 birds at the time of designation, to 55,507 birds in 2015. There has been a slight increase at St Abb's Head to Fast Castle SPA, from 31,750 birds at the time of designation, to 36,206 birds in 2016. Based on figures provided by SNH (Table 9-8), the most recent total combined population estimate for these four SPAs is therefore 154,131 birds.

168. In addition, the Project is also within mean maximum foraging range for breeding guillemots from the Farne Islands SPA, which is approximately 72 km from the Project. This population (49,037 birds in 2016) (SMP 2017) is also included in addition to the SPA reference population in the assessment text.

169. Guillemot is also listed as a qualifying interest for the Outer Firth of Forth & St Andrews Bay pSPA in the breeding and non-breeding seasons (SNH 2016).

*Breeding season (April to mid-August)*

170. Assuming 60% of all guillemots were displaced from the Wind Farm Area during the breeding season, this would affect an estimated 1,321 birds (Table 9-24), increasing to 1,618 birds including the 1 km buffer, and 2,936 birds including the 2 km buffer. However, this estimate includes non-breeding immature birds, as well as breeding adults.

Table 9-24: Summary of guillemot displacement for the Wind Farm Area and surrounding buffer areas in the breeding season

| Displacement | Breeding adults | Immature or non-breeding adults | Total number of birds |
|---|---|---|---|
| **Wind Farm Area** | 675 | 646 | 1,321 |
| **Wind Farm Area + 1 km** | 791 | 927 | 1,618 |
| **Wind Farm Area + 2 km** | 1,436 | 1,500 | 2,936 |

171. Studies have shown that for several seabird species, in addition to breeding birds, colonies are also attended by many immature individuals and a smaller number of non-breeding adults (e.g. Wanless *et al.,* 1998). There is little information on the breakdown of immature and non-breeding adults present at a colony; however, this was estimated using the PVA Stable age structure, as recommended in the Scoping Opinion (Marine Scotland, 2017).

172. Using proportions from the PVA stable age structure, the ratio of adult to immature birds at Forth Islands SPA and Fowlsheugh SPA has been calculated (Table 9-25).

Table 9-25: PVA Stable age structure for guillemots at Forth Islands SPA and Fowlsheugh SPA

| Age (years) | Forth Islands SPA | Fowlsheugh SPA | Mean proportion | Mean percentage |
|---|---|---|---|---|
| **1** | 0.1568 | 0.1545 | 0.15565 | 15.6 |
| **2** | 0.0838 | 0.085 | 0.0844 | 8.4 |
| **3** | 0.0647 | 0.0662 | 0.06545 | 6.5 |
| **4** | 0.0588 | 0.0597 | 0.05925 | 5.9 |
| **5** | 0.0522 | 0.0545 | 0.05335 | 5.3 |
| **6** | 0.0325 | 0.0349 | 0.0337 | 3.4 |
| **Total immature birds** | 0.4488 | 0.4548 | 0.4518 | 45.1 |
| **Breeding adults** | 0.5126 | 0.507 | 0.5098 | 51.0 |
| **Non-breeding adults** | 0.0386 | 0.0382 | 0.0384 | 3.8 |

173. Assuming that 48.9% of the population present are immature or non-breeding birds, then this would mean that an estimated 646 guillemots displaced from the Wind Farm Area during the breeding season would be immature or non-breeding adults, and that the number of displaced breeding adult birds would be 675 birds (Table 9-24). Similarly, an estimated 791 guillemots displaced from the Wind Farm Area and 1 km buffer during the breeding season would be immature or non-breeding adults, with 827 displaced breeding adult birds. An estimated 1,436 guillemots displaced from the Wind Farm Area and 2 km buffer during the breeding season would be immature or non-breeding adults, with 1,500 displaced breeding adult birds.

174. Using the 1% mortality rate advised by the Scoping Opinion (Marine Scotland, 2017), it was calculated that 13 guillemots (seven adults and six immature or non-breeding birds) displaced from the Wind Farm Area, during the breeding season would suffer mortality as a result (Table 9-26). Similarly, 16 guillemots (eight adults and eight immature or non-breeding birds) would suffer mortality in the Wind Farm Area and 1 km buffer, or 29 guillemots (15 adults and 14 immature or non-breeding birds) in the Wind Farm Area and 2 km buffer, during the breeding season.

Table 9-26: Summary of guillemot displacement mortality for the Wind Farm Area and surrounding buffer areas in the breeding season

| Displacement mortality | Breeding adults | Immature or non-breeding adults | Total number of birds | % of SPA population (adults) |
|---|---|---|---|---|
| **Wind Farm Area** | 7 | 6 | 13 | 0.005 |
| **Wind Farm Area + 1 km** | 8 | 8 | 16 | 0.005 |
| **Wind Farm Area + 2 km** | 15 | 14 | 29 | 0.01 |

175. Displacement mortality of up to 15 adult guillemots corresponds to up to 0.01% of the SPA adult breeding population within mean maximum foraging range (154,131 birds) (Table 9-8) (Marine Scotland, 2017). If the most recent count from the Farne Islands SPA is included (49,037 birds), then this would correspond to up to 0.007% of the SPA population within mean maximum foraging range (203,168 birds).

176. For the surviving displaced birds (1,308 birds; 668 adults and 640 immature or non-breeding birds from the Wind Farm Area alone, or 1,602 birds; 819 adults and 783 immature or non-breeding birds from the Wind Farm Area plus 1 km buffer, or 2,907 birds; 1,485 adults and 1,422 immature or non-breeding birds from the Wind Farm Area plus 2 km buffer), there could potentially be a detrimental impact on their breeding success, as a result of having to travel further on each trip to forage elsewhere.

177. For comparison, the CEH displacement model (Searle *et al.*, 2014) estimated that the change in the annual adult guillemot survival rate for the Forth Islands SPA for NnG alone would be -0.2%, based on the homogeneous prey distribution scenario, and -0.3%, based on the heterogeneous prey distribution scenario (Table 9-27).

178. The estimated number of adult guillemots involved was calculated by dividing these survival rates by 100, and then multiplying by the relevant SPA population (Table 9-27). Based on the most recent population counts for the Forth Islands SPA (28,786 individuals), the estimated change in adult survival rates corresponds to a mortality of 58 adult guillemots based on the homogeneous prey distribution scenario, or 86 adult guillemots based on the heterogeneous prey distribution scenario.

Table 9-27: Summary of annual guillemot displacement mortality for the Forth Islands SPA, from NnG alone, as presented in the CEH displacement model (Searle *et al.*, 2014)

| SPA | Change in annual adult survival | | SPA population | Estimated number of adults | |
|---|---|---|---|---|---|
| | Homogeneous [6] | Heterogeneous [6] | | Homogeneous | Heterogeneous |
| **Forth Islands** | -0.2 | -0.3 | 28,786 birds | -58 adults | -86 adults |

179. A worst-case annual estimated mortality of 86 adult guillemots corresponds to a maximum of 0.3% of the Forth Islands SPA breeding population (28,786 birds), from displacement effects from NnG and a 1 km buffer. This demonstrates that if adult guillemot mortality from displacement was to occur at this level, the impact would not be significant at the population level for this SPA.

180. However, this is an annual estimate, based on the heterogeneous prey distribution scenario, an assumed 60% displacement rate, and several other assumptions including the behaviour of seabirds in response to wind farms (including habituation) and the effects of adult body mass change on

[6] Figures from Table 3.2, Searle *et al.* (2014)

subsequent survival, which are detailed in the final report for the displacement model. As previously highlighted, the barrier and displacement rates, which were agreed by the project Steering Committee, are likely to be important parameters in determining the magnitude of the response to the wind farm (Searle *et al.*, 2014). Comparable results for other SPAs within mean maximum foraging range were not presented in the CEH displacement report (Searle *et al.*, 2014).

181. However, evidence from existing operational wind farms indicates that displacement may occur at a lower rate than the 60% rate used in this assessment and recommended by the scoping opinion.

182. A review of avoidance behaviour recorded at operational wind farm projects in Denmark, Germany, the Netherlands, Belgium and the UK by Krijgsveld (2014) reported that strong avoidance by guillemots and razorbills was shown in eight out of 10 studies. Only at Thorntonbank in Belgium, did results suggest that razorbills were attracted to and guillemots were indifferent to or avoided the offshore wind farm, although these results were not statistically significant. It is suggested that the observed results may be the result of foraging birds drifting into the wind farm on the sea surface, rather than birds flying into the wind farm. Wintering guillemots and razorbills occurred in this area in medium densities and results thus reflect a considerable number of observations.

183. At Blighbank, further offshore and in deeper waters, guillemots and razorbills avoided the offshore wind farm. However, this behaviour may have been related to food availability in the area more than the presence of the wind farm (Vanermen et al. 2013).

184. Studies at Horns Rev, Denmark report that although guillemots were recorded in relatively low numbers in the wind farm and buffer compared to the wider monitoring area during the pre-construction surveys, no guillemots occurred within 4 km of the wind farm during the construction period representing a significant decrease. In the operational period, the selectivity index for the wind farm plus a 4 km buffer was significantly lower when compared to the equivalent figure for the pre-construction period suggesting a reduced use of the sea area occupied by, and surrounding the wind farm during the operational phase (Diersche and Garthe 2006).

185. Compared to Horns Rev, the modelled results from OWEZ and the adjacent Princess Amalia wind farm did not conclusively show that guillemots were displaced from either of these offshore wind farms (Leopold *et al.,*2011). Where guillemots were significantly displaced, (2 out of 9 survey visits) this was not total displacement, with birds recorded within both wind farms. However, the authors suggest that higher turbine density probably increased displacement of guillemots. The OWEZ study concluded that the magnitude of the displacement effect for guillemots was less than 50% (Leopold *et al.,* 2011).

186. At OWEZ, despite overall avoidance, foraging guillemots on the water were regularly seen within the wind farm, suggesting that avoidance at OWEZ may be reduced compared to Horns Rev due to the comparatively large spacing between turbines (Krijgsveld et al. 2011, Leopold et al. 2011).

187. One issue that has been highlighted frequently by statutory advisors is that, for operational offshore wind farms in the Netherlands and Germany, species such as guillemot and razorbill predominantly occur in the non-breeding season, and that behaviour in the breeding season, close to colonies may be different.

188. Robin Rigg OWF, in the Solway Firth, is within foraging range of breeding guillemots and razorbills from St Bee’s Head in Cumbria and Mull of Galloway. Evidence from five years of post-construction monitoring at Robin Rigg OWF, suggests that razorbills and guillemots have not been displaced from the Robin Rigg OWF during operation, as razorbills and guillemots were present within the Robin Rigg OWF during all five years of operational monitoring (Nelson *et al.,* 2015a). For guillemot, mean densities of birds on the sea declined during the construction phase, before returning to pre-constructions levels during operation.

189. Although there was an indication of a slight decrease in guillemot and razorbill abundance for birds on the sea across the four operational years, this was not statistically significant, and there were no

significant changes in distribution during operation (Nelson *et al.,* 2015b). It was concluded that changes in guillemot and razorbill abundance and distribution were likely to be due to changes in prey distribution resulting from sedimentary movement, rather than being an effect of the OWF. This explanation is supported by similar patterns in distribution being predicted for both razorbills and guillemots across the five operational years.

190. In other post-construction monitoring studies reviewed, there was no clear evidence showing that guillemots were displaced from the offshore wind farm and the surrounding sea. At the North Hoyle site, located off the coast of North Wales, a highly significant increase in guillemot numbers (estimated at 55%) was reported since the wind farm became operational. However, this finding appears to result from comparing monitoring results from the operational period with those from the construction period, rather than pre-construction (RWE Group, 2007). Post-construction monitoring at Arklow Bank recorded no statistical difference in the number of guillemots recorded between pre and post construction, indicating no displacement of guillemots following construction (Barton *et al.,* 2009).

191. A recent study conducted at the operational Westermost Rough Offshore Wind Farm in July 2017, investigated evidence of displacement for kittiwakes and auks within the wind farm (APEM 2017). This report is presented in Appendix 9.5.

192. Westermost Rough is approximately 35 km from the Flamborough Head and Bempton Cliffs SPA, and is therefore within mean maximum foraging range of breeding guillemots from this colony. The wind farm covers an area of 35 $km^2$ with a capacity of approximately 210 MW, and was fully commissioned in 2015. The wind farm comprises 35 turbines spaced approximately 1 km apart, each with a turbine height of 177 m, hub height of 102 m and rotor diameter of 154 m. Westermost Rough therefore has a comparable design to NnG, in terms of the size of turbines and spacing between turbines. Older wind farms have smaller turbines with lower rotors which are considerably closer together.

193. Guillemot distribution within the Westermost Rough wind farm and surrounding study area in July 2017 is presented in Figure 9-6, Figure 9-7 and Figure 9-8 below.

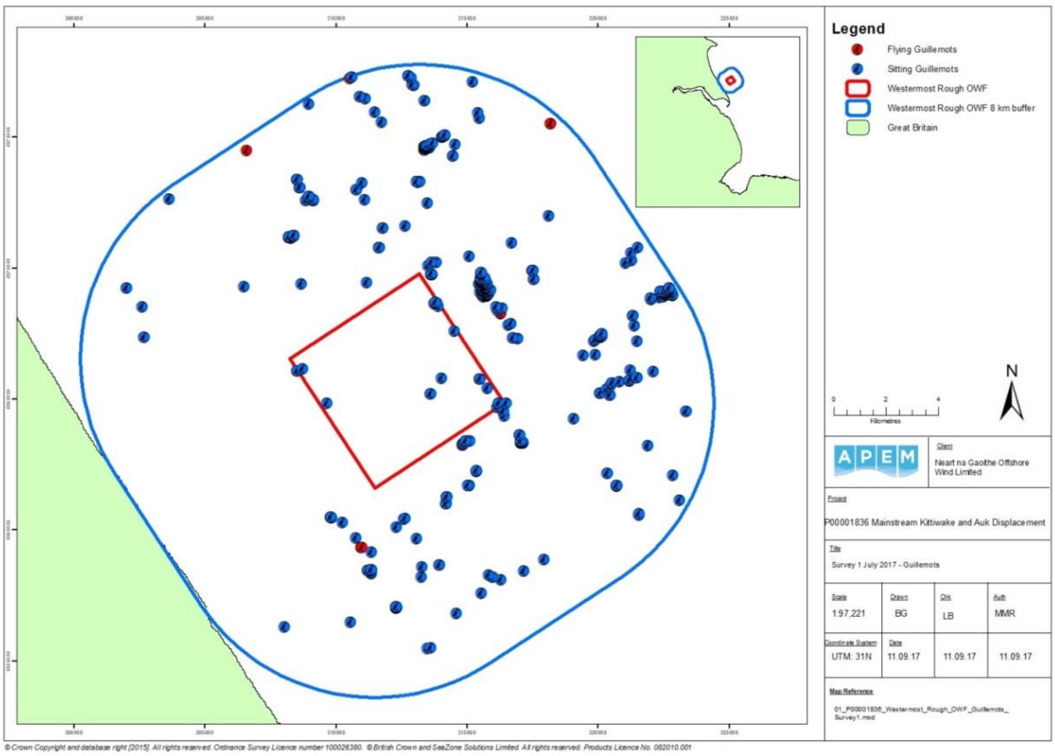


Figure 9-6: Distribution of guillemots recorded in the WROWF and 8 km buffer during Survey 1, July 2017

194. On all three surveys, guillemots were predominantly recorded on the water and occasionally in flight within the wind farm, indicating that birds were not displaced by the presence of the operational turbines.

195. While these figures show a lower number of guillemots in more inshore waters compared to further offshore, the distribution of guillemots within the wind farm compared to the surrounding area is similar on each survey.

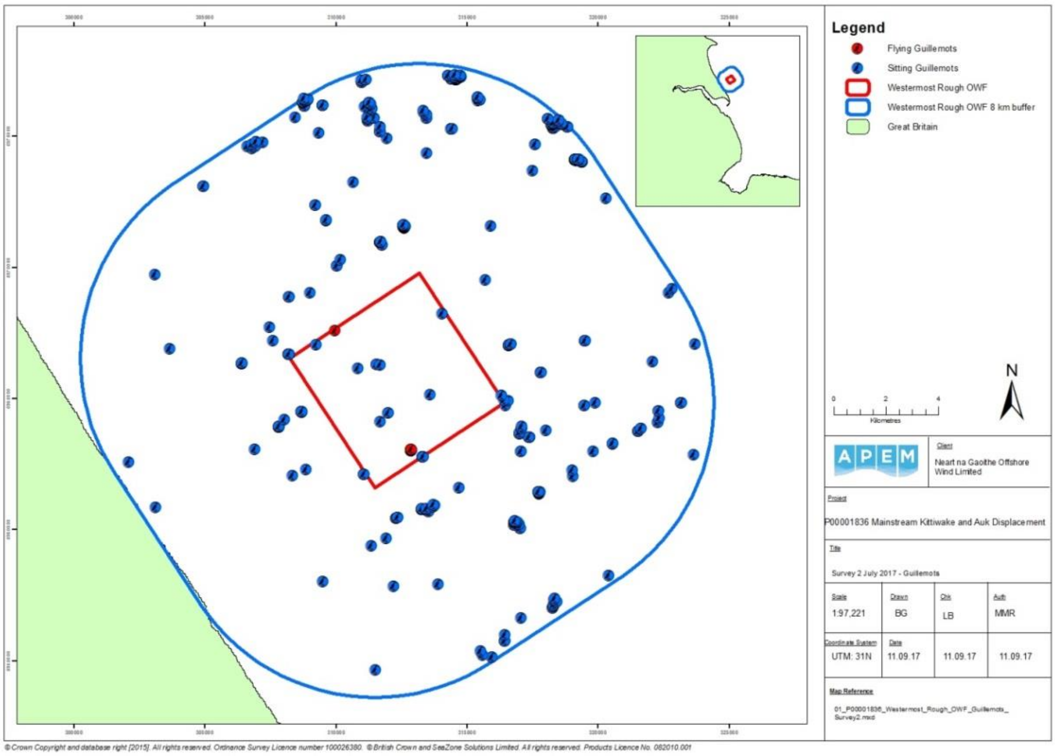


Figure 9-7: Distribution of guillemots recorded in the WROWF and 8 km buffer during Survey 2, July 2017

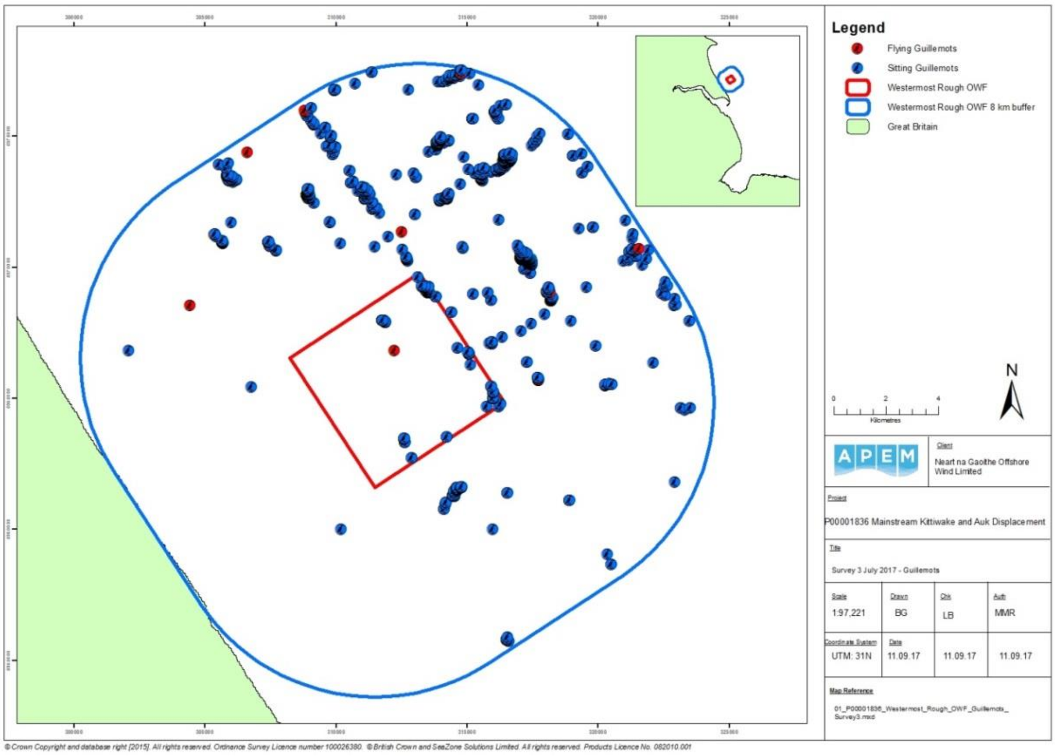


Figure 9-8: Distribution of guillemots recorded in the WROWF and 8 km buffer during Survey 3, July 2017

196. The study recorded a high variability in overall mean densities of auks, including guillemots, calculated for the entire offshore wind farm and the surrounding buffer zone suggesting no evidence of displacement. There were variations in mean densities of auks across the buffer zone but these differences were not statistically significant.

197. In summary, while some studies have shown that partial displacement of guillemots and razorbills has occurred at offshore wind farms, there is evidence to indicate that the proportion of birds displaced is related to spacing distance between turbines. It is noteworthy that, compared with all existing wind farms where monitoring has been undertaken, turbine spacing for the Project (as well as for other Forth and Tay projects) will be considerably greater, at a minimum of 800 metres. Table 9-28 shows the turbine density for NnG, compared with the other Forth and Tay proposals, alongside wind farms referred to above where monitoring has taken place. Of those referred to above, only Westermost Rough is comparable, in terms of height of the turbine rotor above the water and the spacing / density of turbines.

198. Overall, based on the available evidence from operational wind farms, and the considerable increase in turbine spacing for the Project compared to existing projects, it is concluded that if displacement does occur, it will be at a lower rate than 60%. The estimated mortality from displacement presented in this assessment is therefore considered to be very precautionary.

Table 9-28: Comparison of turbine spacing and density between offshore wind farm projects

| Offshore Wind Farm | Number of turbines | Site Area ($km^2$) | Site Turbine Density (turbines/$km^2$) |
|---|---|---|---|
| **NnG (2017)** | 54 | 105 | 0.5 |
| **Seagreen Alpha (2014)** | 75 | 197 | 0.4 |
| **Seagreen Bravo (2014)** | 75 | 194 | 0.4 |
| **Inch Cape (2014)** | 110 | 150 | 0.7 |
| **Seagreen Alpha (2017)** | 60 | 197 | 0.3 |
| **Seagreen Bravo (2017)** | 60 | 194 | 0.3 |
| **Inch Cape (2017)** | 72 | 150 | 0.5 |
| **Inch Cape (2017)** | 40 | 150 | 0.3 |
| **Westermost Rough** | 35 | 35 | 1.0 |
| **Robin Rigg (Scotland)** | 58 | 18 | 3.2 |
| **Arklow Bank (Ireland)** | 7 | 2 | 3.5 |
| **Kentish Flats (England)** | 30 | 10 | 3.0 |
| **Thanet (England)** | 100 | 35 | 2.9 |
| **Greater Gabbard (England)** | 140 | 146 | 1.0 |
| **Alpha Ventus (Germany)** | 12 | 4 | 3.0 |
| **Egmond aan Zee (Netherlands)** | 36 | 24 | 1.5 |
| **Prinses Amalia (Netherlands)** | 60 | 17 | 3.5 |
| **Horns Rev 1 (Denmark)** | 80 | 21 | 3.8 |

| Offshore Wind Farm | Number of turbines | Site Area ($km^2$) | Site Turbine Density (turbines/$km^2$) |
|---|---|---|---|
| **Horns Rev 2 (Denmark)** | 49 | 33 | 1.5 |

199. There have been a series of tracking studies on guillemots breeding on the Isle of May in recent years, undertaken by CEH. In the 2010 breeding season, a study conducted for FTOWDG indicated that guillemots from the Isle of May use both coastal and offshore areas, with a mean maximum range of 18 ± 14 km and a maximum of 61 km (Daunt *et al*., 2011a). This was based on a sample size of 33 tagged guillemots, and a total of 112 trips from the breeding colony. It can be seen from the plot of all tagged birds that the majority of guillemot activity at this time occurred outside the Wind Farm Area, to the north and east of the Isle of May (Appendix 9.6), with fewer tracks passing through the Wind Farm Area.

200. Similar tracking studies were repeated by CEH in the breeding seasons of 2012 (20 tagged birds), 2013 (20 tagged birds) and 2014 (11 tagged birds). In the 2012 breeding season, the majority of recorded activity was again west of the Wind Farm Area, to the north and south of the Isle of May (Appendix 9.6). Guillemots were more widespread in the 2013 breeding season, based on the recorded track data (Appendix 9.6). Activity within the Wind Farm Area was not higher than elsewhere within the tracking activity. In the 2014 breeding season, no tagged birds were recorded in the Wind Farm Area, although the sample size of tagged birds was slightly lower (12 tagged birds) (Appendix 9.6).

201. The main conclusion that can be drawn from these studies is that guillemots are clearly capable of travelling and foraging over considerable distances during the breeding season, and are not relying solely on the Wind Farm Area as a foraging area. It is therefore considered that should guillemots be partially displaced from the Wind Farm Area following construction of the wind farm, any impact on the breeding success of these displaced birds is not likely to be significant.

202. It is concluded that displacement mortality impacts at NnG will have no effect on the breeding SPA populations of guillemots within mean maximum foraging range in the breeding season. The sensitivity of guillemots to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

*Non-breeding season (mid-August to March)*

203. The non-breeding season for guillemot was defined in the Scoping Opinion as mid-August to March (Marine Scotland, 2017), and in the BDMPS review as August to February (Furness 2015). Although there are slight differences in these definitions, it was considered these would not make a significant difference to the assessment, and so the Scoping Opinion definitions were followed.

204. Assuming 60% of all guillemots were displaced from the Wind Farm Area during the non-breeding season (mid-August to March), this would affect an estimated 2,334 birds (Table 9-29), increasing to 3,355 birds including the 1 km buffer, and 4,571 birds including the 2 km buffer.

Table 9-29: Summary of guillemot displacement for the Wind Farm Area and surrounding buffer areas in the non-breeding season

| Displacement | Adults | Immature birds | Total number of birds |
|---|---|---|---|
| **Wind Farm Area** | 1,281 | 1,053 | 2,334 |
| **Wind Farm Area + 1 km** | 1,842 | 1,513 | 3,355 |
| **Wind Farm Area + 2 km** | 2,509 | 2,062 | 4,571 |

205. Using proportions from the PVA stable age structure, the ratio of adult to immature guillemots at Forth Islands SPA and Fowlsheugh SPA was calculated (Table 9-25). If it is assumed that 45.1% of the population present in the non-breeding season are immature birds, then this would mean that an estimated 1,053 guillemots displaced from the Wind Farm Area during the non-breeding season would be immature birds, and that the number of displaced adult birds would be 1,281 birds (Table 9-29). Similarly, an estimated 1,513 guillemots displaced from the Wind Farm Area and 1 km buffer during the non-breeding season would be immature birds, with 1,842 displaced adult birds. An estimated 2,062 guillemots displaced from the Wind Farm Area and 2 km buffer during the non-breeding season would be immature birds, with 2,509 displaced adult birds.

206. Using the 1% mortality rate advised by the Scoping Opinion (Marine Scotland, 2017), it was calculated that 23 guillemots (13 adults and 10 immature birds) displaced from the Wind Farm Area, during the non-breeding season would suffer mortality as a result (

207. Table 9-30). Similarly, 34 guillemots (19 adults and 15 immature birds) would suffer mortality in the Wind Farm Area and 1 km buffer, or 46 guillemots (25 adults and 21 immature birds) in the Wind Farm Area and 2 km buffer, during the non-breeding season.

Table 9-30: Summary of guillemot displacement mortality for the Wind Farm Area and surrounding buffer areas in the non-breeding season

| Displacement mortality | Adults | Immature birds | Total number of birds | % of SPA population |
|---|---|---|---|---|
| **Wind Farm Area** | 13 | 10 | 23 | 0.01 |
| **Wind Farm Area + 1 km** | 19 | 15 | 34 | 0.02 |
| **Wind Farm Area + 2 km** | 25 | 21 | 46 | 0.03 |

208. This is considered an over-estimate, as outside of the breeding season guillemots are no longer limited in their foraging range by having to return to the colony. As birds are free to forage over a wider area, any displacement effects are considerably less likely to have any mortality impact.

209. The total number of guillemots (adults and immature birds) estimated to occur in the UK waters of the North Sea and Channel in the non-breeding period (August to February) is 1,617,306 birds (Furness, 2015). Of this population, an estimated 1,523,146 guillemots (adults and immature birds) are considered to be from UK breeding colonies. If up to 46 guillemots were to suffer mortality as a result of displacement from the Wind Farm Area and 2 km buffer, this would affect up to 0.003% of the North Sea and Channel population from UK breeding colonies (1,523,146 adults and immature birds) in the non-breeding season.

210. Estimated numbers of adult and immature guillemots from the four key SPAs for guillemots considered in this assessment in the UK waters of the North Sea and Channel in the non-breeding season are shown in Table 9-31 (Furness, 2015).

Table 9-31: Estimated numbers of adult and immature guillemots from the four key SPAs in the UK waters of the North Sea in the non-breeding season (Furness, 2015)

| SPA | Non-breeding Season North Sea & Channel | | |
|---|---|---|---|
| | Adult | Immature | Total |
| **Buchan Ness to Collieston Coast** | 20,685 | 13,393 | 34,078 |
| **Fowlsheugh** | 48,160 | 31,184 | 79,344 |

| SPA | Non-breeding Season North Sea & Channel | | |
|---|---|---|---|
| | Adult | Immature | Total |
| **Forth Islands** | 26,413 | 17,374 | 43,787 |
| **St Abb's Head to Fast Castle** | 39,785 | 26,170 | 65,955 |
| **Combined total** | 135,043 | 88,121 | 223,164 |

211. If up to 46 adult and immature guillemots were to suffer mortality as a result of displacement from the Wind Farm Area and 2km buffer, this would affect 0.02% of the North Sea and Channel population from the four key SPAs (223,164 adults and immature birds) in the non-breeding season (Furness, 2015).

212. In comparison, 46 birds corresponds to 0.03% of the SPA breeding population within mean maximum foraging range (154,131 birds) (Table 9-8). If the most recent count from the Farne Islands SPA is included (49,037 birds), then this would correspond to up to 0.02% of the SPA population within mean maximum foraging range (203,168 birds).

213. For the surviving displaced birds, there would be minimal impact from displacement, as foraging birds are not tied to a breeding colony at this time of year and so would be able to find food outside of the Wind Farm Area and 2 km buffer.

214. It is concluded that displacement mortality impacts at NnG will have no effect on guillemots from the four key SPA populations in the non-breeding season. The sensitivity of guillemots to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

*Assessment of displacement mortality throughout the year*

215. Predicted guillemot mortality from all seasons as calculated above, was summed for the whole year for the Wind Farm Area, and the Wind Farm Area plus 2 km buffer (Table 9-32).

Table 9-32: Estimated guillemot mortality (adult and immature birds) from the Wind Farm Area and 2 km buffer on the key breeding SPAs in the UK waters of the North Sea throughout the year

| Season | Wind Farm Area | | Wind Farm Area + 2 km buffer | |
|---|---|---|---|---|
| | No of birds | % of SPA population | No of birds | % of SPA population |
| **Breeding season** | 7 adults | 0.005 | 15 adults | 0.01 |
| **Non-breeding season** | 23 birds | 0.01 | 46 birds | 0.02 |
| **Total** | 20 birds | 0.015 | 61 birds | 0.03 |

216. Based on the seasonal mortality estimates and an assumed mortality rate of 1%, a total of 20 guillemots are estimated to suffer mortality as a result of displacement if impacts are confined to the Wind Farm Area. This represents an estimated 0.015% of the population of the four key SPAs (adult and immatures), based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015).

217. If displacement impacts occur over the Wind Farm Area and a surrounding 2 km buffer, then an estimated 61 guillemots are estimated to suffer mortality as a result of displacement. This represents an estimated 0.03% of the population of the four key SPAs (adult and immatures), based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015).

218. In comparison, 20 birds corresponds to 0.01% of the SPA breeding population within mean maximum foraging range (154,131 birds) (Table 9-8) (Marine Scotland, 2017), while 61 birds corresponds to 0.04% of the SPA breeding population within mean maximum foraging range. If the most recent count from the Farne Islands SPA (49,037 birds) is included in the SPA total, then this would correspond to 0.001% of the SPA population within mean maximum foraging range (202,713 birds) for 20 birds, and 0.03% of the SPA population within mean maximum foraging range for 61 birds. It should be noted that as highlighted in the Scoping Opinion (Marine Scotland, 2017), using the reference population for the SPA breeding population to assess non-breeding season impacts is likely to be extremely precautionary, due to the non-breeding season dispersal of guillemots.

219. In addition, it is considered that a mortality rate of 1% outside of the breeding season, when birds are no longer tied to their breeding colony, is also precautionary. Overall, based on the available evidence from operational wind farms, and the considerable increase in turbine spacing for the Project compared to existing projects, it is concluded that if displacement does occur, it will be at a lower rate than 60%. The estimated mortality from displacement presented in this assessment is therefore considered to be very precautionary.

220. Therefore, it is concluded that displacement mortality impacts at NnG will have no effect on guillemots from the four key SPA populations throughout the year. The sensitivity of guillemots to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

#### *9.9.2.2.4 Razorbill*

221. Monthly peak estimated numbers of razorbills in the Wind Farm Area and surrounding 1 km and 2 km buffers (Appendix 9.2: Table 14) in the breeding season and non-breeding seasons for Years 1 to 3 were averaged to get the three-year mean peak per season (Table 9-33). Where peak numbers occurred in different months within the same season across different years, the peak month was used.

Table 9-33: Seasonal three-year mean peak estimated numbers of razorbills in the Wind Farm Area (plus 1 km and 2 km buffers)

| Year | Wind Farm Area | | Wind Farm Area + 1km buffer | | Wind Farm Area + 2km buffer | |
|---|---|---|---|---|---|---|
| | Breeding | Non-breeding | Breeding | Non-breeding | Breeding | Non-breeding |
| **Year 1** | 765 | 2,655 | 1,194 | 3,316 | 1,460 | 4,664 |
| **Year 2** | 367 | 852 | 419 | 1,785 | 590 | 2,944 |
| **Year 3** | 706 | 706 | 1,254 | 1,254 | 1,694 | 1,694 |
| **3-year mean peak** | 613 | 1,404 | 956 | 2,118 | 1,248 | 3,101 |

222. Based on advice received in the Scoping Opinion (Marine Scotland, 2017), it was assumed that there will be 60% displacement of razorbills from the Wind Farm Area (and 2 km buffer area) in the breeding and non-breeding seasons.

223. Populations at SPAs for breeding razorbills of relevance to this assessment are presented in Table 9-8. In the breeding season, the mean maximum foraging range of breeding razorbills is 48.5 ± 35.0 km, based on a sample size of four birds (Thaxter et al., 2012). Based on this, three SPAs for breeding razorbills (Forth Islands, Fowlsheugh and St Abb's Head to Fast Castle) are within mean maximum foraging range + 1 SD of the Project (Appendix 9.2: Figure 56). These three SPAs have therefore been used as the SPA reference population for this assessment in the breeding and non-breeding seasons.

224. Numbers of razorbills at the Forth Islands SPA have increased, from 2,800 birds at the time of designation, to 5,815 birds in 2017 (Table 9-8). At Fowlsheugh, numbers have increased from 5,800 at the time of designation to 7,426 birds in 2015. Over the same period, the breeding population at St Abb's Head to Fast Castle SPA SPA has declined slightly, from 2,180 birds at the time of designation, to 2,067 birds in 2016. Based on figures provided by SNH (Table 9-8), the most recent total combined population estimate for these two SPAs is therefore 15,308 birds.

225. Razorbill is also listed as a qualifying interest for the Outer Firth of Forth & St Andrews Bay pSPA in the non-breeding season (SMH 2016).

*Breeding season (April to mid-August)*

226. The breeding season for razorbill was defined as April to mid-August in the Scoping Opinion (Marine Scotland, 2017).

227. Assuming 60% of all razorbills are displaced from the Wind Farm Area during the breeding season, this would affect an estimated 368 birds (Table 9-34), increasing to 574 birds including the 1 km buffer, and 749 birds including the 2 km buffer. However, this estimate includes non-breeding adults and immature birds, as well as breeding adults.

Table 9-34: Summary of razorbill displacement for the Wind Farm Area and surrounding buffer areas in the breeding season

| Displacement | Breeding adults | Immature or non-breeding adults | Total number of birds |
|---|---|---|---|
| **Wind Farm Area** | 208 | 160 | 368 |
| **Wind Farm Area + 1 km** | 324 | 250 | 574 |
| **Wind Farm Area + 2 km** | 422 | 327 | 749 |

228. Studies have shown that for several seabird species, in addition to breeding birds, colonies are also attended by many immature individuals and a smaller number of non-breeding adults (e.g. Wanless *et al.,* 1998). There is little information on the breakdown of immature and non-breeding adults present at a colony, however, this has been estimated using the PVA stable age structure, as recommended in the Scoping Opinion (Marine Scotland, 2017).

229. Using proportions from the PVA stable age structure, the ratio of adult to immature razorbills at Forth Islands SPA and Fowlsheugh SPA was calculated (Table 9-35).

Table 9-35: PVA Stable age structure for razorbills at Forth Islands SPA and Fowlsheugh SPA

| Age (years) | Forth Islands SPA | Fowlsheugh SPA | Mean proportion | Mean percentage |
|---|---|---|---|---|
| **1** | 0.1724 | 0.1793 | 0.17585 | 17.6 |
| **2** | 0.1238 | 0.1285 | 0.12615 | 12.6 |
| **3** | 0.0889 | 0.0921 | 0.0905 | 9.1 |
| **Total immature birds** | 0.3851 | 0.3999 | 0.3925 | 39.3 |
| **Breeding adults** | 0.5718 | 0.558 | 0.5649 | 56.5 |
| **Non-breeding adults** | 0.043 | 0.042 | 0.0425 | 4.3 |

230. Assuming that 43.6% of the population present are immature or non-breeding birds, then this would mean that an estimated 160 razorbills displaced from the Wind Farm Area during the breeding season

would be immature or non-breeding adults, and that the number of displaced breeding adult birds would be 208 birds (Table 9-34). Similarly, an estimated 250 razorbills displaced from the Wind Farm Area and 1 km buffer during the breeding season would be immature or non-breeding adults, with 324 displaced breeding adult birds. An estimated 327 razorbills displaced from the Wind Farm Area and 2 km buffer during the breeding season would be immature or non-breeding adults, with 422 displaced breeding adult birds.

231. Using the 1% mortality rate recommended in the Scoping Opinion (Marine Scotland, 2017), it was calculated that four razorbills (two breeding adults and two immature or non-breeding birds) displaced from the Wind Farm Area, during the breeding season would suffer mortality as a result (Table 9-36). Similarly, six razorbills (three breeding adults and three immature or non-breeding birds) would suffer mortality in the Offshore Wind Farm Area and 1 km buffer, or seven razorbills (four breeding adults and three immature or non-breeding birds) in the Wind Farm Area and 2 km buffer, during the breeding season.

Table 9-36: Summary of razorbill displacement mortality for Wind Farm Area and surrounding buffer areas in the breeding season

| Displacement mortality | Breeding adults | Immature or non-breeding adults | Total number of birds | % of SPA population (adults) |
|---|---|---|---|---|
| **Wind Farm Area** | 2 | 2 | 4 | 0.01 |
| **Wind Farm Area + 1 km** | 3 | 3 | 6 | 0.02 |
| **Wind Farm Area + 2 km** | 4 | 3 | 7 | 0.03 |

232. Displacement mortality of up to four adults corresponds to up to 0.03% of the SPA adult breeding population within mean maximum foraging range (15,308 birds) (Table 9-8) (Marine Scotland, 2017).

233. For the surviving displaced birds (364 birds; 205 adults and 159 immature or non-breeding birds from the Wind Farm Area alone, or 568 birds; 320 adults and 248 immature or non-breeding birds from the Wind Farm Area plus 1 km buffer, or 742 birds; 418 adults and 324 immature or non-breeding birds from the Wind Farm Area plus 2 km buffer), there could potentially be a detrimental impact on their breeding success, as a result of having to travel further on each trip to forage elsewhere.

234. In comparison, the CEH Displacement model (Searle et al., 2014) estimated that the change in the annual adult razorbill survival rate for the Forth Islands SPA for NnG alone would be -0.10%, based on the homogeneous prey distribution scenario, and -0.09%, based on the heterogeneous prey distribution scenario (Table 9-37).

235. The estimated number of adult razorbills involved was calculated by dividing these survival rates by 100, and then multiplying by the relevant SPA population (Table 9-37). Based on the most recent population counts for the Forth Islands SPA (5,815 birds), the estimated change in adult survival rates corresponds to a mortality of six adult razorbills based on the homogeneous prey distribution scenario, or five adult razorbills based on the heterogeneous prey distribution scenario.

Table 9-37: Summary of annual razorbill displacement mortality for the Forth Islands SPA from NnG alone, as presented in the CEH displacement model (Searle *et al.*, 2014)

| SPA | Change in annual adult survival | | SPA population | Estimated number of adults | |
|---|---|---|---|---|---|
| | Homogeneous [7] | Heterogeneous [7] | | Homogeneous | Heterogeneous |
| **Forth Islands** | -0.10 | -0.09 | 5,815 birds | -6 adults | -5 adults |

[7] Figures from Table 3.2, Searle *et al.* (2014)

236. A worst-case annual estimated mortality of six adult razorbills corresponds to a maximum of 0.1% of the Forth Islands SPA breeding population (5,815 birds), from displacement effects from NnG and a 1 km buffer. This demonstrates that if adult razorbill mortality from displacement was at this level, the impact would not be significant at the population level for this SPA.

237. However, this is an annual estimate, based on the homogeneous prey distribution scenario, an assumed 60% displacement rate, and several other assumptions including the behaviour of seabirds in response to wind farms (including habituation) and the effects of adult body mass change on subsequent survival, which are detailed in the final report for the displacement model. As previously highlighted, the barrier and displacement rates, which were agreed by the project Steering Committee, are important parameters in determining the magnitude of the response to the wind farm (Searle et al., 2014). Comparable results for other SPAs within mean maximum foraging range were not presented in the CEH displacement report (Searle *et al.*, 2014).

238. However, evidence from existing operational wind farms indicates that displacement may occur at a lower rate than the predicted 60% rate used in this assessment. The supporting text to this effect in the guillemot section (Section 9.9.2.2.3) also applies for razorbill.

239. A recent study conducted at the operational Westermost Rough Offshore Wind Farm in July 2017, investigated the degree of displacement for auks within the wind farm (APEM 2017). This report is presented in Appendix 9.5.

240. Westermost Rough is approximately 35 km from the Flamborough Head and Bempton Cliffs SPA, and is therefore within mean maximum foraging range of breeding razorbills from this colony. The wind farm comprises 35 turbines spaced approximately 1 km apart, each with a turbine height of 177 m, hub height of 102 m and rotor diameter of 154 m. Westermost Rough therefore has a comparable design to NnG, in terms of the size of turbines and spacing between turbines.

241. Razorbill distribution within the Westermost Rough wind farm and surrounding study area in July 2017 is presented in Figure 9-9, Figure 9-10 and Figure 9-11 below.

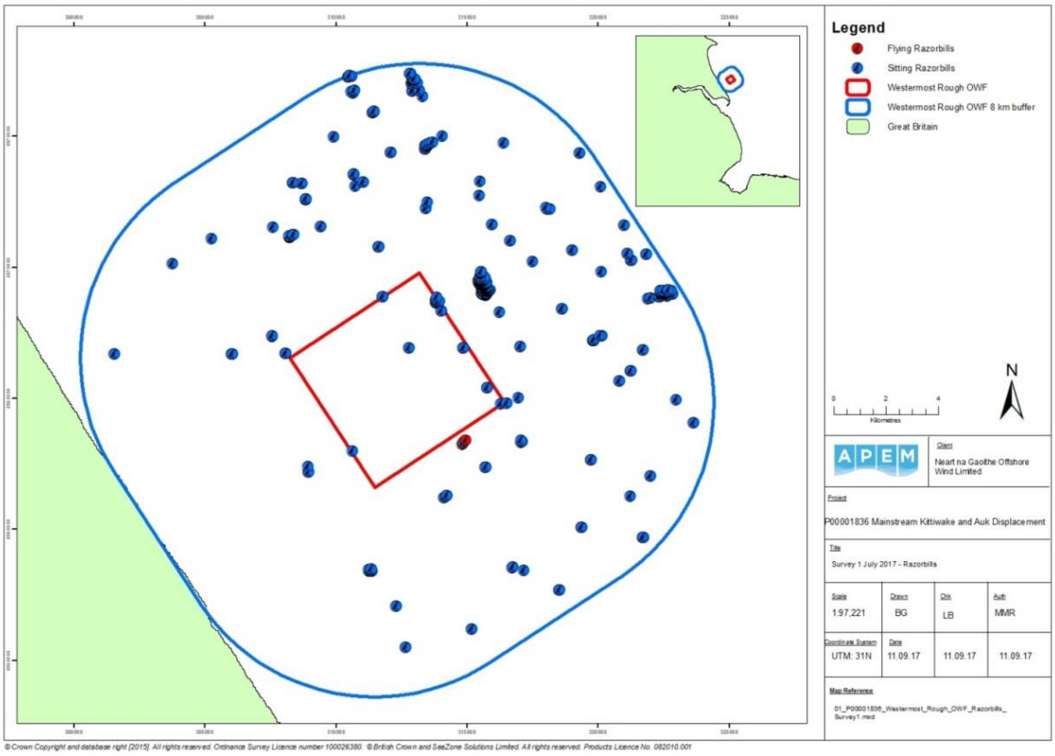


Figure 9-9: Distribution of razorbills recorded in the WROWF and 8 km buffer during Survey 1, July 2017

242. On all three surveys, razorbills were predominantly recorded on the water and occasionally in flight within the wind farm, indicating that birds were not displaced by the presence of the operational turbines.

243. While these figures show a lower number of razorbills in more inshore waters compared to further offshore, the distribution of razorbills within the wind farm compared to the surrounding area is similar on each survey.

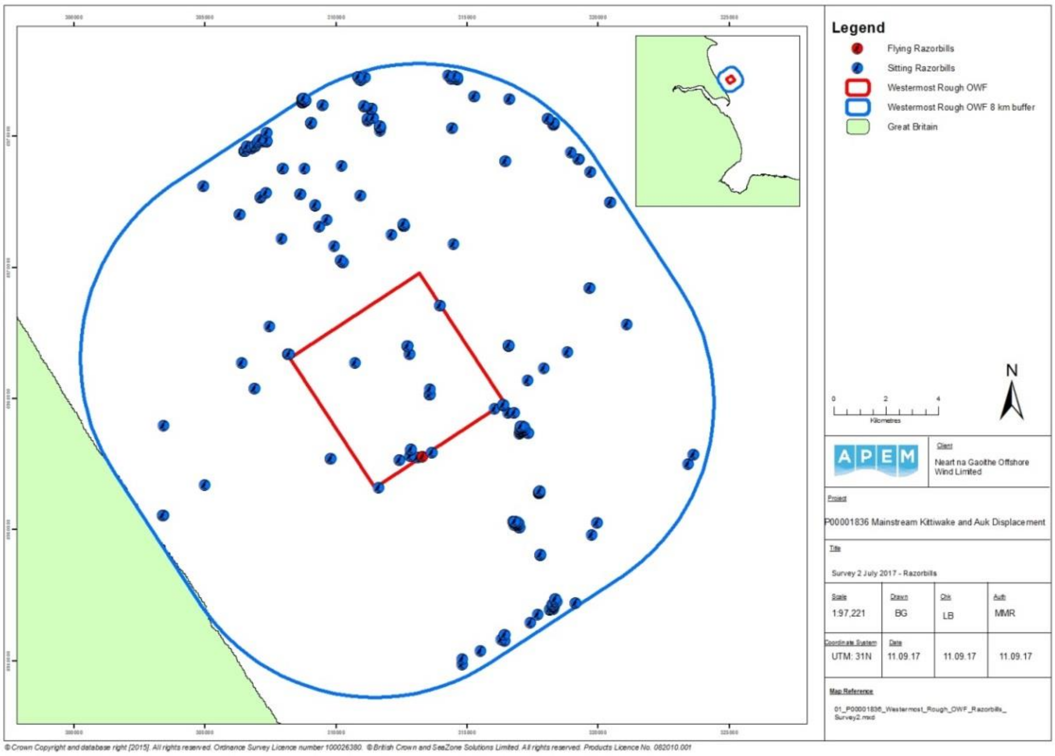


Figure 9-10: Distribution of razorbills recorded in the WROWF and 8 km buffer during Survey 2, July 2017


Figure 9-11: Distribution of razorbills recorded in the WROWF and 8 km buffer during Survey 3, July 2017

244. The study recorded a high variability in overall mean densities of auks, including razorbills, calculated for the entire offshore wind farm and the surrounding buffer zone suggesting no evidence of displacement. There were variations in mean densities of auks across the buffer zone but these differences were not statistically significant.

245. In summary, while studies have shown that partial displacement of guillemots and razorbills has occurred at offshore wind farms, there is evidence to indicate that the proportion of birds displaced is related to spacing distance between turbines. It is noteworthy that, compared with all existing wind farms where monitoring has been undertaken, turbine spacing for the Project (as well as for other Forth and Tay projects) will be considerably greater, at a minimum of 800 metres (Table 9-28).

246. Overall, based on available evidence from operational wind farms, and the considerable increase in turbine spacing for the Project compared to existing projects, it is concluded that if displacement does occur, it will be at a lower rate than 60%.

247. There have been a series of tracking studies on razorbills breeding on the Isle of May in recent years, undertaken by CEH. In the 2010 breeding season, a study conducted for FTOWDG indicated that razorbills from the Isle of May use both coastal and offshore areas, with a mean maximum range of 14 ± 15 km and a maximum of 69 km, although they avoided the deeper water between the Isle of May and the Wee Bankie (Daunt *et al*., 2011a). This was based on a sample size of 18 tagged razorbills, and a total of 111 trips from the breeding colony. The study also indicated that razorbills did not use the Neart na Gaoithe site for non-flight activities such as foraging or resting. It can be seen from the plot of all tagged birds that the majority of razorbill activity at this time occurred outside the Wind Farm Area, to the north, east and west of the Isle of May (Appendix 9.6), with fewer tracks passing through the Wind Farm Area.

248. Similar tracking studies were repeated by CEH in the breeding seasons of 2012 (16 tagged birds), 2013 (seven tagged birds) and 2014 (five tagged birds). In the 2012 breeding season, the majority of recorded activity was again west of the Wind Farm Area, to the east and west of the Isle of May (Appendix 9.6). In the 2013 breeding season, there was little activity of tagged birds recorded within the Wind Farm Area, although the sample size of tagged birds was smaller than in 2010 or 2012

(Appendix 9.6). Similarly, in the 2014 breeding season, there was little activity of tagged birds recorded in the Wind Farm Area, although the sample size of tagged birds was low (Appendix 9.6).

249. The main conclusion that can be drawn from these studies is that razorbills are clearly capable of travelling and foraging over considerable distances during the breeding season, and are not relying solely on the Wind Farm Area as a foraging area. It is therefore considered that should razorbills be partially displaced from the Wind Farm Area following construction of the wind farm, any impact on the breeding success of these displaced birds is not likely to be significant.

250. It is concluded that displacement mortality impacts at NnG will have no effect on the breeding SPA populations of razorbills within mean maximum foraging range in the breeding season. The sensitivity of razorbills to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

*Non-breeding season (mid-August to March)*

251. The non-breeding season was defined in the Scoping Opinion as mid-August to March (Table 9-7) (Marine Scotland. However, there are three seasons presented in the BDMPS review for the "non-breeding season", defined as follows: Autumn (August to October), Winter (November and December) and Spring (January to March) (Furness 2015). As the population estimates given in the BDMPS report are the same for the Autumn and Spring periods, these populations have been used as SPA reference populations, and the non-breeding season was taken as mid-August to March, as defined in the Scoping Opinion.

252. Assuming 60% of all razorbills were displaced from the Wind Farm Area during the non-breeding season (mid-August to March), this would affect an estimated 842 birds (Table 9-38), increasing to 1,522 birds including the 1 km buffer, and increasing to 1,861 birds including the 2 km buffer.

Table 9-38: Summary of razorbill displacement for the Wind Farm Area and surrounding buffer areas in the non-breeding season

| Displacement | Adults | Immature birds | Total number of birds |
|---|---|---|---|
| **Wind Farm Area** | 511 | 331 | 842 |
| **Wind Farm Area + 1 km** | 771 | 500 | 1,271 |
| **Wind Farm Area + 2 km** | 1,130 | 731 | 1,861 |

253. Using proportions from the PVA stable age structure, the ratio of adult to immature razorbills at Forth Islands SPA and Fowlsheugh SPA was calculated (Table 9-35). If it is assumed that 39.3% of the population present in the non-breeding season are immature birds, then this would mean that an estimated 331 razorbills displaced from the Wind Farm Area during the non-breeding season would be immature birds, and that the number of displaced adult birds would be 511 birds (Table 9-38). Similarly, an estimated 500 razorbills displaced from the Wind Farm Area and 1 km buffer during the non-breeding season would be immature birds, with 771 displaced adult birds. An estimated 731 razorbills displaced from the Wind Farm Area and 2 km buffer during the non-breeding season would be immature birds, with 1,130 displaced adult birds.

254. Using the 1% mortality rate recommended in the Scoping Opinion (Marine Scotland, 2017), it was calculated that eight razorbills (five adults and three immature birds) displaced from the Wind Farm Area, during the non-breeding season would suffer mortality as a result (Table 9-39). Similarly, 13 razorbills (seven adults and six immature birds) would suffer mortality in the Wind Farm Area and 1 km buffer, or 19 razorbills (11 adults and eight immature birds) in the Wind Farm Area and 2 km buffer, during the non-breeding season.

Table 9-39: Summary of razorbill displacement mortality for the Wind Farm Area and surrounding buffer areas in the non-breeding season

| Displacement mortality | Adults | Immature birds | Total number of birds | % of SPA population |
|---|---|---|---|---|
| **Wind Farm Area** | 5 | 3 | 8 | 0.03 |
| **Wind Farm Area + 1 km** | 7 | 6 | 13 | 0.05 |
| **Wind Farm Area + 2 km** | 11 | 8 | 19 | 0.08 |

255. This is considered an over-estimate, as outside of the breeding season razorbills are no longer limited in their foraging range by having to return to the colony. As birds are free to forage over a wider area, any displacement effects are considerably less likely to have any mortality impact.

256. The total number of razorbills (adults and immature birds) estimated to occur in the UK waters of the North Sea and Channel in the autumn (August to October) and spring (January to March) periods of the non-breeding season (mid-August to October) is 591,874 birds (Furness, 2015). Of this population, an estimated 157,443 razorbills (adults and immature birds) are considered to be from UK breeding colonies. If up to 19 razorbills were to suffer mortality as a result of displacement from the Wind Farm Area and 2 km buffer, this would affect up to 0.01% of the North Sea and Channel population from UK breeding colonies (157,443 adults and immature birds) in the non-breeding season.

257. Estimated numbers of adult and immature razorbills from the three key SPAs for razorbills considered in this assessment in the UK waters of the North Sea and English Channel in the non-breeding season are shown in Table 9-40 (Furness, 2015).

Table 9-40: Estimated numbers of adult and immature razorbills from the three key SPAs in the UK waters of the North Sea and Channel in the autumn and spring periods of the non-breeding season (Furness, 2015)

| SPA | Non-breeding season | | |
|---|---|---|---|
| | Adult | Immature | Total |
| **Fowlsheugh** | 7,048 | 4,757 | 11,805 |
| **Forth Islands** | 5,250 | 3,544 | 8,794 |
| **St Abb's Head to Fast Castle** | 2,438 | 1,646 | 4,084 |
| **Combined total** | 14,736 | 9,947 | 24,683 |

258. If up to 19 razorbills were to suffer mortality as a result of displacement from the Wind Farm Area and 2km buffer, this would affect up to 0.08% of the North Sea and Channel population from the three key SPAs (24,683 adults and immature birds) in the autumn period of the non-breeding season, based on the BDMPS review (Furness, 2015). In comparison, 19 birds corresponds to 0.1% of the SPA breeding population within mean maximum foraging range (14,486 birds) (Table 9-8).

259. For the surviving displaced birds, there would be minimal impact from displacement, as foraging birds would be able to find food outside of the Wind Farm Area and 2 km buffer.

260. It is concluded that displacement mortality impacts at NnG will have no effect on razorbills from the three key SPA populations in the non-breeding season. The sensitivity of razorbills to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

*Assessment of displacement mortality throughout the year*

261. Predicted razorbill mortality from all seasons from displacement as calculated above, was summed for the whole year (Table 9-41).

262. Based on the seasonal mortality estimates and an assumed mortality rate of 1%, a total of 10 razorbills are estimated to suffer mortality if displacement impacts are confined to the Wind Farm Area. This represents an estimated 0.04% of the population of the three key SPAs, based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015).

Table 9-41: Estimated razorbill mortality (adult and immature birds) from the Wind Farm Area and 2 km buffer on the three key SPAs in the UK waters of the North Sea throughout the year

| Season | Wind Farm Area | | Wind Farm Area + 2 km buffer | |
|---|---|---|---|---|
| | No of birds | % of SPA population | No of birds | % of SPA population |
| **Breeding season** | 2 adults | 0.01 | 4 adults | 0.03 |
| **Non-breeding season** | 8 birds | 0.03 | 19 birds | 0.08 |
| **Total** | 10 birds | 0.04% | 23 birds | 0.1% |

263. If displacement impacts occur over the Wind Farm Area and a surrounding 2 km buffer, then an estimated 23 razorbills are estimated to suffer mortality as a result of displacement. This represents an estimated 0.1% of the population of the three key SPAs, based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015).

264. In comparison, 10 birds corresponds to 0.07% of the SPA breeding population within mean maximum foraging range (15,308 birds) (Table 9-8), while 23 birds corresponds to 0.2% of the SPA breeding population within mean maximum foraging range. It should be noted that, as highlighted in the Scoping Opinion (Marine Scotland, 2017), using the reference population for the SPA breeding population to assess non-breeding season impacts is likely to be extremely precautionary, due to the non-breeding season dispersal of razorbills.

265. In addition, it is considered that a mortality rate of 1% outside of the breeding season, when birds are no longer tied to their breeding colony, is also precautionary. Overall, based on the available evidence from operational wind farms, and the considerable increase in turbine spacing for the Project compared to existing projects, it is concluded that if displacement does occur, it will be at a lower rate than 60%. The estimated mortality from displacement presented in this assessment is therefore considered to be very precautionary.

266. It is concluded that displacement mortality impacts at NnG will have no effect on razorbills from the three key SPA populations throughout the year. The sensitivity of razorbills to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

### *9.9.2.2.5 Puffin*

267. Monthly peak estimated numbers of puffins in the Wind Farm Area in the breeding season (April to mid-August) and non-breeding season (mid-August to March) for Years 1 to 3 (Appendix 9.2: Table 15) were averaged to get the three-year mean peak per season (Table 9-42). Where peak numbers occurred in different months within the same season across different years, the peak month was used. This was repeated for the 1 km and 2 km buffers around the Wind Farm Area.

Table 9-42: Seasonal three-year mean peak estimated numbers of puffins in the Wind Farm Area (plus 1 km and 2 km buffer)

| Year | Wind Farm Area | | Wind Farm Area + 1km buffer | | Wind Farm Area + 2km buffer | |
|---|---|---|---|---|---|---|
| | Breeding | Non-breeding | Breeding | Non-breeding | Breeding | Non-breeding |
| **Year 1** | 1,754 | 1,881 | 3,359 | 3,359 | 7,508 | 4,109 |
| **Year 2** | 2,481 | 1,821 | 2,831 | 2,935 | 3,442 | 4,994 |
| **Year 3** | 3,812 | 911 | 5,474 | 1,363 | 7,568 | 1,864 |
| **3-year mean peak** | 2,682 | 1,538 | 3,888 | 2,552 | 6,173 | 3,656 |

268. Based on advice received in the Scoping Opinion (Marine Scotland, 2017), it was assumed that there will be 60% displacement of puffins from the Wind Farm Area (and 2 km buffer area) in the breeding and non-breeding seasons.

269. Populations at SPAs for breeding puffins of relevance to this assessment are presented in Table 9-8. In the breeding season, the mean maximum foraging range of breeding puffins is 105.4 ± 46.0 km, based on a sample size of eight birds (Thaxter et al., 2012). Based on this, one SPA for breeding puffins (Forth Islands is within mean maximum foraging range ± 1 SD of the Project (Appendix 9.2**:** Figure 65). This SPA has therefore been used as the SPA reference population for this assessment in the breeding and non-breeding seasons.

270. Numbers of puffins at the Forth Islands SPA have increased from 14,000 pairs at the time of designation, to 45,005 pairs between 2009 and 2017 (Table 9-8).

271. In addition, the Project is also within mean maximum foraging range ± 1 SD for breeding puffins from the Farne Islands SPA (72 km from the Project), and Coquet Island SPA (106 km from the Project) (Appendix 9.2**:** Figure 65). These SPA populations (39,962 pairs on Farne Islands in 2013 and 12,344 pairs on Coquet Island in 2013) (SMP 2017) are also included in the assessment text, in addition to the SPA reference population.

272. Puffin is also listed as a qualifying interest for the Outer Firth of Forth & St Andrews Bay pSPA in the breeding season (SNH 2016).

*Breeding season (April to mid-August)*

273. Assuming 60% of all puffins were displaced from the Wind Farm Area during the breeding season, this would affect an estimated 1,609 birds (Table 9-43), increasing to 2,333 birds including the 1 km buffer, and 3,704 birds including the 2 km buffer. However, this estimate includes non-breeding immature birds, as well as breeding adults.

Table 9-43: Summary of puffin displacement for the Wind Farm Area and surrounding buffer areas in the breeding season

| Displacement | Breeding adults | Immature or non-breeding adults | Total number of birds |
|---|---|---|---|
| **Wind Farm Area** | 814 | 795 | 1,609 |
| **Wind Farm Area + 1 km** | 1,180 | 1,153 | 2,333 |
| **Wind Farm Area + 2 km** | 1,874 | 1,830 | 3,704 |

274. Studies have shown that for several seabird species, in addition to breeding birds, colonies are also attended by many immature individuals and a smaller number of non-breeding adults (e.g. Wanless

*et al.,* 1998). There is little information on the breakdown of immature and non-breeding adults present at a colony, however, this was estimated using the PVA stable age structure, as recommended in the Scoping Opinion (Marine Scotland, 2017). Using proportions from the PVA stable age structure, the ratio of adult to immature birds at the Forth Islands SPA was calculated (Table 9-44).

Table 9-44: PVA Stable age structure for puffins at Forth Islands SPA and Fowlsheugh SPA

| Age (years) | Forth Islands SPA | Percentage |
|---|---|---|
| **1** | 0.1555 | 15.6 |
| **2** | 0.125 | 12.5 |
| **3** | 0.1004 | 10.0 |
| **4** | 0.0746 | 7.5 |
| **Total immature birds** | 0.4555 | 45.6 |
| **Breeding adults** | 0.5064 | 50.6 |
| **Non-breeding adults** | 0.0381 | 3.8 |

275. Assuming that 49.4% of the population present are immature or non-breeding birds, then this would mean that an estimated 795 puffins displaced from the Wind Farm Area during the breeding season would be immature or non-breeding adults, and that the number of displaced breeding adult birds would be 814 birds (Table 9-43). Similarly, an estimated 1,153 puffins displaced from the Wind Farm Area and 1 km buffer during the breeding season would be immature or non-breeding adults, with 1,180 displaced breeding adult birds. An estimated 1,830 puffins displaced from the Wind Farm Area and 2 km buffer during the breeding season would be immature or non-breeding adults, with 1,874 displaced breeding adult birds.

276. Using the 2% mortality rate recommended by the Scoping Opinion (Marine Scotland, 2017), it was calculated that 32 puffins (16 breeding adults and 16 immature or non-breeding birds) displaced from the Wind Farm Area, during the breeding season would suffer mortality as a result (Table 9-45). Similarly, 47 puffins (24 breeding adults and 23 immature or non-breeding birds) would suffer mortality in the Wind Farm Area and 1 km buffer, or 74 puffins (37 breeding adults and 37 immature or non-breeding birds) in the Wind Farm Area and 2 km buffer, during the breeding season.

Table 9-45: Summary of puffin displacement mortality for the Wind Farm Area and surrounding buffer areas in the breeding season

| Displacement mortality | Breeding adults | Immature or non-breeding adults | Total number of birds | % of SPA population (adults) |
|---|---|---|---|---|
| **Wind Farm Area** | 16 | 16 | 32 | 0.02 |
| **Wind Farm Area + 1 km** | 24 | 23 | 47 | 0.03 |
| **Wind Farm Area + 2 km** | 37 | 37 | 74 | 0.04 |

277. Displacement mortality of 16 adults in the Wind Farm Area corresponds to 0.02% of the Forth Islands SPA adult breeding population (45,005 pairs) (Table 9-8) (Marine Scotland, 2017). Displacement mortality of 24 adults in the Wind Farm Area and 1 km buffer corresponds to 0.03% of the Forth Islands SPA adult breeding population. Displacement mortality of 37 adults in the Wind Farm Area and 2 km buffer corresponds to 0.04% of the Forth Islands SPA adult breeding population.

278. For the surviving displaced adults, there could potentially be a detrimental impact on their breeding success, as a result of having to travel further on each trip to forage elsewhere.

279. In comparison, the CEH Displacement model (Searle *et al.*, 2014) estimated that the change in the annual adult puffin survival rate for the Forth Islands SPA for NnG alone would be -0.46%, based on the homogeneous prey distribution scenario, and -0.64%, based on the heterogeneous prey distribution scenario (Table 9-46).

280. The estimated number of adult puffins involved was calculated by dividing these survival rates by 100, and then multiplying by the relevant SPA population (Table 9-46). Based on the most recent population counts for the Forth Islands SPA (45,005 pairs, or 90,010 birds), the estimated change in adult survival rates corresponds to a mortality of 414 adult puffins based on the homogeneous prey distribution scenario, or 576 adult puffins based on the heterogeneous prey distribution scenario.

Table 9-46: Summary of annual puffin displacement mortality for the Forth Islands SPA from NnG alone, as presented in the CEH displacement model (Searle *et al.*, 2014)

| SPA | Change in annual adult survival | | SPA population | Estimated number of adults | |
|---|---|---|---|---|---|
| | Homogeneous [8] | Heterogeneous [8] | | Homogeneous | Heterogeneous |
| **Forth Islands** | -0.46 | -0.64 | 45,005 pairs | -414 adults | -576 adults |

281. The worst-case annual estimated mortality of 576 adult puffins corresponds to a maximum of 0.6% of the Forth Islands SPA breeding population (45,005 pairs), from displacement effects from NnG and a 1 km buffer. This demonstrates that if adult puffin mortality from displacement was at this level, the impact would not be significant at the population level for this SPA.

282. However, this is an annual estimate, based on the heterogeneous prey distribution scenario, an assumed 60% displacement rate, and several other assumptions including the behaviour of seabirds in response to wind farms (including habituation) and the effects of adult body mass change on subsequent survival, which are detailed in the final report for the displacement model (Searle *et al.*, 2014).

283. Searle *et al.*, (2014) discuss the implications of the assumptions made regarding homogeneous and heterogeneous prey distribution. The report states that both methods rely on assumptions that are unlikely to be realistic in practice, but it is not known which of the two scenarios is likely to be closer to reality. The main assumptions highlighted by Searle *et al.*, (2014) are that:

- The heterogeneous prey results assume that the density of prey can be directly inferred from the density of observed seabird foraging locations (within relatively small datasets), but in reality the GPS data does not give a complete picture of the density of foraging birds, and, further, the density of foraging birds is unlikely to be related solely to the density of prey.
- The homogeneous prey results assume that prey is uniformly distributed across the Forth/Tay area, which is not the case.

284. The report recommends that results from both methods should be considered, although considerable caution should be applied to interpretation of all results. The greatest caution is needed in cases where bird distributions were inferred from GPS data for small numbers of birds, such as puffins, and in these situations the heterogeneous prey distributions are likely to be of particular concern. The modelling for puffins was based on a sample size of seven tagged puffins in 2012, however, it was found that the tagged birds behaved differently from a set of ‘control’ birds that were not tagged

[8] Figures from Table 3.2, Searle *et al.* (2014)

(Harris *et al*., 2012). As a result, displacement model outputs for puffin were considered unreliable by the SNCBs and MSS (Marine Scotland, 2014a).

285. There is little field-based evidence on the effects on puffins from operational offshore wind farms. This is because existing offshore wind farms for which published results are available are located in areas where puffins are naturally scarce. Occasionally puffins were recorded during Horns Rev, Egmond aan Zee and Arklow Bank post-construction monitoring but not in sufficient numbers to undertake any statistical analysis of effects (Petersen, 2005, Leopold *et al.,* 2011, Barton *et al,* 2010).

286. The extent to which wind farms are likely to act as a barrier to puffins is unknown. However, a recent study looking at the theoretical energy costs of a barrier effect concluded, "If an Atlantic puffin were to travel an additional 10,000 m due to the presence of wind farms then it would expend 103% of its daily energy expenditure on the extended flight activity alone" (Masden *et al.*, 2010).

287. However, a comparison of foraging ranges using satellite tagged breeding adult puffins from two colonies on the Shiant Isles and Hermaness, Shetland, has shown that puffins are capable of flying considerable distances in search of prey during the breeding season. Based on six satellite tagged birds from each colony, preliminary results showed that birds from the Shiant Isles were mostly feeding in the Minch, and travelling approximately 20 km from the colony. In contrast, some of the tagged puffins from the Hermaness colony were travelling much further, with one bird travelling over 400 km to feed (800 km round trip), and another travelling approximately 150 km from the colony. Observations of prey being brought in to the two colonies suggest that birds at the Shiants were bringing larger adult sandeels, whereas the puffins at Hermaness were bringing back small, immature sandeels (RSPB, 2017).

288. While this study demonstrates that different colonies may experience different prey availability conditions, it also demonstrates that puffins are able to fly considerable distances in search of food during the breeding season. On this basis, it is concluded that displacement or barrier effects are unlikely to have an additional significant effect on daily energy expenditure for breeding puffins.

289. A recent study conducted at the operational Westermost Rough Offshore Wind Farm in July 2017, investigated the degree of displacement for auks, including puffins within the wind farm (APEM 2017). This report is presented in Appendix 9.5.

290. Westermost Rough is approximately 35 km from the Flamborough Head and Bempton Cliffs SPA, and is therefore within mean maximum foraging range of breeding puffins from this colony. The wind farm comprises 35 turbines spaced approximately 1 km apart, each with a turbine height of 177 m, hub height of 102 m and rotor diameter of 154 m. Westermost Rough therefore has a comparable design to NnG, in terms of the size of turbines and spacing between turbines.

291. Puffin distribution within the Westermost Rough wind farm and surrounding study area in July 2017 is presented in Figure 9-12, Figure 9-13 and Figure 9-14 below.

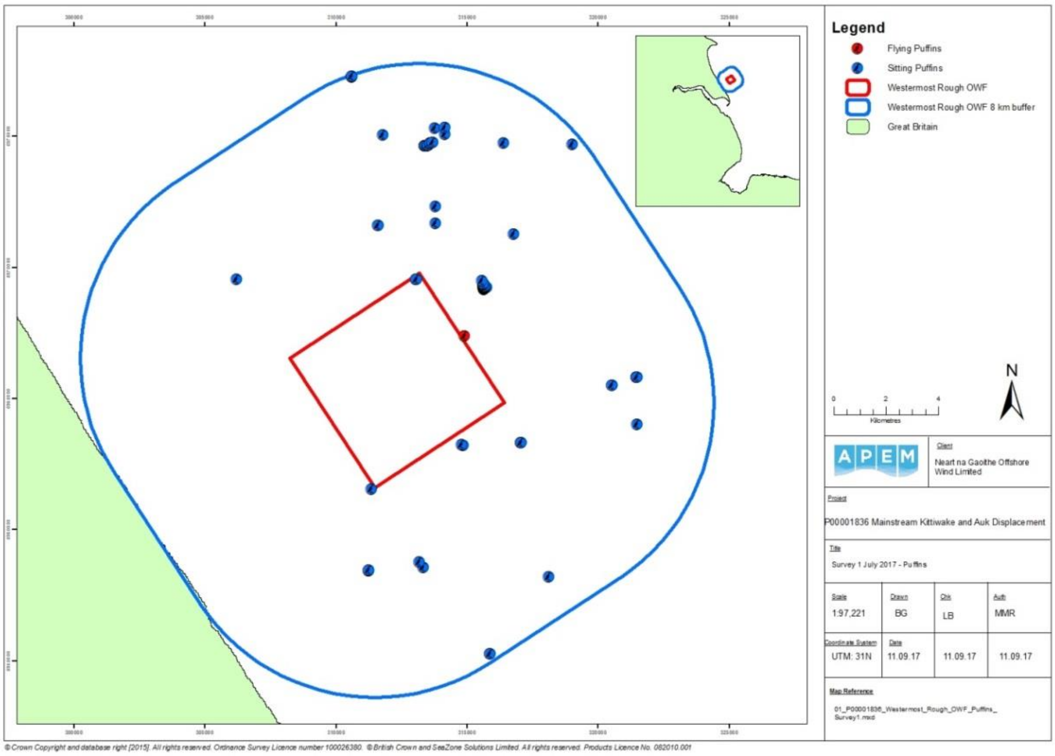


Figure 9-12: Distribution of puffins recorded in the WROWF and 8 km buffer during Survey 1, July 2017

292. On all three surveys, the sample sizes for puffins recorded in the study area were small, and most birds were recorded on the water. However, the survey results showed a similar distribution pattern to the other three species (kittiwake, guillemot and razorbill) in that puffins were recorded in lower numbers in more inshore waters compared to further offshore. However, numbers and distribution within the wind farm compared to the surrounding area is similar on each survey, indicating that birds were not displaced by the presence of the operational turbines.

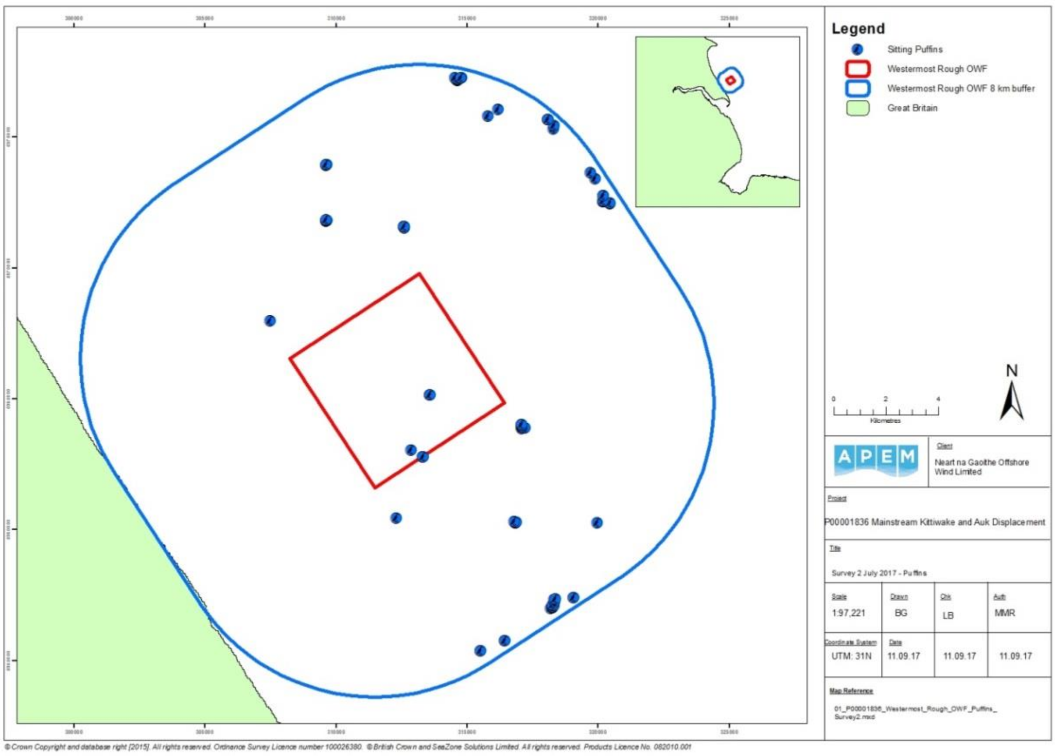


Figure 9-13: Distribution of puffins recorded in the WROWF and 8 km buffer during Survey 2, July 2017




Figure 9-14: Distribution of puffins recorded in the WROWF and 8 km buffer during Survey 3, July 2017

293. The study recorded a high variability in overall mean densities of auks, including puffins, calculated for the entire offshore wind farm and the surrounding buffer zone suggesting no evidence of displacement. There were variations in mean densities of auks across the buffer zone but these differences were not statistically significant.

294. Overall, based on available evidence from other studies and the low predicted mortality arising from displacement, it is concluded that displacement mortality impacts at NnG will have no effect on the breeding SPA populations of puffins within mean maximum foraging range in the breeding season. The sensitivity of puffins to displacement is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

***Non-breeding season (mid-August to March)***

295. The non-breeding season for puffin was defined in the Scoping Opinion and in the BDMPS review as mid-August to March (Marine Scotland, 2017; Furness, 2015).

296. Assuming 60% of all puffins were displaced from the Wind Farm Area during the non-breeding season, this would affect an estimated 923 birds (Table 9-47), increasing to 1,531 birds including the 1 km buffer, and 2,194 birds including the 2 km buffer.

Table 9-47: Summary of puffin displacement for the Wind Farm Area and surrounding buffer areas in the non-breeding season

| Displacement | Adults | Immature birds | Total number of birds |
|---|---|---|---|
| **Wind Farm Area** | 502 | 421 | 923 |
| **Wind Farm Area + 1 km** | 833 | 698 | 1,531 |
| **Wind Farm Area + 2 km** | 1,194 | 1,000 | 2,194 |

297. Using proportions from the PVA stable age structure, the ratio of adult to immature puffins at Forth Islands SPA and Fowlsheugh SPA was calculated (Table 9-44). If it is assumed that 45.6% of the population present in the non-breeding season are immature birds, then this would mean that an estimated 421 puffins displaced from the Wind Farm Area during the non-breeding season would be immature birds, and that the number of displaced adult birds would be 502 birds (Table 9-47). Similarly, an estimated 698 puffins displaced from the Wind Farm Area and 1 km buffer during the non-breeding season would be immature birds, with 833 displaced adult birds. An estimated 1,000 puffins displaced from the Wind Farm Area and 2 km buffer during the non-breeding season would be immature birds, with 1,194 displaced adult birds.

298. Using the 2% mortality rate recommended by the Scoping Opinion (Marine Scotland, 2017), it was calculated that 18 puffins (ten adults and eight immature birds) displaced from the Wind Farm Area, during the non-breeding season would suffer mortality as a result (Table 9-48). Similarly, 31 puffins (17 adults and 14 immature birds) would suffer mortality in the Wind Farm Area and 1 km buffer, or 44 puffins (24 adults and 20 immature birds) in the Wind Farm Area and 2 km buffer, during the non-breeding season.

Table 9-48: Summary of puffin displacement mortality for the Wind Farm Area and surrounding buffer areas in the non-breeding season

| Displacement mortality | Adults | Immature birds | Total number of birds | % of SPA population |
|---|---|---|---|---|
| **Wind Farm Area** | 10 | 8 | 18 | 0.03 |
| **Wind Farm Area + 1 km** | 17 | 14 | 31 | 0.05 |
| **Wind Farm Area + 2 km** | 24 | 20 | 44 | 0.07 |

299. This is considered an over-estimate, as outside of the breeding season puffins are no longer limited in their foraging range by having to return to the colony. As birds are free to forage over a wider area, any displacement effects are considerably less likely to have any mortality impact.

300. The total number of puffins (adults and immature birds) estimated to occur in the UK waters of the North Sea and Channel in the non-breeding season (mid-August to March) is 231,957 birds (Furness, 2015). Of this population, an estimated 162,061 puffins (adults and immature birds) are considered to be from UK breeding colonies. If up to 44 puffins were to die as a result of displacement from the Wind Farm Area, this would affect 0.03% of the North Sea and Channel population from UK breeding colonies (162,061 adults and immature birds) in the non-breeding season.

301. Estimated numbers of adult and immature puffins from the Forth Islands SPA in the UK waters of the North Sea and Channel in the non-breeding season (mid-August to March) are shown in Table 9-49 (Furness, 2015).

Table 9-49: Estimated numbers of adult and immature puffins from the Forth Islands SPA in the UK waters of the North Sea and Channel in the non-breeding season (Furness, 2015)

| SPA | Non-breeding season North Sea | | |
|---|---|---|---|
| | Adult | Immature | Total |
| **Forth Islands** | 62,231 | 2,589 | 64,820 |

302. If up to 44 puffins were to suffer mortality as a result of displacement from the Wind Farm Area and 2 km buffer, this would affect up to 0.07% of the North Sea population from the Forth Islands SPAs (64,820 adults and immature birds) in the non-breeding season (Furness, 2015) (Table 9-48). This is

considered an over-estimate, as outside of the breeding season puffins are no longer limited in their foraging range by having to return to the nest. As birds are free to forage over a wider area, any displacement effects are considerably less likely to have a mortality impact.

303. For the surviving displaced birds, there would be minimal impact from displacement, as foraging birds would be able to find food outside of the Wind Farm Area and 2 km buffer. Therefore, it is concluded that displacement mortality impacts at NnG will have no effect on puffins from the key SPA population in the non-breeding season. The sensitivity of puffins to displacement is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

*Assessment of displacement mortality throughout the year*

304. Predicted puffin mortality from all seasons from displacement as calculated above, was summed for the whole year (Table 9-50).

305. A total of 34 puffins are assumed to suffer mortality if displacement impacts are confined to the Wind Farm Area, based on an assumed mortality rate of 2%. This represents an estimated 0.05% of the population of the key SPA, based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015).

Table 9-50: Estimated puffin mortality (adult and immature birds) from the Wind Farm Area and 2 km buffer on the three key SPAs in the UK waters of the North Sea throughout the year

| Season | Wind Farm Area | | Wind Farm Area + 2 km buffer | |
|---|---|---|---|---|
| | No of birds | % of SPA population | No of birds | % of SPA population |
| **Breeding season** | 16 adults | 0.02 | 37 adults | 0.04 |
| **Non-breeding season** | 18 birds | 0.03 | 44 birds | 0.07 |
| **Total** | 34 birds | 0.05 | 81 birds | 0.1 |

306. If displacement impacts occur over the Wind Farm Area and a surrounding 2 km buffer, then an estimated 81 puffins are assumed to suffer mortality as a result of displacement. This represents an estimated 0.1% of the population of the key SPA, based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015).

307. However, it is considered that a mortality rate of 2% outside of the breeding season, when birds are not tied to their breeding colony, is precautionary. Therefore, it is concluded that displacement mortality impacts at NnG will have no effect on puffins from the key SPA population throughout the year. The sensitivity of puffins to displacement is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

### 9.9.2.3 Collision Mortality

308. In the Scoping Opinion, MS-LOT advised that collision rate modelling would be required for gannet, herring gull and kittiwake. The RSPB also recommended that lesser black-backed gull and great black-backed gull should be considered for collision rate modelling (Marine Scotland, 2017). In addition, a further five species (Arctic skua, great skua, little gull, black-headed gull and common gull) have been included in the collision rate modelling, on the basis of flight heights recorded during baseline surveys. Although numbers of these species recorded on baseline surveys were generally low, more than 1% of recorded flight height for these species was above 27.5m in height.

309. Collision rate modelling was carried out using the methods described in Band (2012). For kittiwake and gannet, the assessment presents estimated collisions using Band model Option 1 with site specific flight height data, and Option 2 using generic flight height data from Johnson *et al*. (2014).

310. For gannet, an avoidance rate of 98.9% (± 0.002) has been used in the assessment, with estimates using 98% for summer months also presented, as requested by the RSPB in the Scoping Opinion (Marine Scotland, 2017). For kittiwake, an avoidance rate of 98.9% (± 0.002) has been used, as recommended in the Scoping Opinion (Marine Scotland, 2017). The nocturnal activity scores of 2 (25%) were used for kittiwake and 1 (0%) for gannet, as recommended in the Scoping Opinion (Marine Scotland, 2017).

311. For herring gull, lesser black-backed gull and great black-backed gull, the assessment has presented estimated collisions using the Band model Option 1 with site specific flight height data, and Options 2 and 3 using Johnson *et al*. (2014). For herring gull, the following avoidance rates have been used:

- 99.5% (± 0.001) for Band Option 1;
- 99.5% (± 0.001) for Band Option 2;
- 99.0% (± 0.002) for Band Option 3.

312. For lesser black-backed gull and great black-backed gull, the following avoidance rates have been used, based on the BTO Avoidance Rate review (Cook *et al.,*2014):

- 99.5% (± 0.001) for Band Option 1;
- 99.5% (± 0.001) for Band Option 2;
- 98.9% (± 0.002) for Band Option 3.

313. A nocturnal activity score of 2 (25%) was used for herring gull, and a nocturnal activity score of 3 (50%) was used for lesser black-backed gull and great black-backed gull.

314. Input data for the worst-case design scenario (54 turbines) are presented in Appendix 9.3: Table 1. Information on rotation speed, pitch and the proportion of time in operation was available per month; therefore, collision rate modelling has used monthly figures for these variables along with bird density.

315. Biometric input data for the bird species assessed, such as length, wingspan and recorded monthly densities for the five main bird species are shown in Appendix 9.3: Table 2. Biometric data were obtained from Snow and Perrins (1997) and flight speeds from Alerstam *et al*. (2007), Pennycuick (1987) and Pennycuick (1997). As a precautionary approach, flapping was used for all species to account for the unknown behaviour as birds pass the rotor-swept area.

316. For Band Option 1, densities used in the collision rate modelling were based on mean monthly values from three years of baseline surveys at the Project study site. The proportion of birds at rotor height (PCH in Appendix 9.3: Table 2 and Table 3) was calculated from data recorded during the ship-based surveys and following standardised European Seabirds at Sea (ESAS) protocols in which only flying birds recorded as 'in transect' (thus during the snapshot count) are included (Camphuysen and Garthe 2004, Webb and Durinck 1992). The heights of flying birds recorded as 'in transect' were recorded in categories. To account for observers rounding off, particularly at heights above 30 m, flying birds were pooled into 10 m categories and divided equally across the 1 m bands within these categories. This assumes a precautionary approach as it tends to over-estimate the numbers of birds in the upper limits of each category. The proportion of birds at rotor height (PCH) was then calculated based on the birds at 32 m and above (for a minimum rotor height of 32m above mean sea level, MSL, i.e. 35m above LAT).

317. For Band Options 2 and 3, flight height data accompanying Johnston *et al*. (2014) were used. In Band Option 2, the proportions of birds at rotor height (PCH) were taken as those at 32 m and above. In Band Option 3, the collision model calculation uses these flight height data as input data to calculate the proportions of birds throughout the rotor height.

318. For all species (gannet, kittiwake, herring gull, lesser black-backed gull and great black-backed gull) the proportion of birds at rotor height for site-specific survey data were lower than the data presented in Johnston et al. (2014).

319. The large array correction factor, which takes account of the declining proportion of birds surviving passage through initial rows of turbines and thus exposed to collision risk in later rows, was not applied in this assessment, as this has little effect on the results and is only of relevance for very large wind farms of hundreds of turbines.

320. In addition, collision rate modelling was carried out for five passage species (great skua, Arctic skua, little gull, black-headed gull and common gull) (Appendix 9.3: Table 3). Due to the low number of these species recorded during baseline surveys, modelling was based on an assumption that 1,000 individuals of each species passed through the Wind Farm Area in a south-north direction in April and again in a north-south direction in September, using the 'migrant collision risk' option in the Band Model, and Band Model Option 2. The width of the development area was taken as 8.22km.

321. Turbine parameters for the Original Project and the current Project are shown in Table 9-51.

Table 9-51: Number of turbines, diameter and blade tip height for 2014 and 2017 projects

| | NnG | |
|---|---|---|
| | **2014 consented** | **2017 Worst-case** |
| **No. of turbines** | 75 | 54 |
| **Rotor diameter** | Up to 154m | Up to 167m |
| **Air Gap** | 30.5m above LAT | 35m above LAT |
| **Maximum height to blade tip (LAT)** | 197m | Up to 208m |

322. A comparison of the proportion of birds at collision height (PCH) for Option 1 and Option 2 for the five key species assessed here is presented in Table 9-52. Differences in PCH for the two Band Model options are discussed in the relevant species text.

Table 9-52: Proportion of birds at collision height (PCH) for Option 1 and Option 2 for the five key species included in the collision assessment

| **54 turbines**<br>**98.9% AR (± 2 SD)** | **Band Option 1**<br>32m upwards | **Band Option 2**<br>**32 – 300m** |
|---|---|---|
| **Gannet** | 0.018 | 0.036 |
| **Kittiwake** | 0.019 | 0.047 |
| **Herring Gull** | 0.120 | 0.160 |
| **Lesser black-backed Gull** | 0.041 | 0.131 |
| **Great black-backed Gull** | 0.119 | 0.167 |

#### *9.9.2.3.1 Collision estimates for gannet*

323. The CRM assessment estimated the number of potential gannet collisions per season based on the worst-case design scenario (54 turbines). The minimum height for the turbine blades above the sea surface for this design is 32.0 m at mean sea level (MSL) (35 m LAT).

*Breeding season*

324. Estimated gannet collisions for the worst-case design scenario (54 turbines) using an avoidance rate of 98.9% (± 0.002), as recommended in the Scoping Opinion (Marine Scotland, 2017), are shown in Table 9-53. Two sets of figures are presented: Band Model Option 1 and Band Model Option 2, for the breeding and non-breeding seasons. In addition, estimated collisions based on an avoidance rate of 98% (± 0.002) for the breeding season (mid-March to September) are presented in Table 9-54.

325. The proportion of gannets at collision height (PCH) for the different Band Model options used in the assessment are shown in Table 9-52. The proportion at collision height was lowest for the Band Option 1 dataset (0.018) and highest for the Band Model Option 2 dataset (0.036).

326. For the purposes of this assessment, all gannets in the breeding season were assumed to be from the Forth Islands SPA, as recommended in the Scoping Opinion (Marine Scotland, 2017). This SPA has therefore been used as the SPA reference population for this assessment in the breeding season (75,259 pairs).

327. Baseline surveys recorded the age of gannets where possible, with 877 immature (non-breeding) birds (2.5%) and 34,208 adults (97.5%) aged on surveys between mid-March and September, and 193 immature (non-breeding) birds (3.6%) and 5,222 adults (96.4%) aged on surveys between October and mid-March (Appendix 9.2: Table 3). These age ratios were applied to the estimated number of collisions for the breeding and non-breeding seasons to give the estimated number of collisions for adult and immature gannets.

328. For the worst case design scenario (54 turbines), a total of 93 gannet collisions (91 adults and two immature birds) were estimated for the breeding season, using an avoidance rate of 98.9% and Band Option 2 (Table 9-53). This corresponds to 0.06% of the Forth Islands SPA breeding population (75,259 pairs) (Table 9-8). Based on an avoidance rate of 98.9% and using Band Option 2, a total of 14 gannet collisions (13 adults and one immature bird) were estimated for the non-breeding season (October to mid-March), for the worst case design scenario.

Table 9-53: Estimated number of gannet collisions based on 54 turbines, Band Model Option 1 & 2 and an avoidance rate of 98.9% ± 2 SD

| 54 turbines<br>98.9% AR (± 2 SD) | Band Option 1 | Band Option 2 |
|---|---|---|
| **Collisions in breeding season, all ages** | 46 ± 8.3 | 93 ± 16.9 |
| **Collisions in breeding season, adults birds** | 45 | 91 |
| **Collisions in breeding season, immature birds** | 1 | 2 |
| **Collisions in non-breeding season, all ages** | 7 ± 1.3 | 15 ± 2.7 |
| **Collisions in non-breeding season, adults birds** | 7 | 14 |
| **Collisions in non-breeding season, immature birds** | 0 | 1 |
| **Total collisions per year, all ages** | 53 ± 9.6 | 108 ± 19.6 |

329. For comparison, the estimated number of gannet collisions using Band Model Option 1 & 2 and an avoidance rate of 98% for the breeding season, as requested by RSPB in the Scoping Opinion (Marine Scotland, 2017) are shown in Table 9-54.

Table 9-54: Estimated number of gannet collisions in the breeding season, based on 54 turbines, Band Model Option 1 & 2 and an avoidance rate of 98%

| 54 turbines<br>98% AR | Band Option 1 | Band Option 2 |
|---|---|---|
| **Collisions in breeding season, all ages** | 83 | 169 |
| **Collisions in breeding season, adults birds** | 81 | 165 |
| **Collisions in breeding season, immature birds** | 2 | 4 |

330. For the worst case design scenario (54 turbines), a total of 169 gannet collisions (165 adults and four immature birds) were estimated for the breeding season, using an avoidance rate of 98% and Band Option 2 (Table 9-54). This corresponds to 0.1% of the Forth Islands SPA breeding population (75,259 pairs) (Table 9-8).

331. As expected, using an avoidance rate of 98% and Band Option 2 gives a higher estimated number of adult gannet collisions in the breeding season (165 birds), compared to 91 adults estimated using an avoidance rate of 98.9% and Band Option 2. However, a study of avoidance rates by the BTO recommended that for gannet, an avoidance rate of 98.9% should be used with the basic Band Model, (which includes Option 2, as used here) (Cook *et al.,* 2014). This was also the avoidance rate recommended for gannet in the Scoping Opinion (Marine Scotland, 2017). Based on these recommendations, an avoidance rate of 98.9% has been used in this assessment.

332. The figure of 91 adult gannet collisions is also considered highly precautionary. Post-construction monitoring at operational wind farms indicate that the majority of gannets are likely to avoid the footprint of the proposed wind farm (PMSS, 2006; Christensen *et al*, 2004; Leopold *et al*, 2011; Diersche and Garthe, 2006). No records of gannets colliding with wind turbines were reported by Diersche and Garthe (2006) in a literature review on the effects of offshore wind farms on seabirds.

333. Gannets observed entering the Egmond aan Zee wind farm in the Netherlands always stopped foraging, decreased flight height to <10 m (i.e. well below rotor height) and flew out of the wind farm (Leopold *et al*, 2011).

334. Although most post-construction studies of gannets have occurred outside the breeding season and away from breeding colonies, some post-construction studies have been carried out at offshore wind farms within foraging range of breeding gannets. Post-construction monitoring at Robin Rigg Offshore Wind Farm in the Solway Firth, recorded no gannets flying within the operating wind farm over a five year period. This study also found that gannets largely flew below turbine swept-rotor height (35-125 m) throughout the entire study area, with less than 2% of all gannets in flight recorded at rotor height (Nelson *et al*, 2015). Robin Rigg is within mean maximum foraging distance of the gannet breeding colony on Ailsa Craig (33,226 pairs in 2014), and also Scar Rocks in Dumfries and Galloway (2,376 pairs in 2014) (SMP 2017).

335. Appendix 9.7 presents maps of gannets tracked from the Bass Rock in the breeding season in 2010, 2011, 2012 and 2015. Birds tagged in the 2010 to 2012 breeding seasons were all breeding adults from the Bass Rock colony, while birds tagged in the 2015 breeding season were breeding adults and non-breeding immature birds. This gannet data was made available by Keith Hamer of the University of Leeds.

336. The maps demonstrate that adult birds travel a considerable distance from the Bass Rock colony, and that the Wind Farm Area is not a key foraging area for gannets in the breeding season. A paper on gannet flight height using pressure tags concluded that foraging gannets were more likely to fly at rotor height than gannets that were travelling or commuting from one place to another, e.g. returning to the Bass Rock after a foraging trip (Cleasby *et al.*, 2015). A comparison of flight direction and flight height of adult gannets recorded on baseline surveys between March and September within the Wind Farm Area and 2 km buffer is presented in Appendix 9.2: Table 2. The majority of adult gannets recorded flying in the direction of the Bass Rock (recorded as flying west, south-west or south) were flying below 7.5m in height (90.7%) (n=18,900 birds). In comparison, just under three quarters of adult gannets recorded flying away from the Bass Rock (recorded as flying north, north-east or east) were flying below 7.5m in height (73.6%%) (n=12,119 birds). Although a relatively crude assessment, these results indicate that the majority of adult gannets flying within the Wind Farm Area and 2 km buffer are well below the rotor swept area.

337. The proportion of gannets at collision height (PCH) for the different Band Model options used in the assessment are shown in Table 9-52. The proportion at collision height was lowest for the Band Option 1 dataset (0.018) and highest for the Band Model Option 2 dataset (0.036). This assessment was based on Band Option 2 (the generic dataset, with a higher proportion of birds at collision height), therefore it is considered precautionary. It is considered that using the Band Option 1 dataset is more representative of gannet flight behaviour at NnG than using the generic dataset with Band Option 2, and that the overall number of collisions in the breeding season will be lower than the number assessed here.

338. In addition, the consistent reports of high avoidance of gannets from offshore wind farms in a variety of different study situations in European marine areas indicates that it is likely that this is how breeding birds from the Bass Rock colony will respond to the Project. Correspondingly, the estimated number of gannet collisions (91 adults) presented here is therefore considered an over-estimate.

339. It is concluded that collision mortality impacts at NnG will have no effect on the breeding SPA population of gannets within mean maximum foraging range in the breeding season. The sensitivity of gannets to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

*Autumn period of the non-breeding season*

340. The autumn period of the non-breeding season for gannet was defined in the Scoping Opinion as October and November (Marine Scotland, 2017), and in the BDMPS review as September to November (Furness 2015). Although there are slight differences in these definitions, it was considered these would not make a significant difference to the assessment, and so the Scoping Opinion definitions were followed.

341. Estimated gannet collisions between October and November for the worst-case design scenario (54 turbines) using an avoidance rate of 98.9% (+- 0.002), as recommended in the Scoping Opinion (Marine Scotland, 2017) are shown in Table 9-55. Two sets of figures are presented: Band Model Option 1 and Band Model Option 2.

342. Baseline surveys recorded 147 immature (non-breeding) birds (5.5%) and 2,549 adults (94.5%) on surveys between October and November (Appendix 9.2: Table 3). These age ratios were applied to the estimated number of collisions for the autumn period of the non-breeding season to give the estimated number of collisions for adult and immature gannets.

Table 9-55: Estimated number of gannet collisions in the autumn period of the non-breeding season (September to November), based on 54 turbines, Band Model Option 1 & 2 and an avoidance rate of 98.9% ± 2 SD

| 54 turbines<br>98.9% AR (± 2 SD) | Band Option 1 | Band Option 2 |
|---|---|---|
| **Collisions in autumn period of non-breeding season, all ages** | 4 ± 0.7 | 7 ± 1.3 |
| **Collisions in autumn period of non-breeding season, adults birds** | 4 | 7 |
| **Collisions in autumn period of non-breeding season, immature birds** | 0 | 0 |

343. For the worst-case design scenario (54 turbines), a total of seven gannet collisions (all adults) were estimated for the autumn period of the non-breeding season (October and November), using an avoidance rate of 98.9% and Band Option 2 (Table 9-55).

344. The total number of gannets (adults and immature birds) estimated to occur in the UK waters of the North Sea and Channel in the autumn period of the non-breeding period (September to November) is 456,298 birds (Furness, 2015). Of this population, an estimated 411,125 gannets (adults and immature birds) are considered to be from UK breeding colonies. If seven gannets were to suffer mortality in the autumn period of the non-breeding season as a result of turbine collision, this would affect 0.002% of the North Sea and Channel population from UK breeding colonies (411,125 adults and immature birds).

345. Estimated numbers of adult and immature gannets from the key SPA for gannets considered in this assessment in the UK waters of the North Sea and Channel in the autumn period of the non-breeding season are shown in Table 9-56 (Furness, 2015).

Table 9-56: Estimated numbers of adult and immature gannets from the Forth Islands SPA in the UK waters of the North Sea and Channel in the autumn period of the non-breeding season (Furness, 2015)

| SPA | Autumn North Sea | | |
|---|---|---|---|
| | Adult | Immature | Total |
| **Forth Islands** | 110,964 | 80,893 | 191,857 |

346. If seven gannets (worst case) were to suffer mortality in the autumn period of the non-breeding season as a result of turbine collision, this would affect 0.004% of the North Sea and Channel population from the key SPA (191,857 adults and immature birds)(Furness, 2015).

347. It is concluded that collision mortality impacts at NnG will have no effect on gannets from the SPA population in the autumn period of the non-breeding season. The sensitivity of gannets to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

*Spring period of the non-breeding season*

348. The spring period of the non-breeding season for gannet was defined in the Scoping Opinion as December to mid-March (Marine Scotland, 2017), and in the BDMPS review as December to March (Furness 2015). Although there are slight differences in these definitions, it was considered these would not make a significant difference to the assessment, and so the Scoping Opinion definitions were followed.

349. Estimated gannet collisions between December and mid-March for the worst-case design scenario (54 turbines) and an avoidance rate of 98.9% (+- 0.002), as recommended in the Scoping Opinion (Marine Scotland, 2017) are shown in Table 9-57. Two sets of figures are presented: Band Model Option 1 and Band Model Option 2.

350. Baseline surveys recorded 46 immature (non-breeding) birds (1.7%) and 2,673 adults (98.3%) on surveys between December and mid-March (Appendix 9.2 Table 3). These age ratios were applied to the estimated number of collisions for the spring period of the non-breeding season to give the estimated number of collisions for adult and immature gannets.

Table 9-57: Estimated number of gannet collisions in the spring period of the non-breeding season (December to mid-March), based on 54 turbines, Band Model Option 1 & 2 and an avoidance rate of 98.9% ± 2 SD

| 54 turbines<br>98.9% AR (± 2 SD) | Band Option 1 | Band Option 2 |
|---|---|---|
| **Collisions in spring period of non-breeding season, all ages** | 4 ± 0.6 | 7 ± 1.3 |
| **Collisions in spring period of non-breeding season, adults birds** | 4 | 7 |
| **Collisions in spring period of non-breeding season, immature birds** | 0 | 0 |

351. For the worst-case design scenario (54 turbines), a total of seven gannet collisions (all adults) were estimated for the spring period of the non-breeding season (December to mid-March), based on Band Option 2 (Table 9-57).

352. The total number of gannets (adults and immature birds) estimated to occur in the UK waters of the North Sea and Channel in the spring period of the non-breeding period (December to March) is 248,385 birds (Furness, 2015). Of this population, an estimated 226,482 gannets (adults and immature birds) are considered to be from UK breeding colonies. If seven gannets (worst case) were to suffer mortality in the spring period of the non-breeding season as a result of turbine collision, this would affect 0.003% of the North Sea and Channel population from UK breeding colonies (226,482 adults and immature birds).

353. Estimated numbers of adult and immature gannets from the key SPA for gannets considered in this assessment in the UK waters of the North Sea and Channel in the spring period of the non-breeding season are shown in Table 9-58 (Furness, 2015).

Table 9-58: Estimated numbers of adult and immature gannets from the Forth Islands SPA in the UK waters of the North Sea and Channel in the spring period of the non-breeding season (Furness, 2015)

| SPA | Spring North Sea | | |
|---|---|---|---|
| | Adult | Immature | Total |
| **Forth Islands** | 77,675 | 35,952 | 113,627 |

354. If seven gannets (worst case) were to suffer mortality in the spring period of the non-breeding season as a result of turbine collision, this would affect 0.006% of the North Sea and Channel population from the key SPA (113,627 adults and immature birds) (Furness, 2015).

355. It is concluded that collision mortality impacts at NnG will have no effect on gannets from the SPA population in the spring period of the non-breeding season. The sensitivity of gannets to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

*Assessment of collision mortality throughout the year*

356. Predicted gannet mortality from all seasons from collision as calculated above, was summed for the whole year for the worst-case scenario (54 turbines) (Table 9-59).

Table 9-59: Estimated number of gannet collisions per year, based on 54 turbines, Band Model Option 2 and an avoidance rate of 98.9% ± 2 SD

| 54 turbines<br>98.9% AR (± 2 SD) | Band Option 2 | % of SPA population |
|---|---|---|
| **Collisions in breeding season, all ages** | 93 ± 16.9 | 0.06% |
| **Collisions in autumn period of non-breeding season, all ages** | 7 ± 1.3 | 0.004% |
| **Collisions in spring period of non-breeding season, all ages** | 7 ± 1.3 | 0.003% |
| **Total** | 107 ± 19.5 | 0.07% |

357. For the worst case design scenario (54 turbines), a total of 107 gannets (adult and immatures) are estimated to suffer mortality each year from collision impacts, based on Band Model Option 2 and an avoidance rate of 98.9%. This represents an estimated 0.07% of the population (adult and immatures) of the key SPA, based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015).

358. This is considered precautionary, as it is based on Band Option 2, which used the generic dataset from Johnston *et al.* 2014, rather than the site-specific flight height data collected on baseline surveys. It is considered that using the Band Option 1 dataset would more representative of gannet flight behaviour at NnG than using the generic dataset with Band Option 2, and that the number of collisions in the breeding season will be lower than the number assessed here.

359. It is concluded that collision mortality impacts at NnG will have no effect on gannets from the SPA population throughout the year. The sensitivity of gannets to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

#### *9.9.2.3.2 Collision estimates for kittiwake*

*Breeding season*

360. The CRM assessment has estimated the number of potential kittiwake collisions per season for the worst-case design scenario (54 turbines). The minimum height for the turbine blades above the sea surface for this scenario is 32.0 m at mean sea level (MSL) (35 m LAT).

361. The proportion of kittiwakes at collision height for the different Band Model options used in the assessment are shown in Table 9-52. The proportion at collision height was lowest for the Band Option 1 dataset (0.019) and highest for the Band Model Option 2 dataset (0.047).

362. Baseline surveys recorded the age of kittiwakes where possible, with 222 immature (non-breeding) birds (6.8%) and 3,033 adults (93.2%) aged on surveys in the breeding season as defined in the Scoping Opinion (Table 9-7) (mid-April to August), and 1,041 immature (non-breeding) birds (39.5%) and 1,597 adults (60.5%) aged on surveys in the non-breeding season (September to mid-April) (Appendix 9.2: Table 5). These age ratios were applied to the estimated number of collisions for the breeding and non-breeding seasons to give the estimated number of collisions for adult and immature kittiwakes.

363. Populations at SPAs for breeding kittiwakes of relevance to this assessment are presented in Table 9-8. In the breeding season, the mean maximum foraging range of breeding kittiwakes is 60.0 ± 23.3 km, based on a sample size of six birds (Thaxter *et al.,* 2012). Based on this, three SPAs for breeding kittiwakes (Forth Islands, Fowlsheugh and St Abb's Head to Fast Castle) are within mean maximum foraging range + 1 SD of the Project. These three SPAs have therefore been used as the SPA reference population for this assessment in the breeding season (17,652 pairs). For the non-breeding season, the Buchan Ness to Collieston Coast SPA was also included.

364. Estimated kittiwake collisions for the worst-case design scenario (54 turbines) based on an avoidance rate of 98.9% (+- 0.002), as recommended in the Scoping Opinion (Marine Scotland, 2017), are shown in Table 9-60. Two sets of figures are presented: Band Model Option 1 and Band Model Option 2, for the breeding and non-breeding seasons.

Table 9-60: Estimated number of kittiwake collisions based on 54 turbines, Band Model Option 1 & 2 and an avoidance rate of 98.9% ± 2 SD

| 54 turbines<br>98.9% AR (± 2 SD) | Band Option 1 | Band Option 2 |
|---|---|---|
| **Collisions in breeding season, all ages** | 3 ± 0.6 | 9 ± 1.6 |
| **Collisions in breeding season, adults birds** | 3 | 8 |
| **Collisions in breeding season, immature birds** | 0 | 1 |
| **Collisions in non-breeding season, all ages** | 8 ± 1.4 | 19 ± 3.5 |
| **Collisions in non-breeding season, adults birds** | 5 | 12 |
| **Collisions in non-breeding season, immature birds** | 3 | 7 |
| **Total collisions per year, all ages** | 11 ± 2.0 | 28 ± 5.0 |

365. For the worst-case design scenario (54 turbines), a total of eight adult kittiwake collisions were estimated for the breeding season, using an avoidance rate of 98.9% and Band Option 2 (Table 9-60). This corresponds to 0.02% of the breeding population for the three key SPAs (17,652 pairs) (Table 9-8). A total of 19 kittiwake collisions (12 adults and seven immature bird) were estimated for the non-breeding season (October to mid-March), for the worst-case design scenario.

366. It is concluded that collision mortality impacts at NnG will have no effect on the breeding SPA populations of kittiwakes within mean maximum foraging range in the breeding season. The sensitivity of kittiwakes to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

*Autumn period of the non-breeding season*

367. The autumn period of the non-breeding season for kittiwake was defined in the Scoping Opinion as September to December (Marine Scotland, 2017), and in the BDMPS review as August to December (Furness 2015). Although there are slight differences in these definitions, it was considered these would not make a significant difference to the assessment, and so the Scoping Opinion definitions were followed.

368. Estimated kittiwake collisions between September and December for the worst-case design scenario (54 turbines) based on an avoidance rate of 98.9% (+- 0.002), as recommended in the Scoping Opinion (Marine Scotland, 2017) are shown in Table 9-61. Two sets of figures are presented: Band Model Option 1 and Band Model Option 2.

369. A total of 43.1% of kittiwakes aged during baseline surveys between September and December were immature birds (Appendix 9.2: Table 5). This percentage was applied to the estimated number of collisions for the autumn period of the non-breeding season to give the estimated number of collisions for adult and immature kittiwakes.

Table 9-61: Estimated number of kittiwake collisions in the autumn period of the non-breeding season (September to December), based on 54 turbines, Band Model Option 1 & 2 and an avoidance rate of 98.9% ± 2 SD

| 54 turbines<br>98.9% AR (± 2 SD) | Band Option 1 | Band Option 2 |
|---|---|---|
| **Collisions in autumn period of non-breeding season, all ages** | 7 ± 1.3 | 17 ± 3.1 |
| **Collisions in autumn period of non-breeding season, adult birds** | 4 | 10 |
| **Collisions in autumn period of non-breeding season, immature birds** | 3 | 7 |

370. For the worst-case design scenario (54 turbines), a total of 17 kittiwake collisions (10 adults and seven immature birds) for the autumn period of the non-breeding season (September to December) were estimated, using an avoidance rate of 98.9% and Band Option 2 (Table 9-61).

371. The total number of kittiwakes (adults and immature birds) estimated to occur in the UK waters of the North Sea in the autumn period (August to December) is 829,937 birds (Furness, 2015). Of this population, an estimated 432,129 kittiwakes (adults and immature birds) are considered to be from UK breeding colonies. If 17 kittiwakes were to die as a result of collision impacts from the Project in the autumn period of the non-breeding season, this would affect 0.004% of the North Sea population from UK breeding colonies (432,129 adults and immature birds).

372. Estimated numbers of adult and immature kittiwakes from the four key SPAs for kittiwakes considered in this assessment (Table 9-8) in the UK waters of the North Sea in the autumn period (August to December) are shown in Table 9-18 (Furness, 2015).

373. If 17 kittiwakes were to suffer mortality as a result of collision impacts from the Project in the autumn period of the non-breeding season, this would affect 0.03% of the North Sea population from the four key SPAs (54,039 adults and immature birds) (Furness, 2015).

374. It is concluded that collision mortality impacts at NnG will have no effect on kittiwakes from the four key SPA populations in the autumn period of the non-breeding season. The sensitivity of kittiwakes to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

*Spring period of the non-breeding season*

375. The spring period of the non-breeding season for kittiwake was defined in the Scoping Opinion as January to mid-April (Marine Scotland, 2017), and in the BDMPS review as January to April (Furness 2015). Although there are slight differences in these definitions, it was considered these would not make a significant difference to the assessment, and so the Scoping Opinion definitions were followed.

376. Estimated kittiwake collisions between January and mid-April for the worst-case design scenario (54 turbines) based on an avoidance rate of 98.9% (+- 0.002), as recommended in the Scoping Opinion (Marine Scotland, 2017) are shown in Table 9-62. Two sets of figures are presented: Band Model Option 1 and Band Model Option 2.

377. A total of 20.8% of kittiwakes aged during baseline surveys between January and mid-April were immature birds (Appendix 9.2). This percentage was applied to the estimated number of collisions for the spring period of the non-breeding season to give the estimated number of collisions for adult and immature kittiwakes.

Table 9-62: Estimated number of kittiwake collisions in the spring period of the non-breeding season (January to mid-April), based on 54 turbines, Band Model Option 1 & 2 and an avoidance rate of 98.9% ± 2 SD

| 54 turbines<br>98.9% AR (± 2 SD) | Band Option 1 | Band Option 2 |
|---|---|---|
| **Collisions in spring period of non-breeding season, all ages** | 1 ± 0.1 | 2 ± 0.3 |
| **Collisions in spring period of non-breeding season, adults birds** | 1 | 2 |
| **Collisions in spring period of non-breeding season, immature birds** | 0 | 0 |

378. For the worst-case design scenario (54 turbines), a total of two kittiwake collisions (both adults) were estimated for the spring period of the non-breeding season (January to mid-April), using an avoidance rate of 98.9% and Band Option 2 (Table 9-62).

379. The total number of kittiwakes (adults and immature birds) estimated to occur in the UK waters of the North Sea in the spring period of the non-breeding period (January to April) is 627,816 birds (Furness, 2015). Of this population, an estimated 389,392 kittiwakes (adults and immature birds) are considered to be from UK breeding colonies. If two kittiwakes were to die as a result of turbine collision in the spring period of the non-breeding season, this would affect 0.0005% of the North Sea population from UK breeding colonies (389,392 adults and immature birds).

380. Estimated numbers of adult and immature kittiwakes from the four key SPAs for kittiwakes considered in this assessment in the UK waters of the North Sea in the spring period of the non-breeding season are shown in (Table 9-21).

381. If two kittiwakes were to suffer mortality as a result of turbine collision in the spring period of the non-breeding season, this would affect 0.004% of the North Sea population from the four key SPAs (49,044 adults and immature birds) (Furness, 2015).

382. It is concluded that collision mortality impacts at NnG will have no effect on kittiwakes from the four key SPA populations in the spring period of the non-breeding season. The sensitivity of kittiwakes to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

*Assessment of collision mortality throughout the year*

383. Predicted kittiwake mortality from all seasons from collision as calculated above, was summed for the whole year for the worst-case scenario (54 turbines) (Table 9-63).

Table 9-63: Estimated number of kittiwake collisions per year, based on 54 turbines, Band Model Option 2 and an avoidance rate of 98.9% ± 2 SD

| 54 turbines<br>98.9% AR (± 2 SD) | Band Option 2 | % of SPA population |
|---|---|---|
| **Collisions in breeding season, all ages** | 9 ± 1.6 | 0.03% |
| **Collisions in autumn period of non-breeding season, all ages** | 17 ± 3.1 | 0.03% |
| **Collisions in spring period of non-breeding season, all ages** | 2 ± 0.3 | 0.004% |
| **Total** | 28 ± 5.0 | 0.06% |

384. For the worst-case design scenario (54 turbines), a total of 28 kittiwakes (adult and immatures) are estimated to suffer mortality each year from collision impacts, based on Band Model Option 2 and an avoidance rate of 98.9%. This represents an estimated 0.06% of the population (adult and immatures) of the key SPAs, based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015).

385. Based on this annual figure, it is concluded that collision mortality impacts at NnG will have no effect on kittiwakes from the four key SPA populations throughout the year. The sensitivity of kittiwakes to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

#### *9.9.2.3.3 Collision estimates for herring gull*

*Breeding season*

386. The CRM assessment estimated the number of potential herring gull collisions per season for the worst-case design scenario (54 turbines). The minimum height for the turbine blades above the sea surface for this scenario is 32.0 m at mean sea level (MSL) (35 m LAT).

387. The proportion of herring gulls at collision height (PCH) for the different Band Model options used in the assessment are shown in Table 9-52. The proportion at collision height was lowest for the Band Model Option 2 dataset (0.16) and highest for the Band Option 1 dataset (0.321).

388. Estimated herring gull collisions for the worst-case design scenario (54 turbines) using an avoidance rate of 99.5% (± 0.001) with Band Option 1 and 2, and 99.0% (± 0.002) with Band Option 3, as recommended in the Scoping Opinion (Marine Scotland, 2017) are shown in Table 9-64. Three sets of figures are presented: Band Model Option 1, Band Model Option 2 and Band Model Option 3, for the breeding and non-breeding seasons.

389. Baseline surveys recorded the age of herring gulls where possible, with 138 immature (non-breeding) birds (22.6%) and 472 adults (77.4%) aged on surveys in the breeding season (April to August), and 367 immature (non-breeding) birds (33.7%) and 723 adults (66.3%) aged on surveys in the non-breeding season (September to March) (Appendix 9.2: Table 7). This age ratio was applied to the estimated number of collisions for the breeding period to give the estimated number of collisions for adult and immature herring gulls.

390. Populations at SPAs for breeding herring gulls of relevance to this assessment are presented in Table 9-8. In the breeding season, the mean maximum foraging range of breeding herring gulls is 61.1 ± 44 km, based on a sample size of two birds (Thaxter *et al.,* 2012). Based on this, three SPAs for breeding herring gulls (Forth Islands, Fowlsheugh and St Abb's Head to Fast Castle) are within mean maximum foraging range + 1 SD of the Project. These three SPAs have therefore been used as the SPA

reference population for this assessment in the breeding season (7,030 pairs) (Table 9-8). For the non-breeding season, the Buchan Ness to Collieston Coast SPA was also included.

391. For the worst-case design scenario (54 turbines), a total of two herring gull collisions (both adults) were estimated for the breeding season, using an avoidance rate of 99.5% and Band Option 2 (Table 9-64). This corresponds to 0.01% of the breeding population for the three key SPAs (7,030 pairs) (Table 9-8). A total of four herring gull collisions (three adults and one immature bird) were estimated for the non-breeding season (September to March), for the worst case design scenario.

Table 9-64: Estimated number of herring gull collisions based on 54 turbines, an avoidance rate of 99.5% (± 1SD) with Band Option 1 and 2, and 99.0% (± 2SD) with Band Option 3

| 54 turbines | Band Option 1 99.5% AR ± 1 SD | Band Option 2 99.5% AR ± 1 SD | Band Option 3 99.0% AR ± 2SD |
|---|---|---|---|
| **Collisions in breeding season, all ages** | 1 ± 0.3 | 2 ± 0.4 | 1 ± 0.3 |
| **Collisions in breeding season, adults birds** | 1 | 2 | 1 |
| **Collisions in breeding season, immature birds** | 0 | 0 | 0 |
| **Collisions in non-breeding season, all ages** | 3 ± 0.5 | 4 ± 0.7 | 3 ± 0.6 |
| **Collisions in non-breeding season, adults birds** | 2 | 3 | 2 |
| **Collisions in non-breeding season, immature birds** | 1 | 1 | 1 |
| **Total collisions per year, all ages** | 4 ± 0.8 | 6 ± 1.1 | 4 ± 0.8 |

392. It is concluded that collision mortality impacts at NnG will have no effect on the breeding SPA populations of herring gulls within mean maximum foraging range in the breeding season. The sensitivity of herring gulls to collision is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

*Non-breeding season*

393. The herring gull non-breeding season was defined in the Scoping Opinion as September to March (Table 9-7), while the BDMPS review defined the non-breeding season for herring gull as consisting of September to February (Furness 2015). Although there are slight differences in these definitions, it was considered these would not make a significant difference to the assessment, and so the Scoping Opinion definitions were followed.

394. Estimated herring gull collisions for the worst-case design scenario (54 turbines) based on an avoidance rate of 99.5% (± 0.001) with Band Option 1 and 2, and 99.0% (± 0.002) with Band Option 3, as recommended in the Scoping Opinion (Marine Scotland, 2017) are shown in Table 9-64. Three sets of figures are presented: Band Model Option 1, Band Model Option 2 and Band Model Option 3, for the non-breeding season.

395. A total of 33.7% of herring gulls aged during baseline surveys between September and March were immature birds (Appendix 9.2: Table 7). This percentage rate was applied to the estimated number of collisions for the BDMPS non-breeding season to give the estimated number of collisions for adult and immature herring gulls.

396. For the worst-case design scenario (54 turbines), a total of four herring gull collisions (three adults and one immature bird) were estimated for the non-breeding season (September to March), using an avoidance rate of 99.5% and Band Option 2 (Table 9-64).

397. The total number of herring gulls (adults and immature birds) estimated to occur in the UK waters of the North Sea and Channel in the non-breeding period (September to February) is 466,511 birds (Furness, 2015). Of this population, an estimated 331,381 herring gulls (adults and immature birds) are considered to be from UK breeding colonies. If four herring gulls were to die as a result of turbine collision from the Project in the non-breeding season, this would affect 0.001% of the North Sea and Channel population from UK breeding colonies (331,381 adults and immature birds).

398. Estimated numbers of adult and immature herring gulls from the four key SPAs for herring gulls considered in this assessment in the UK waters of the North Sea in the non-breeding season (September to March) are shown in Table 9-65 (Furness, 2015).

Table 9-65: Estimated numbers of adult and immature herring gulls from the four key SPAs in the UK waters of the North Sea and Channel in the non-breeding season (Furness, 2015)

| SPA | Non-breeding season North Sea | | |
|---|---|---|---|
| | Adult | Immature | Total |
| **Buchan Ness to Collieston Coast** | 6,166 | 6,449 | 12,615 |
| **Fowlsheugh** | 513 | 536 | 1,049 |
| **Forth Islands** | 5,597 | 5,855 | 11,452 |
| **St Abb's Head to Fast Castle** | 473 | 495 | 968 |
| **Combined total** | 12,749 | 13,335 | 26,084 |

399. If four herring gulls were to suffer mortality as a result of turbine collision in the non-breeding season, this would affect 0.02% of the North Sea and Channel population from the four key SPAs (26,084 adults and immature birds (Furness, 2015).

400. It is concluded that collision mortality impacts at NnG will have no effect on herring gulls from the four key SPA populations in the non-breeding season. The sensitivity of herring gulls to collision is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

*Assessment of collision mortality throughout the year*

401. Predicted herring gull mortality from all seasons from collision as calculated above, was summed for the whole year for the worst case design scenario (54 turbines) (Table 9-66).

Table 9-66: Estimated number of herring gull collisions per year, based on 54 turbines, an avoidance rate of 99.5% (± 1SD) and Band Option 2

| 54 turbines<br>98.9% AR (± 2 SD) | Band Option 2 | % of SPA population |
|---|---|---|
| **Collisions in breeding season, all ages** | 2 ± 0.4 | 0.01% |
| **Collisions in non-breeding season, all ages** | 4 ± 0.7 | 0.02% |
| **Total** | 6 ± 1.1 | 0.03% |

402. For the worst-case design scenario (54 turbines), six herring gulls (adult and immature birds) are estimated to suffer mortality each year from collision impacts, based on Band Model Option 2 and an avoidance rate of 99.5%. This represents an estimated 0.03% of the population (adult and

immatures) of the key SPAs, based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015).

403. Based on this annual figure, it is concluded that collision mortality impacts at NnG will have no effect on herring gulls from the four key SPA populations throughout the year. The sensitivity of herring gulls to collision is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

#### *9.9.2.3.4 Collision estimates for lesser black-backed gull*

*Breeding season*

404. The CRM assessment estimated the number of potential lesser black-backed gull collisions per season for the worst-case design scenario (54 turbines). The minimum height for the turbine blades above the sea surface for this scenario is 32.0 m at mean sea level (MSL) (35 m LAT).

405. The proportion of lesser black-backed gulls at collision height for the different Band Model options used in the assessment are shown in Table 9-52. The proportion at collision height was lowest for the Band Option 1 dataset (0.079) and highest for the Band Model Option 2 dataset (0.131).

406. Estimated lesser black-backed gull collisions for the worst-case design scenario (54 turbines) based on an avoidance rate of 99.5% (± 0.001) with Band Option 1 and 2, and 98.9% (± 0.002) with Band Option 3, based on the BTO Avoidance Rate review (Cook *et al.,*2014) are shown in Table 9-67. Three sets of figures are presented: Band Model Option 1, Band Model Option 2 and Band Model Option 3, for the breeding and non-breeding seasons.

407. Baseline surveys recorded the age of lesser black-backed gulls where possible, with 20 immature (non-breeding) birds (15.0%) and 113 adults (85.0%) aged on surveys in the breeding season (April to August), and eight immature (non-breeding) birds (16.7%) and 40 adults (83.3%) aged on surveys in the non-breeding season (September to March) (Appendix 9.2: Table 9 ). This age ratio was applied to the estimated number of collisions for the breeding and non-breeding seasons to give the estimated number of collisions for adult and immature lesser black-backed gulls.

408. Populations at SPAs for breeding lesser black-backed gulls of relevance to this assessment are presented in Table 9-8. In the breeding season, the mean maximum foraging range of breeding lesser black-backed gulls is 141.0 ± 50.8 km, based on a sample size of three birds (Thaxter *et al.,* 2012). Based on this, one SPA for breeding lesser black-backed gulls (Forth Islands) is within mean maximum foraging range + 1 SD of the Project (Appendix 9.2: Figure 31). This SPA has therefore been used as the SPA reference population for this assessment in the breeding season (2,571 pairs) (Table 9-8).

Table 9-67: Estimated number of lesser black-backed gull collisions based on 54 turbines, an avoidance rate of 99.5% (± 1SD) with Band Option 1 and 2, and 98.9% (± 2SD) with Band Option 3

| 54 turbines | Band Option 1 99.5% AR ± 1 SD | Band Option 2 99.5% AR ± 1 SD | Band Option 3 98.9% AR ± 2SD |
|---|---|---|---|
| **Collisions in breeding season, all ages** | 0 ± 0.04 | 1 ± 0.1 | 1 ± 0.1 |
| **Collisions in breeding season, adults birds** | 0 | 1 | 1 |
| **Collisions in breeding season, immature birds** | 0 | 0 | 0 |
| **Collisions in non-breeding season, all ages** | 0 | 0 | 0 |
| **Collisions in non-breeding season, adults birds** | 0 | 0 | 0 |
| **Collisions in non-breeding season, immature birds** | 0 | 0 | 0 |
| **Total collisions per year, all ages** | 0 ± 0.04 | 1 ± 0.1 | 1 ± 0.1 |

409. For the worst-case design scenario (54 turbines), a total of one adult lesser black-backed gull collision was estimated for the breeding season, using an avoidance rate of 99.5% and Band Option 2 (Table 9-67). This corresponds to 0.02% of the breeding population for the key SPA (2,571 pairs) (Table 9-8). Based on an avoidance rate of 99.5% and using Band Option 2,there were zero lesser black-backed gull collisions estimated for the non-breeding season (September to March), for the worst case design scenario.

410. It is concluded that collision mortality impacts at NnG will have no effect on the breeding SPA populations of lesser black-backed gulls within mean maximum foraging range in the breeding season. The sensitivity of lesser black-backed gulls to collision is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

*Autumn, winter and spring periods of the non-breeding season*

411. There are three periods presented in the BDMPS review for the "non-breeding season" for lesser black-backed gull, defined as follows: Autumn migration (August to October), Winter (November to February) and Spring migration (March to April) (Furness 2015).

412. Based on the Collision Rate Modelling undertaken for this assessment, there were no lesser black-backed gull collisions estimated between August and March. Therefore, no additional assessment based on the BDMPS review has been undertaken for this species.

*Assessment of collision mortality throughout the year*

413. Based on the seasonal mortality estimates for the 54 turbine design, a total of one lesser black-backed gull is estimated to die each year from collision impacts, based on Band Model Option 2 and an avoidance rate of 99.5% (Table 9-67). This represents an estimated 0.02% of the population of the key SPA, based on breeding colony counts (Table 9-8).

414. Based on this annual figure, it is concluded that collision mortality impacts at NnG will have no effect on lesser black-backed gulls from the key SPA population throughout the year. The sensitivity of lesser black-backed gulls to collision is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

### *9.9.2.3.5 Collision estimates for great black-backed gull*

*Breeding season*

415. The CRM assessment estimated the number of potential great black-backed gull collisions per season for the worst-case design scenario (54 turbines). The minimum height for the turbine blades above the sea surface for this scenario is 32.0 m at mean sea level (MSL) (35 m LAT).

416. The proportion of great black-backed gulls at collision height for the different Band Model options used in the assessment are shown in Table 9-52. The proportion at collision height was lowest for the Band Model Option 2 dataset (0.167) and highest for the Band Option 1 dataset (0.181).

417. Estimated great black-backed gull collisions for the worst-case design scenario (54 turbines) based on an avoidance rate of 99.5% (± 0.001) with Band Option 1 and 2, and 98.9% (± 0.002) with Band Option 3, based on the BTO Avoidance Rate review (Cook *et al.,*2014) are shown in Table 9-68. Three sets of figures are presented: Band Model Option 1, Band Model Option 2 and Band Model Option 3, for the breeding and non-breeding seasons.

418. Baseline surveys recorded the age of great black-backed gulls where possible, with 40 immature (non-breeding) birds (57.1%) and 30 adults (42.9%) aged on surveys between April to August (Appendix 9.2: Table 11). This age ratio was applied to the estimated number of collisions for the breeding season to give the estimated number of collisions for adult and immature great black-backed gulls.

419. Great black-backed gull is not listed as a qualifying interest species in the breeding season for any SPAs on the Scottish east coast south of Peterhead (JNCC, 2017). The nearest SPA for breeding great blacked-gulls is Copinsay SPA, approximately 297 km from the Project. In the breeding season, the estimated maximum foraging distance for this species is less than 10 km (Furness & Tasker, 2000).

420. Using an avoidance rate of 99.5% and Band Option 2, zero great black-backed gull collisions were estimated for the breeding season (April to August), for the worst-case design scenario (54 turbines) (Table 9-68).

Table 9-68: Estimated number of great black-backed gull collisions in the breeding and non-breeding seasons, based on 54 turbines, an avoidance rate of 99.5% (± 1SD) with Band Option 1 and 2, and 98.9% (± 2SD) with Band Option 3

| 54 turbines | Band Option 1 99.5% AR ± 1 SD | Band Option 2 99.5% AR ± 1 SD | Band Option 3 98.9% AR ± 2SD |
|---|---|---|---|
| **Collisions in breeding season, all ages** | 0 ± 0.03 | 0 ± 0.04 | 0 ± 0.03 |
| **Collisions in breeding season, adults birds** | 0 | 0 | 0 |
| **Collisions in breeding season, immature birds** | 0 | 0 | 0 |
| **Collisions in non-breeding season, all ages** | 2 ± 0.4 | 3 ± 0.6 | 3 ± 0.5 |
| **Collisions in non-breeding season, adults birds** | 1 | 1 | 1 |
| **Collisions in non-breeding season, immature birds** | 1 | 2 | 2 |
| **Total collisions per year, all ages** | 2 ± 0.4 | 3 ± 0.6 | 3 ± 0.5 |

421. Results from the Collision Risk Modelling demonstrate that there will be no adverse effects on great black-backed gulls in the breeding season caused by collision impacts arising from the Project.

*Non-breeding season*

422. In the BDMPS review, the “non-breeding season” for great black backed gull is defined as September to March (Furness 2015), and this definition was applied for this assessment.

423. Baseline surveys recorded the age of great black-backed gulls where possible, with 266 immature (non-breeding) birds (53.8%) and 228 adults (46.2%) aged on surveys in the non-breeding season (September to March) (Appendix 9.2: Table 11). This age ratio was applied to the estimated number of collisions for the non-breeding season to give the estimated number of collisions for adult and immature great black-backed gulls.

424. Using an avoidance rate of 99.5% and Band Option 2, there were three great black-backed gull collisions (one adult and two immature birds) estimated for the non-breeding season (September to March), for the worst-case design scenario (54 turbines) (Table 9-68).

425. The total number of great black-backed gulls (adults and immature birds) estimated to occur in the UK waters of the North Sea in the non-breeding season (September to March) is 91,399 birds (Furness, 2015). Of this population, an estimated 28,663 great black-backed gulls (adults and immature birds) are considered to be from UK breeding colonies. If three great black-backed gulls were to die as a result of turbine collision in the non-breeding season, this would affect 0.01% of the North Sea population from UK breeding colonies (28,663 adults and immature birds).

426. Great blacked-backed gulls are not a qualifying species at any of the key SPAs used in this assessment. The nearest SPA for great black-backed gulls to the Project is is Copinsay SPA, approximately 297 km away.

427. Estimated numbers of adult and immature great black-backed gulls from Copinsay SPA for great black-backed gulls in the UK waters of the North Sea in the non-breeding season (September to March) are shown in Table 9-69 (Furness, 2015).

Table 9-69: Estimated numbers of adult and immature great black-backed gulls from Copinsay SPA in the UK waters of the North Sea in the non-breeding season (Furness, 2015)

| SPA | Non-breeding season North Sea | | |
|---|---|---|---|
| | Adult | Immature | Total |
| **Copinsay** | 436 | 549 | 985 |

428. If three great black-backed gulls were to suffer mortality as a result of turbine collision in the non-breeding season, this would affect 0.3% of the North Sea population from Copinsay SPA (985 adults and immature birds (Furness, 2015). However, given the distances involved, it is considered highly unlikely that all collisions would involve birds from one SPA.

*Assessment of collision mortality throughout the year*

429. For the worst-case design scenario (54 turbines), a total of three great black-backed gulls are estimated to suffer mortality each year from collision impacts, using Band Model Option 2 and an avoidance rate of 99.5% (Table 9-68). This represents an estimated 0.3% of the population of the Copinsay SPA (Furness 2015).

430. This is precautionary, as given the distances involved, it is considered highly unlikely that all collisions would involve birds from the Copinsay SPA.

431. Based on this annual figure, it is concluded that collision mortality impacts at NnG will have no effect on great black-backed gulls from any UK SPA throughout the year. The sensitivity of great black-backed gulls to collision is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

### *9.9.2.3.6 Collision estimates for additional species*

432. For the five additional species (black-headed gull, common gull, little gull, Arctic skua and great skua), collision risk modelling based on 1,000 birds passing through the development area in a north-south/south-north direction two times a year predicted that there would be no collisions in the breeding and non-breeding seasons for any of these species for the worst-case design scenario (54 turbines) (Table 9-70).

Table 9-70: Estimated number of collisions for five less regular species, based on 54 turbines, the recommended BTO avoidance rate, with Band Option 2

| Species | Breeding season | Non-breeding season | Annual collisions |
|---|---|---|---|
| **Black-headed gull** | 0 | 0 | 0 |
| **Common gull** | 0 | 0 | 0 |
| **Little gull** | 0 | 0 | 0 |
| **Great skua** | 0 | 0 | 0 |
| **Arctic skua** | 0 | 0 | 0 |

433. Based on this annual figure, it is concluded that collision mortality impacts at NnG will have no effect on these five species throughout the year. The sensitivity of these species to collision is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

#### *9.9.2.3.7 Displacement and collision impacts combined*

434. Kittiwake was considered for both displacement and collision impacts, and therefore these assessments were combined, using the worst-case results from the seasonal assessments (Table 9-71).

Table 9-71: Estimated kittiwake mortality from displacement and collision impacts throughout the year

| Season | Wind Farm Area | | Wind Farm Area + 2 km buffer | |
|---|---|---|---|---|
| | No of birds | % of SPA population | No of birds | % of SPA population |
| **Total displacement** | 17 | 0.04% | 25 | 0.05% |
| **Total collisions** | 28 ± 5.0 | 0.06% | 28 ± 5.0 | 0.06% |
| **Total** | 45 | 0.1 | 53 | 0.1 |

435. For the worst-case design scenario (54 turbines), a total of 45 kittiwakes (adult and immatures) are estimated to die each year from displacement and collision impacts combined. This represents an estimated 0.1% of the population (adult and immatures) of the key SPAs, based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015).

436. If displacement impacts affect kittiwakes out to a distance of 2 km from the Wind Farm Area, then a total of 53 kittiwakes (adult and immatures) are estimated to die each year from displacement and collision impacts combined, based on Band Model Option 2 and an avoidance rate of 98.9%. This represents an estimated 0.1% of the population (adult and immatures) of the key SPAs, based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015).

437. However, this assessment is considered precautionary, based on the displacement and mortality rates used. As highlighted by SNH in the Scoping Opinion (Marine Scotland, 2017), for kittiwake, collision risk and displacement are currently considered to be mutually exclusive impacts, and therefore combining mortality estimates for kittiwake displacement and collision should be considered extremely precautionary.

438. In addition, it is considered that the use of a mortality rate of 2% for displacement impacts outside of the breeding season, when birds are no longer tied to their breeding colony, is also precautionary. It is concluded that displacement and collision mortality impacts at NnG will have no effect on kittiwakes from the four key SPA populations throughout the year. The sensitivity of kittiwake to collision is assessed as high, while sensitivity to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

### 9.9.2.4 Population Viability Analysis (PVA) for the Project

439. Population models were developed for breeding populations of gannet, kittiwake, guillemot, razorbill and puffin, as recommended in the Scoping Opinion (Marine Scotland, 2017). The calculated numbers of collisions, along with the estimated effects of displacement were applied to these population models for relevant breeding colonies. These effects were assessed for the Project alone, and cumulatively with the Inch Cape and SeaGreen A and B projects, as well as with other offshore wind farm projects in the UK North Sea and England Channel (See Section 9.9.5).

440. Methods for the PVA are presented in Appendix 9.8. MSS recently commissioned a research project undertaken by CEH to review the use of Population Viability Analysis (PVA) metrics in the context of assessing effects of offshore renewable developments on seabirds and to test PVA metric sensitivity to mis-specification of input parameters (Jitlal *et al.*, 2017). This work identified three metrics that

were subsequently highlighted in the Scoping Opinion as being required in an assessment (Marine Scotland, 2017):

- Median of the ratio of impacted to unimpacted annual growth rate;
- Median of the ratio of impacted to unimpacted population size; and
- Centile for unimpacted population that matches the 50th centile for impacted population.

441. These metrics are presented for each species included in the PVA assessment for the project alone and for the cumulative PVA assessment.

**Scenarios**

442. In order to assess the potential effects of proposed and constructed wind farms on the modelled bird populations, a number of scenarios were run. This involved applying additional mortality to the population based on outputs from collision rate modelling using Band Option 2, displacement or both (Table 9-72). In each scenario, this additional mortality was applied to the relevant season, age-classes and populations, based on advice from SNH (Marine Scotland, 2017).

443. Due to limitations in consequently assigning ages of birds from the survey data, the population viability analysis stable age structure was used to assign effects across age classes for gannet, kittiwake, guillemot and razorbill throughout the year. For puffin, effects were applied on adult birds and during the breeding season only, as recommended in the Scoping Opinion (Marine Scotland).

444. Effects from collisions and displacement were apportioned to the relevant SPA populations based on the scenarios outlined in Table 9-72. Further details on these scenarios are presented in Appendix 9.8.

Table 9-72: Scenarios applied to the population models (F&T = NnG, Inch Cape and Seagreen A & B, UK = OWF projects in North Sea and English Channel for gannet and North Sea for Kittiwake) and following SNH advice (Marine Scotland, 2017)

| Species | SPA Population | Collisions | Displacement | Collisions and displacement |
|---|---|---|---|---|
| **Gannet** | Forth Islands | NnG, F&T, UK | - | |
| **Kittiwake** | Forth Islands | NnG, F&T, UK | - | NnG, F&T, UK |
| **Kittiwake** | Fowlsheugh | NnG, F&T, UK | - | NnG, F&T, UK |
| **Guillemot** | Forth Islands | - | NnG, F&T | - |
| **Guillemot** | Fowlsheugh | - | NnG, F&T | - |
| **Razorbill** | Forth Islands | - | NnG, F&T | - |
| **Razorbill** | Fowlsheugh | - | NnG, F&T | - |
| **Puffin** | Forth Islands | - | NnG, F&T | - |

445. Effects were based on collision rate modelling using Band Option 2 and displacement figures following SNCB guidance (Table 9-73). Apportioning for the relevant populations was based on a two-step process: (i) proportion in SPAs, and (ii) across the relevant SPA populations. Further information is provided in Appendix 9.8.

Table 9-73: Effects applied to population models for NnG (54 turbines). Unless indicated as refering to adults (ad), effects are applied using the stable age structure.

| Species | SPA Population | Collisions | Displacement | Collisions and displacement (breeding season) |
|---|---|---|---|---|
| **Gannet** | Forth Islands | 108 | | |
| **Kittiwake** | Forth Islands | 6 | | 3 ad + 6 |
| **Kittiwake** | Fowlsheugh | 12 | | 5 ad + 12 |
| **Puffin** | Forth Islands | | 35 ad | |
| **Guillemot** | Forth Islands | | 3 ad + 8 | |
| **Guillemot** | Fowlsheugh | | 5 ad + 16 | |
| **Razorbill** | Forth Islands | | 1 ad + 7 | |
| **Razorbill** | Fowlsheugh | | 2 ad + 9 | |

### *9.9.2.4.1 Gannet*

446. Changes in the predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Project over 25 years are shown in Table 9-74.

Table 9-74: Change in predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Project over 25 years

| Species | SPA Population | Baseline change after 25 years (no wind farm) | Percentage point change with NnG after 25 years (collisions all year) | Percentage change in median annual growth rate compared to baseline | Counterfactual of the annual growth rate |
|---|---|---|---|---|---|
| **Gannet** | Forth Islands | 1.7171 | -0.055 | -3.20 | 96.80% |

447. For both the baseline and built scenarios, the gannet breeding population is predicted to increase over the 25 year period, although there is a slight decrease in this growth rate when NnG is present. Overall, the change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario is a decrease of 3.20%. Alternatively, the counterfactual of the growth rate is 96.80% of that for the scenario with no wind farm constructed (Table 9-74).

448. Changes in the predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without NnG over 25 years are shown in Table 9-75.

Table 9-75: Change in predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Project over 25 years

| Species | SPA & start population | Baseline population after 25 years (no wind farm) | Population after 25 years with NnG (collisions all year) | Percentage change in median final population size compared to baseline | Counterfactual of Population Size (CPS) |
|---|---|---|---|---|---|
| **Gannet** | Forth Islands 75,259 pairs | 132,394 pairs | 130,761pairs | -1.23 | 98.77% |

449. For both the baseline and built scenarios, the gannet breeding population is predicted to increase over the 25 year period, however, the gannet breeding population at the Forth Islands SPA is predicted to be slightly lower with NnG than with no wind farm present (Table 9-75). Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is a decrease of 1.23%. Alternatively, the counterfactual population size is 98.77% of that for the scenario with no wind farm constructed.

450. Changes in the predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Project over 50 years are shown in Table 9-76.

Table 9-76: Change in predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Project over 50 years

| Species | SPA Population | Baseline change after 50 years (no wind farm) | Percentage point change with NnG after 50 years (collisions all year) | Percentage change in median annual growth rate compared to baseline | Counterfactual of the annual growth rate |
|---|---|---|---|---|---|
| **Gannet** | Forth Islands | 1.7189 | -0.064 | -3.74 | 96.26% |

451. For both the baseline and built scenarios, the gannet breeding population is predicted to increase over the 50 year period, although as with the 25 year modelling, there is a slight decrease in this growth rate when NnG is present. Overall, the change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario after 50 years is a decrease of 3.74%. Alternatively, the counterfactual of the growth rate is 96.26% of that for the scenario with no wind farm constructed (Table 9-76).

452. Changes in the predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without NnG over 50 years are shown in Table 9-77.

Table 9-77: Change in predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Project over 50 years

| Species | SPA & start Population | Baseline population after 50 years (no wind farm) | Population after 50 years with NnG (collisions all year) | Percentage change in median final population size compared to baseline | Counterfactual of Population Size (CPS) |
|---|---|---|---|---|---|
| **Gannet** | Forth Islands 75,259 pairs | 203,046 pairs | 197,206 pairs | -2.88 | 97.12% |

453. For both the baseline and built scenarios, the gannet breeding population is predicted to increase over the 50 year period, however the gannet breeding population at the Forth Islands SPA is predicted to be slightly lower with NnG present, than with no wind farm present (Table 9-77). Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is a decrease of 2.88%. Alternatively, the counterfactual of population size (CPS) is 97.12% of that for the scenario with no wind farm constructed.

454. A comparison of the 50$^{th}$ centile values for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Project over 25 years and 50 years is shown in Table 9-78.

Table 9-78: Comparison of the 50th centile values for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Project over 25 years and 50 years

| Species | SPA Population | 50th centile for unimpacted population (Baseline) | Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG (collisions all year) | Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG (collisions all year) |
|---|---|---|---|---|
| **Gannet** | Forth Islands | 0.5 | 0.39 | 0.30 |

455. For an unimpacted population 50% of the model runs would not be lower than the median. For the Forth Islands SPA, comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted populations shows that over 25 years at least 39%, and over 50 years at least 30%, of the runs end not lower than the median population size of the unimpacted population.

#### *9.9.2.4.2 Kittiwake*

456. Changes in the predicted population growth rate for kittiwakes breeding in the Forth Islands SPA and Fowlsheugh SPA with and without NnG over 25 years are shown in Table 9-79.

Table 9-79: Change in predicted population growth rate for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 25 years

| Species | SPA Population | Baseline change after 25 years (no wind farm) | Percentage point change with NnG after 25 years | | Percentage change in median annual growth rate compared to baseline | | Counterfactual of the annual growth rate | |
|---|---|---|---|---|---|---|---|---|
| | | | Collision (y) | Collision (y) & Disp (br) | Collision (y) | Collision (y) & Disp (br) | Collision (y) | Collision (y) & Disp (br) |
| **Kittiwake** | Forth Islands | 0.9099 | -0.051 | -0.047 | -5.56 | -5.15 | 94.44% | 94.85% |
| | Fowlsheugh | -2.2647 | -0.054 | -0.059 | -2.39 | -2.61 | 102.39% | 102.61% |

457. For the Forth Islands SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to increase over the 25 year period, although there is a slightly lower rate of increase when NnG is present (Table 9-79). The scenario with collisions all year and displacement during the breeding season resulted in a slightly higher rate of increase suggesting that displacement effects were not predicted to be significant. The counterfactuals of the annual growth rate for collision alone and collision with displacement were also similar to each other.

458. For the Fowlsheugh SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to decrease over the 25 year period, although there is a slightly higher rate of decrease when NnG is present (Table 9-79). As with the Forth Islands SPA, there was not a large difference between estimated changes in annual growth rate between the collision alone and collision with displacement scenarios, suggesting that displacement effects were not predicted to be significant. For Fowlsheugh SPA, as the baseline population for kittiwake has a negative growth rate, the counterfactual growth rate of >100% indicates a further decline in growth rate for these impacted scenarios.

459. Changes in the predicted population size for kittiwakes breeding at the Forth Islands and Fowlsheugh SPAs with and without NnG over 25 years are shown in Table 9-80.

Table 9-80: Change in predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 25 years

| Species | SPA & start Population | Baseline population after 25 years (no wind farm) | Population after 25 years with NnG | | Percentage change in median final population size compared to baseline | | Counterfactual of Population Size (CPS | |
|---|---|---|---|---|---|---|---|---|
| | | | Coll (y) | Coll (y) & Disp (br) | Coll (y) | Coll (y) & Disp (br) | Coll (y) | Coll (y) & Disp (br) |
| **Kittiwake** | Forth Islands 4,663 pairs | 6,118 pairs | 6,034 pairs | 6,059 pairs | -1.37 | -0.97 | 98.63% | 99.03% |
| | Fowlsheugh 9,665 pairs | 4,629 pairs | 4,577 pairs | 4,563 pairs | -1.12 | -1.42 | 98.88% | 98.58% |

460. For the Forth Islands SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to increase over the 25 year period, although the end population is predicted to be slightly lower after 25 years when NnG is present, for all collision and displacement scenarios, with the largest difference occurring for annual collisions (Table 9-80). Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG is a maximum decrease of 1.37% for the Forth Islands SPA, for annual collisions. Alternatively, the CPS value is 98.63% of that for the scenario with no wind farm constructed. This suggests that displacement effects were not predicted to be significant. For the Fowlsheugh SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to decrease over the 25 year period, with the end population predicted to be slightly lower at the end of the 25 year period when NnG is present, for all collision and displacement scenarios (Table 9-80). When annual collisions and breeding season displacement are considered together, the resulting end population is estimated to be slightly lower than the predicted end population for collision alone. The counterfactuals of population size for collision alone and collision with displacement were also similar to each other.

461. Changes in the predicted population growth rate for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG over 50 years are shown in Table 9-81.

Table 9-81: Change in predicted population growth rate for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 50 years

| Species | SPA Population | Baseline change after 50 years (no wind farm) | Percentage point change with NnG after 50 years | | Percentage change in median annual growth rate compared to baseline | | Counterfactual of the annual growth rate | |
|---|---|---|---|---|---|---|---|---|
| | | | Collision (y) | Collision (y) & Disp (br) | Collision (y) | Collision (y) & Disp (br) | Collision (y) | Collision (y) & Disp (br) |
| **Kittiwake** | Forth Islands | 0.9068 | -0.043 | -0.051 | -4.73 | -5.61 | 95.27% | 94.39% |
| | Fowlsheugh | -2.2758 | -0.045 | -0.055 | -1.96 | -2.41 | 101.96% | 102.41% |

462. For the Forth Islands SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to increase over the 50 year period, although there is a slightly higher rate of decrease when NnG is present (Table 9-81). The scenario with collisions all year and breeding season

displacement resulted in a slightly lower rate of increase compared to collisions alone, and this was mirrored by the values for the counterfactual of the annual growth rate.

463. For the Fowlsheugh SPA, for both baseline and built scenarios, the kittiwake breeding population is predicted to decrease over the 50 year period, although there is a slightly higher rate of decrease when NnG is present (Table 9-81). The scenario with collisions all year and breeding season displacement resulted in a slightly higher rate of decrease compared to collisions alone. As the baseline population for kittiwake at Fowlsheugh SPA has a negative growth rate, the counterfactual growth rate of >100% indicates a further decline in growth rate for these impacted scenarios.

464. Changes in the predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG over 50 years are shown in Table 9-82.

Table 9-82: Change in predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 50 years

| Species | SPA & start Population | Baseline population after 50 years (no wind farm) | Population after 50 years with NnG | | Percentage change in median final population size compared to baseline | | Counterfactual of Population Size (CPS | |
|---|---|---|---|---|---|---|---|---|
| | | | Coll (y) | Coll (y) & Disp (br) | Coll (y) | Coll (y) & Disp (br) | Coll (y) | Coll (y) & Disp (br) |
| Kittiwake | Forth Islands 4,663 pairs | 7,665 pairs | 7,515 pairs | 7,458 pairs | -1.95 | -2.70 | 98.05% | 97.30% |
| | Fowlsheugh 9,665 pairs | 2,593 pairs | 2,547 pairs | 2,532 pairs | -1.76 | -2.34 | 98.24% | 97.66% |

465. For the Forth Islands SPA, the kittiwake breeding population is predicted to increase over the 50 year period, although the end population is predicted to be slightly lower when NnG is present, for both collision alone and collision with breeding season displacement (Table 9-82). Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG is a maximum decrease of 2.70%, for annual collisions and breeding season displacement. Alternatively, the CPS value is 97.30% of that for the scenario with no wind farm constructed.

466. For the Fowlsheugh SPA, the kittiwake breeding population is predicted to decrease over the 50 year period, although the end poplation is predicted to be slightly lower at the end of the 50 year period when NnG is present, with the largest difference again occurring for annual collisions and breeding season displacement (Table 9-82). The change in the median final population size for this combination when comparing the baseline (no wind farm) with NnG was a maximum decrease of 2.34%. This translates to a CPS value of 97.66% of that of the baseline scenario.

467. A comparison of the 50$^{th}$ centile values for kittiwakes breeding at the Forth Islands and Fowlsheugh SPAs with and without the Project over 25 years and 50 years is shown in Table 9-83.

Table 9-83: Comparison of the 50th centile values for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 25 years and 50 years

| Species | SPA Population | 50th centile for unimpacted population (Baseline) | Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG | | Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG | |
|---|---|---|---|---|---|---|
| | | | Coll (y) | Coll (y) & Disp (br) | Coll (y) | Coll (y) & Disp (br) |
| **Kittiwake** | Forth Islands | 0.50 | 0.43 | 0.45 | 0.42 | 0.38 |
| | Fowlsheugh | 0.50 | 0.41 | 0.39 | 0.42 | 0.40 |

468. For an unimpacted population 50% of the model runs would not be lower than the median. For the Forth Islands SPA, comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted populations shows that over 25 years at least 43%, and over 50 years at least 38% of the runs end not lower than the median population size of the unimpacted population. For Fowlsheugh SPA, over 25 years at least 39%, and over 50 years at least 40%, of the runs end not lower than the median population size of the unimpacted population.

### *9.9.2.4.3 Guillemot*

469. Changes in the predicted population growth rate for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 25 years are shown in Table 9-84.

Table 9-84: Change in predicted population growth rate for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 25 years

| Species | SPA Population | Baseline change after 25 years (no wind farm) | Percentage point change with NnG after 25 years (displacement all year) | Percentage change in median annual growth rate compared to baseline | Counterfactual of the annual growth rate |
|---|---|---|---|---|---|
| **Guillemot** | Forth Islands | 1.8949 | -0.025 | -1.31 | 98.69% |
| | Fowlsheugh | 2.3258 | +0.004 | +0.17 | 100.17% |

470. For the Forth Islands SPA, for both the baseline and built scenarios, the guillemot breeding population is predicted to increase over the 25 year period, with a slightly decreased growth rate predicted when NnG is present, compared to the baseline (no wind farm) scenario (Table 9-84). Overall, the change in the median annual growth rate when comparing the baseline with the built scenario is a decrease of 1.31%. Alternatively, the counterfactual of the growth rate is 98.69% of that for the scenario with no wind farm constructed. This suggests that displacement will not have a significant negative effect on breeding guillemots at the Forth Islands SPA.

471. For the Fowlsheugh SPA, for both the baseline and built scenarios, the guillemot breeding population is also predicted to increase over the 25 year period, with a very slightly increase in growth rate predicted when NnG is present, compared to the baseline (no wind farm) scenario (Table 9-84). Overall, the change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario is a slight increase of 0.17%. The counterfactual of the growth rate is 100.17% of that for the scenario with no wind farm constructed. Again, this indicates that displacement will not have a negative effect on breeding guillemots at the Fowlsheugh SPA.

472. Changes in the predicted population size for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 25 years are shown in Table 9-85.

Table 9-85: Change in predicted population size for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 25 years

| Species | SPA & start Population | Baseline population after 25 years (no wind farm) | Population after 25 years with NnG (displacement all year) | Percentage change in median final population size compared to baseline | Counterfactual of Population Size (CPS) |
|---|---|---|---|---|---|
| **Guillemot** | Forth Islands 38,573 pairs | 67,234 pairs | 67,611 pairs | +0.56 | 100.56% |
| | Fowlsheugh 74,379 pairs | 150,711 pairs | 150,453 pairs | -0.17 | 99.83% |

473. For the Forth Islands SPA, the guillemot breeding population is predicted to increase over the 25 year period, with the end population predicted to be slightly larger at the end of the 25 year period when NnG is present (Table 9-85). Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is an increase of +0.56%. This gives a CPS value of 100.56%. As with the result for the growth rate after 25 years (Table 9-84), this indicates that there will be no significant negative effect from displacement on the guillemot population at the Forth Islands SPA, arising from NnG.

474. For the Fowlsheugh SPA, the guillemot breeding population is also predicted to increase over the 25 year period, with the end population predicted to be slightly lower at the end of the 25 year period when NnG is present (Table 9-85). Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is decrease of 0.17%. This results in a CPS value of 99.83% of the baseline scenario. This indicates that there will be no significant negative effect from displacement on the guillemot population at Fowlsheugh SPA, arising from NnG.

475. Changes in the predicted population growth rate for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG over 50 years are shown in Table 9-86.

Table 9-86: Change in predicted population growth rate for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 50 years

| Species | SPA Population | Baseline change after 50 years (no wind farm) | Percentage point change with NnG after 50 years (displacement all year) | Percentage change in median annual growth rate compared to baseline | Counterfactual of the annual growth rate |
|---|---|---|---|---|---|
| **Guillemot** | Forth Islands | 1.8916 | -0.014 | -0.73 | 99.27% |
| | Fowlsheugh | 2.3278 | -0.026 | -1.13 | 98.87% |

476. For both the baseline and built scenarios, the guillemot breeding population at the Forth Islands SPA and Fowlsheugh SPA is predicted to increase over the 50 year period, although there is a slight decrease in this growth rate when NnG is present. Overall, the change in the median annual growth rates when comparing the baseline (no wind farm) with NnG is a decrease of 0.73% for the Forth Islands SPA, with a corresponding counterfactual of the growth rate of 99.27%. For Fowlsheugh SPA, there is a predicted decrease of 1.13%, with a corresponding counterfactual of the growth rate of 98.87% (Table 9-86). These changes in the growth rate over 50 years are very similar to the changes

predicted after 25 years (Table 9-84),and indicate that displacement will not have a negative effect on breeding guillemots at the Forth Islands or Fowlsheugh SPAs.

477. Changes in the predicted population size for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG over 50 years are shown in Table 9-87.

Table 9-87: Change in predicted population size for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 50 years

| Species | SPA & start Population | Baseline population after 50 years (no wind farm) | Population after 50 years with NnG (displacement all year) | Percentage change in median final population size compared to baseline | Counterfactual of Population Size (CPS) |
|---|---|---|---|---|---|
| Guillemot | Forth Islands 38,573 pairs | 108,366 pairs | 107,270 pairs | -1.01 | 98.99% |
| | Fowlsheugh 74,379 pairs | 267,057 pairs | 264,113 pairs | -1.10 | 98.90% |

478. For the Forth Islands SPA, the guillemot breeding population is predicted to increase over the 50 year period, with the end population being slightly lower when NnG is present (Table 9-87). Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG is a decrease of 1.01%. This results in a CPS value of 98.99% of the baseline scenario. As with the results for 25 years (Table 9-84), this indicates that there will be no significant negative effect from displacement on the guillemot population from the Forth Islands SPA, arising from NnG.

479. For the Fowlsheugh SPA, the guillemot breeding population is also predicted to increase over the 50 year period, with the end population being slightly lower at the end of the 50 year period when NnG is present (Table 9-87). Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG is decrease of 1.10%. This results in a CPS value of 98.90% of the baseline scenario, indicating that there will be no significant negative effect from displacement on the guillemot population at Fowlsheugh SPA, arising from NnG.

480. A comparison of the 50th centile values for guillemots breeding at the Forth Islands and Fowlsheugh SPAs with and without the Project over 25 years and 50 years is shown in Table 9-88.

Table 9-88: Comparison of the 50th centile values for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 25 years and 50 years

| Species | SPA Population | 50th centile for unimpacted population (Baseline) | Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG (displacement all year) | Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG (displacement all year) |
|---|---|---|---|---|
| Guillemot | Forth Islands | 0.50 | 0.52 | 0.47 |
| | Fowlsheugh | 0.50 | 0.49 | 0.47 |

481. For an unimpacted population, 50% of the model runs would not be lower than the median. For the Forth Islands SPA, comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted populations shows that over 25 years at least 52%, and over 50 years at least 47%, of the runs end not lower than the median population size of the unimpacted population.

For Fowlsheugh SPA, over 25 years at least 49%, and over 50 years at least 47%, of the runs end not lower than the median population size of the unimpacted population.

### *9.9.2.4.4 Razorbill*

482. Changes in the predicted population growth rate for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 25 years are shown in Table 9-89.

Table 9-89: Change in predicted population growth rate for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 25 years

| Species | SPA Population | Baseline change after 25 years (no wind farm) | Percentage point change with NnG after 25 years (displacement all year) | Percentage change in median annual growth rate compared to baseline | Counterfactual of the annual growth rate |
|---|---|---|---|---|---|
| **Razorbill** | Forth Islands | 0.0313 | -0.027 | -86.58 | 13.42% |
| | Fowlsheugh | 0.9516 | -0.065 | -6.78 | 93.22% |

483. For the Forth Islands SPA, for both the baseline and built scenarios, the razorbill breeding population is predicted to increase over the 25 year period, however the growth rate is predicted to be very low (Table 9-89). The growth rate with NnG present is predicted to be slightly lower than the baseline scenario, with an estimated percentage point change of -0.027 predicted. Overall, the change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario is a decrease of 86.58% for the Forth Islands SPA, with a corresponding counterfactual of the growth rate of 13.42%. However, this is due to the fact that the Forth Islands SPA population of razorbill is predicted to be fairly stable over the 25 years, with a population growth rate close to zero. This means that any change will be relatively large, relative to the small initial rate. Similarly, the counterfactual of the growth rate is highly influenced by the initial growth rate and bears little relevance to the change in growth rate on its own. Therefore, in this case, the percentage point change, which shows a very slight decrease of 0.027, gives a better representation of the change in growth rate.

484. For Fowlsheugh SPA, for both the baseline and built scenarios, the razorbill breeding population is also predicted to increase over the 25 year period, with a higher growth rate than that predicted for the Forth Islands SPA. There is predicted to be a slight decrease in this growth rate when NNG is present. Overall, the change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario is a decrease of 6.78%, with a corresponding counterfactual of the growth rate of 93.22% (Table 9-89).

485. Changes in the predicted population size for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 25 years are shown in Table 9-90.

Table 9-90: Change in predicted population size for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 25 years

| Species | SPA & start Population | Baseline population after 25 years (no wind farm) | Population after 25 years with NnG (displacement all year) | Percentage change in median final population size compared to baseline | Counterfactual of Population Size (CPS) |
|---|---|---|---|---|---|
| **Razorbill** | Forth Islands 7,792 pairs | 7,862 pairs | 7,870 pairs | +0.10 | 100.10% |
| | Fowlsheugh 9,950 pairs | 13,491 pairs | 13,324 pairs | -1.23 | 98.77% |

486. For the Forth Islands SPA, for the baseline and built scenarios, the razorbill breeding population is predicted to increase very slightly over 25 years, with a slightly higher end population predicted when NnG is present (Table 9-90). Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is an increase of 0.10%, which gives a corresponding CPS value of 100.10%. This suggests that displacement will not have a significant negative effect on breeding razorbills at the Forth Islands SPA.

487. For the Fowlsheugh SPA, for the baseline and built scenarios, the razorbill breeding population is also predicted to increase over 25 years, with a slightly lower end population when NnG is present (Table 9-90). Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is a decrease of 1.23%, which gives a corresponding CPS value of 98.77%. Again, the results indicate that displacement will not have a significant negative effect on breeding razorbills at Fowlsheugh SPA.

488. Changes in the predicted population growth rate for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 50 years are shown in Table 9-91.

Table 9-91: Change in predicted population growth rate for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 50 years

| Species | SPA Population | Baseline change after 50 years (no wind farm) | Percentage point change with NnG after 50 years (displacement all year) | Percentage change in median annual growth rate compared to baseline | Counterfactual of the annual growth rate |
|---|---|---|---|---|---|
| **Razorbill** | Forth Islands | 0.0631 | -0.087 | -137.24 | -37.24% |
| | Fowlsheugh | 0.9416 | -0.071 | -7.50 | 92.50% |

489. For the Forth Islands SPA, for the baseline scenario, the razorbill breeding population is predicted to increase over the 50 year period, however the growth rate is predicted to be very low (Table 9-91). The population with NnG present is predicted to decline slightly over 50 years, compared to the baseline scenario, with an estimated percentage point change of -0.087 predicted. The values for the percentage change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario, and the corresponding counterfactual of the growth rate are both overestimated by the model, due to the fact that the Forth Islands SPA population of razorbill is predicted to be fairly stable over the 50 years, with a population growth rate close to zero. This means that any change will be relatively large, relative to the small initial rate. Similarly, the counterfactual of the growth rate is highly influenced by the initial growth rate and bears little

relevance to the change in growth rate on its own. Therefore, in this case, the percentage point change gives a better representation of the change in growth rate.

490. For Fowlsheugh SPA, for both the baseline and built scenarios, the razorbill breeding population is predicted to increase over the 50 year period, with a higher growth rate than that predicted for the Forth Islands SPA. There is predicted to be a slight decrease in this growth rate when NnG is present. Overall, the change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario is a decrease of 7.50%, with a corresponding counterfactual of the growth rate of 92.50% (Table 9-91).

491. Changes in the predicted population size for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 50 years are shown in Table 9-92.

Table 9-92: Change in predicted population size for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 50 years

| Species | SPA & start Population | Baseline population after 50 years (no wind farm) | Population after 50 years with NnG (displacement all year) | Percentage change in median final population size compared to baseline | Counterfactual of Population Size (CPS) |
|---|---|---|---|---|---|
| **Razorbill** | Forth Islands<br>7,792 pairs | 8,063 pairs | 7,749 pairs | -3.89 | 96.11% |
| | Fowlsheugh<br>9,950 pairs | 16,932 pairs | 16,353 pairs | -3.42 | 96.58% |

492. For the Forth Islands SPA, for the baseline and built scenarios, the razorbill breeding population is predicted to increase very slightly over 50 years, with a slightly lower end population predicted when NnG is present (Table 9-92). Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG is a decrease of 3.89%. This results in a CPS value of 96.11% of the baseline scenario.

493. For the Fowlsheugh SPA, for the baseline and built scenarios, the razorbill breeding population is predicted to increase over 50 years, with a slightly lower end population predicted when NnG is present (Table 9-92). Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG is a decrease of 3.42%. This translates into a CPS value of 96.58% of the baseline with no wind farm.

494. A comparison of the 50$^{th}$ centile values for razorbills breeding at the Forth Islands and Fowlsheugh SPAs with and without the Project over 25 years and 50 years is shown in Table 9-93.

Table 9-93: Comparison of the 50$^{th}$ centile values for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Project over 25 years and 50 years

| Species | SPA Population | 50th centile for unimpacted population (Baseline) | Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG (displacement all year) | Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG (displacement all year) |
|---|---|---|---|---|
| **Razorbill** | Forth Islands | 0.50 | 0.50 | 0.45 |
| | Fowlsheugh | 0.50 | 0.48 | 0.44 |

495. For an unimpacted population 50% of the model runs would not be lower than the median. For the Forth Islands SPA, comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted populations shows that over 25 years at least 50%, and over 50 years at least 45%, of the runs end not lower than the median population size of the unimpacted population. For Fowlsheugh SPA, over 25 years at least 48%, and over 50 years at least 44% of the runs end not lower than the median population size of the unimpacted population.

#### *9.9.2.4.5 Puffin*

496. Changes in the predicted population growth rate for puffins breeding at the Forth Islands SPA with and without NnG over 25 years are shown in Table 9-94.

Table 9-94: Change in predicted population growth rate for puffins breeding at the Forth Islands SPA with and without the Project over 25 years

| Species | SPA Population | Baseline change after 25 years (no wind farm) | Percentage point change with NnG after 25 years (displacement breeding season) | Percentage change in median annual growth rate compared to baseline | Counterfactual of the annual growth rate |
|---|---|---|---|---|---|
| **Puffin** | Forth Islands | 4.6103 | -0.016 | -0.34 | 99.66% |

497. For both the baseline and built scenarios, the puffin breeding population at the Forth Islands SPA is predicted to increase over the 25 year period, although there is a slight decrease in this growth rate when NnG is present. Overall, the change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario is a decrease of 0.34% for the Forth Islands SPA (Table 9-94). Alternatively, the counterfactual of the growth rate is 99.52% of that for the scenario with no wind farm constructed. This indicates that there will be no significant negative effect from displacement on the puffin population at the Forth Islands SPA, arising from NnG.

498. Changes in the predicted population size for puffins breeding at the Forth Islands SPA with and without the Project over 25 years are shown in Table 9-95.

Table 9-95: Change in predicted population size for puffins breeding at the Forth Islands SPA with and without the Project over 25 years

| Species | SPA & start Population | Baseline population after 25 years (no wind farm) | Population after 25 years with NnG (displacement breeding season) | Percentage change in median final population size compared to baseline | Counterfactual of Population Size (CPS) |
|---|---|---|---|---|---|
| **Puffin** | Forth Islands 45,005 pairs | 174,231 pairs | 172,875 pairs | -0.78 | 99.22% |

499. For the Forth Islands SPA, for both the baseline and built scenarios, the puffin breeding population is predicted to increase over 25 years, with a slightly lower end population when NnG is present (Table 9-95). Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is a decrease of 0.78%, which gives a CPS value of 99.22% of that of the baseline estimate. This indicates that there will be no significant negative effect from displacement on the puffin population at the Forth Islands SPA, arising from NnG.

500. Changes in the predicted population growth rate for puffins breeding at the Forth Islands SPA with and without NnG over 50 years are shown in Table 9-96.

Table 9-96: Change in predicted population growth rate for puffins breeding at the Forth Islands SPA with and without the Project over 50 years

| Species | SPA Population | Baseline change after 50 years (no wind farm) | Percentage point change with NnG after 50 years (displacement breeding season) | Percentage change in median annual growth rate compared to baseline | Counterfactual of the annual growth rate |
|---|---|---|---|---|---|
| **Puffin** | Forth Islands | 4.6011 | -0.027 | -0.59 | 99.41% |

501. For both the baseline and built scenarios, the puffin breeding population at the Forth Islands SPA is predicted to increase over the 50 year period, although there is a slight decrease in this growth rate when NnG is present. Overall, the change in the median annual growth rate when comparing the baseline (no wind farm) with NnG is a decrease of 0.59% for the Forth Islands SPA (Table 9-96). Alternatively, the counterfactual of the growth rate is 99.41% of that for the scenario with no wind farm constructed. This is similar to the values predicted after 25 years (Table 9-94), and indicates that there will be no significant negative effect from displacement on the puffin population at the Forth Islands SPA, arising from NnG.

502. Changes in the predicted population size for puffins breeding at the Forth Islands SPA with and without the Project over 50 years are shown in Table 9-97.

Table 9-97: Change in predicted population size for puffins breeding at the Forth Islands SPA with and without the Project over 50 years

| Species | SPA & start Population | Baseline population after 50 years (no wind farm) | Population after 50 years with NnG (displacement breeding season) | Percentage change in median final population size compared to baseline | Counterfactual of Population Size (CPS) |
|---|---|---|---|---|---|
| **Puffin** | Forth Islands 45,005 pairs | 531,902 pairs | 525,558 pairs | -1.19 | 98.81% |

503. For the Forth Islands SPA, for both the baseline and built scenarios, the puffin breeding population is predicted to increase over 50 years, with a slightly lower end population when NnG is present (Table 9-97). Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG is a decrease of 1.19%. The CPS value is 98.81% that of the baseline situation after the 50 year period. This is similar to the values predicted after 25 years (Table 9-95), and indicates that there will be no significant negative effect from displacement on the puffin population at the Forth Islands SPA, arising from NnG.

504. A comparison of the 50$^{th}$ centile values for puffins breeding at the Forth Islands SPA with and without the Project over 25 years and 50 years is shown in Table 9-98.

Table 9-98: Comparison of the 50th centile values for puffins breeding at the Forth Islands SPA with and without the Project over 25 years and 50 years

| Species | SPA Population | 50th centile for unimpacted population (Baseline) | Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG (displacement breeding season) | Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG (displacement breeding season) |
|---|---|---|---|---|
| **Puffin** | Forth Islands | 0.50 | 0.47 | 0.47 |

505. For an unimpacted population 50% of the model runs would not be lower than the median. Comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted populations shows that over both 25 years and 50 years at least 47% of the runs end not lower than the median population size of the unimpacted population.

**Summary of PVA for the Project alone**

506. For gannet, the PVA only considered annual collision effects. For the wind farm scenarios tested, the predicted population growth rate increased, regardless of the modelled build scenario, although the predicted rate of population growth was lower than for the baseline scenario, with no wind farms built. Similarly, the predicted end populations after 25 and 50 years increased for both the baseline and built scenarios, with slightly lower end populations predicted when NnG was present. Overall, results indicate that collision impacts from NnG alone on the breeding gannet population at Forth Islands SPA over the lifetime of the Project are not likely to be significant.

For kittiwake, the PVA considered annual collision effects in isolation and in combination with displacement effects in the breeding season. For the Forth Islands SPA, the kittiwake breeding population is predicted to increase over 25 and 50 years, although there is a slightly lower rate of increase when NnG is present. Similarly, the predicted end populations after 25 and 50 years increased for both the baseline and built scenarios, with slightly lower end populations predicted when NnG was present.

For Fowlsheugh SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to decrease over 25 and 50 years, although there is a slightly higher rate of decrease when NnG is present. Similarly, the predicted end populations after 25 and 50 years decreased for both the baseline and built scenarios, with slightly lower end populations predicted when NnG was present.

507. Overall, results indicate that collision and displacement impacts from NnG alone on the breeding kittiwake population at Forth Islands SPA and Fowlsheugh SPA over the lifetime of the Project are likely to be small and have relatively little influence on the resulting population size.

508. For guillemot and razorbill, the PVA considered displacement effects throughout the year. For guillemot, for the wind farm scenarios tested, the predicted population growth rate at both the Forth Islands SPA and Fowlsheugh SPA increased, regardless of the modelled build scenario. Similarly, the predicted end populations after 25 and 50 years increased for both the baseline and built scenarios, with slightly lower end populations predicted when NnG was present. For the 25 and 50 year assessments, the difference between the population growth rate and the end population sizes for the baseline and built scenarios were small, indicating that there is likely to be very little impact from displacement from NnG alone on the breeding populations at Forth Islands SPA and Fowlsheugh SPA over the lifetime of the Project.

509. For razorbill, for the wind farm scenarios tested, the predicted population growth rate at Forth Islands SPA and Fowlsheugh SPA increased, regardless of the modelled build scenario, however the growth rate at the Forth Islands SPA was predicted to be very low. Similarly, for both SPA populations, the predicted end populations after 25 and 50 years increased for both the baseline and

built scenarios, with slightly lower end populations predicted when NnG was present. These results indicate that displacement impacts from NnG alone on the breeding razorbill populations at Forth Islands SPA and Fowlsheugh SPA over the lifetime of the Project are not likely to be significant.

510. For puffin, the PVA only considered displacement effects in the breeding season. For the wind farm scenarios tested, the predicted population growth rate increased, regardless of the modelled build scenario, although the predicted rate of population growth was lower than for the baseline scenario, with no wind farms built. Similarly, the predicted end populations after 25 and 50 years increased for both the baseline and built scenarios, with slightly lower end populations predicted when NnG was present. This indicates that displacement impacts from NnG alone on the breeding population at Forth Islands SPA over the lifetime of the Project are not likely to be significant.

#### 9.9.2.5 Impacts on Outer Firth of Forth & St Andrews Bay pSPA

511. Once operational, the presence of the Project could potentially result in collision and displacement impacts on seabirds from the Outer Firth of Forth & St Andrews Bay pSPA. It has not yet been determined how many turbines will lie within the pSPA boundary. However, based on the published current pSPA site boundary (SNH 2016), the Project footprint will overlap the pSPA by a maximum of 34 $km^2$ (Table 9-2). This corresponds to approximately 1.3% of the overall area of the pSPA (2,720.68 $km^2$.

512. As outlined in Section 9.7.4.2, there are 21 species currently listed as Qualifying Interests for the pSPA. Of these, nine seabird species were regularly recorded within the Wind Farm Area on baseline surveys. These species have therefore been included in this assessment of impacts on the Outer Firth of Forth & St Andrews Bay pSPA during the operational phase of the Project (Table 9-99). A further four species that are considered Qualifying Interest species for the pSPA (Arctic tern, common tern, shag and Manx shearwater) occurred within the Wind Farm Area in very low numbers on baseline surveys or were not recorded. These species and the remaining eight species of divers, grebes and seaducks which mainly occur in the inner Forth and Tay estuaries, have been scoped out of this assessment, based on advice received in the Scoping Opinion (Marine Scotland, 2017).

Table 9-99: Qualifying Interest species for the Outer Firth of Forth & St Andrews Bay pSPA included in the assessment of displacement and collision impacts

| Qualifying interest | Displacement | Collision impacts |
|---|---|---|
| **Gannet** | x | Collision impacts in breeding season |
| **Kittiwake** | Displacement impacts in breeding and non-breeding seasons | Collision impacts in breeding and non-breeding seasons |
| **Herring gull** | x | Collision impacts in breeding and non-breeding seasons |
| **Guillemot** | Displacement impacts in breeding and non-breeding seasons | x |
| **Razorbill** | Displacement impacts in non-breeding season | x |
| **Puffin** | Displacement impacts in breeding season | x |
| **Little gull** | Displacement impacts in non-breeding season | Collision impacts in non-breeding season |
| **Common gull** | Displacement impacts in non-breeding season | Collision impacts in non-breeding season |

| Qualifying interest | Displacement | Collision impacts |
|---|---|---|
| **Black-headed gull** | Displacement impacts in non-breeding season | Collision impacts in non-breeding season |

513. Direct habitat loss within the Outer Firth of Forth & St Andrews Bay pSPA arising from the installation of the turbines is assessed in Section 9.9.1.1.

514. The largest potential displacement effect is predicted to occur during the operational phase of the Project, caused by the physical presence of the turbines. For this reason, this assessment only considers displacement effects arising from the presence of the wind turbines. However, it is recognised that temporary displacement of seabirds within the Wind Farm Area may occur during the construction and decommissioning phases, due the physical presence of vessels. However, any such displacement effects, if they do occur, are considered a temporary, localised effect, and are therefore not considered significant.

#### *9.9.2.5.1 Displacement Impacts in the breeding season*

515. Displacement impacts have been considered for seven qualifying interest species for the pSPA, based on advice in the Scoping Opinion (Marine Scotland, 2017). Displacement impacts in the breeding season were considered for kittiwake, guillemot and puffin.

516. For the following assessment, it is assumed that for each species considered, the pSPA population is spread evenly across the pSPA. For breeding season impacts, the reference pSPA population was taken as the most recent available counts of the breeding populations of the terrestrial SPA breeding colonies that border the pSPA. This approach was agreed at a meeting between NnG, Marine Scotland, SNH and JNCC to discuss the pSPA designation in October 2016, on the basis that the population estimates presented for the pSPA during the pSPA consulation process (SNH 2016), were the minimum number of birds that occurred regularly within the pSPA boundary that could be used to build the case for designation. Counts from the adjacent terrestrial SPA breeding colonies bordering the pSPA were considered more representative of the numbers of birds likely to occur within the pSPA in the breeding season.

*Kittiwake*

517. For kittiwake, both the Forth Islands SPA (4,663 pairs), and St. Abb's Head to Fast Castle SPA (3,334 pairs) border the pSPA, therefore, for the purposes of this assessment, the pSPA population during the breeding season was estimated at 7,997 pairs (Table 9-8).

518. If the pSPA kittiwake population in the breeding season (7,997 pairs) is distributed evenly across the pSPA and the Wind Farm Area overlaps with 1.3% of the total area of the pSPA, then an estimated 104 birds from the pSPA kittiwake population may be displaced, if it is assumed that all birds were displaced. If a 2 km buffer is applied, then the overlap would be 3.4%, and an estimated 272 birds from the pSPA kittiwake population may be displaced.

519. However, based on advice in the Scoping Opinion, the displacement rate for kittiwake was assumed to be 30%, resulting in 31 birds (29 adults and two immature birds) being displaced from the overlapping Wind Farm Area, or 82 birds (76 adults and six immature birds) from the overlapping Wind Farm Area and 2 km buffer. The above age breakdown of 6.8% immature birds in the breeding season was taken from age data recorded on baseline surveys (Appendix 9.2: Table 5).

520. Applying the 2% mortality rate from the Scoping Opinion would result in one adult from the pSPA kittiwake population suffering mortality, if displacement affected just the overlapping Wind Farm Area, or two birds (all adults) if displacement affected the overlapping Wind Farm Area and 2km buffer area. This is equivalent to between 0.01% and 0.03% of the pSPA population in the breeding season (7,997 pairs) (Table 9-100).

521. An alternative approach would be to use the mean peak seasonal population of the Wind Farm Area to estimate the number of birds likely to be displaced. The three-year peak mean population of kittiwakes recorded in the Wind Farm Area on breeding season baseline surveys was 1,772 birds (Table 9-12). Approximately 32% of the Wind Farm Area overlaps with the pSPA. Assuming that all kittiwakes recorded in the Wind Farm Area during baseline surveys were evenly distributed across the Wind Farm Area, then 32% (567 birds), would be displaced from the overlapping Wind Farm Area in the breeding season, if all birds are displaced. If a 2 km buffer is applied, then the area of overlap with the pSPA would increase to 46%. Therefore, 46% of the 3-year peak mean population of 2,164 kittiwakes recorded in the Wind Farm Area and 2 km buffer on baseline surveys could be displaced (Table 9-12), which equates to 995 individuals, if all birds are displaced.

522. Applying a displacement rate of 30%, as recommended in the Scoping Opinion (Marine Scotland, 2017), would result in 170 kittiwakes (158 adults and 12 immature birds) being affected from the overlapping Wind Farm Area in the breeding season, or 299 kittiwakes (279 adults and 20 immature birds) from the overlapping Wind Farm Area and 2 km buffer.

523. Applying the 2% mortality rate, as recommended by the Scoping Opinion, would result in three adult birds from the pSPA kittiwake population suffering mortality, if displacement affected just the overlapping Wind Farm Area, or six adult birds if displacement affected the overlapping Wind Farm Area and 2km buffer area. This is equivalent to 0.04% and 0.08% of the pSPA population in the breeding season (7,997 pairs).

524. Using site-specific baseline data, the estimated number of kittiwakes that would suffer mortality as a result of being displaced within the pSPA is greater than estimated when using the pSPA cited population (Table 9-100).

Table 9-100: Estimated kittiwake mortality in the Outer Firth of Forth & St Andrews Bay pSPA from displacement impacts in the breeding season

| Season | Wind Farm Area | | Wind Farm Area + 2 km buffer | |
|---|---|---|---|---|
| | No of birds | % of pSPA population | No of birds | % of pSPA population |
| **pSPA population estimate** | 1 | 0.01 | 2 | 0.03 |
| **3-year peak mean population estimate** | 3 | 0.04 | 6 | 0.08 |

*Guillemot*

525. For guillemot, both the Forth Islands SPA (28,786 birds), and St. Abb's Head to Fast Castle SPA (36,206 birds) border the pSPA, therefore, for the purposes of this assessment, the pSPA population during the breeding season was estimated at 64,992 birds (Table 9-8).

526. If the pSPA guillemot population in the breeding season (64,992 birds) is distributed evenly across the pSPA and the Wind Farm Area overlaps with 1.3% of the total area of the pSPA, then an estimated 845 birds from the pSPA guillemot population may be displaced, if all birds were displaced. If a 2 km buffer is applied, then the overlap would be 3.4%, and an estimated 2,210 birds from the pSPA guillemot population may be displaced.

527. However, based on advice in the Scoping Opinion, the displacement rate for guillemot was assumed to be 60%, resulting in 507 birds (259 breeding adults and 248 immature or non-breeding adults) being displaced from the overlapping Wind Farm Area, or 1,326 birds (678 breeding adults and 648 immature or non-breeding adults) from the overlapping Wind Farm Area and 2 km buffer. The above

age breakdown of 48.9% immature or non-breeding adults in the breeding season was based on the PVA stable age structure (Table 9-25).

528. Applying the 1% mortality rate recommended in the Scoping Opinion would result in five birds (three breeding adults and two immature or non-breeding adults) from the pSPA guillemot population suffering mortality, if displacement affected just the overlapping Wind Farm Area, or 13 birds (seven breeding adults and six immature or non-breeding adults) if displacement affected the overlapping Wind Farm Area and 2km buffer area. This is equivalent to between 0.01% and 0.02% of the pSPA population in the breeding season (64,992 birds) (Table 9-101).

529. An alternative approach would be to use the mean peak seasonal population of the Wind Farm Area to estimate the number of birds likely to be involved. The three-year peak mean population of guillemots recorded in the Wind Farm Area on breeding season baseline surveys was 2,202 birds (Table 9-23). Approximately 32% of the Wind Farm Area overlaps with the pSPA. Assuming that all guillemots recorded in the Wind Farm Area during baseline surveys were evenly distributed across the Wind Farm Area, then approximately 32% (705 birds), would be displaced from the overlapping Wind Farm Area in the breeding season, if all birds are displaced. If a 2 km buffer is applied, then the area of overlap with the pSPA would increase to 46%. Therefore, 46% of the 3-year peak mean population of 4,894 guillemots recorded in the Wind Farm Area and 2 km buffer on baseline surveys could be displaced in the breeding season, which equates to 2,251 individuals, if all birds are displaced.

530. Applying a displacement rate of 60%, as recommended in the Scoping Opinion (Marine Scotland, 2017), would result in 423 guillemots (216 breeding adults and 207 immature or non-breeding adults) being affected from the overlapping Wind Farm Area, or 1,351 guillemots (690 breeding adults and 661 immature or non-breeding adults) from the overlapping Wind Farm Area and 2 km buffer in the breeding season.

531. Applying the 1% mortality rate recommended in the Scoping Opinion would result in four birds (two breeding adults and two immature or non-breeding adults) from the pSPA guillemot population suffering mortality, if displacement affected just the overlapping Wind Farm Area, or 14 birds (seven breeding adults and seven immature or non-breeding adults) if displacement affected the overlapping Wind Farm Area and 2km buffer area. This is equivalent to between 0.01% and 0.04% of the pSPA population in the breeding season (64,992 birds).

532. Using site-specific baseline data, the estimated number of guillemots that would suffer mortality as a result of being displaced from within the pSPA is similar to that estimated when using the pSPA cited population (Table 9-101).

Table 9-101: Estimated guillemot mortality in the Outer Firth of Forth & St Andrews Bay pSPA from displacement impacts in the breeding season

| Season | Wind Farm Area | | Wind Farm Area + 2 km buffer | |
|---|---|---|---|---|
| | No of birds | % of pSPA population | No of birds | % of pSPA population |
| pSPA population estimate | 5 | 0.01 | 13 | 0.02 |
| 3-year peak mean population estimate | 4 | 0.01 | 14 | 0.02 |

*Puffin*

533. For puffin, the Forth Islands SPA (45,005 pairs), borders the pSPA, therefore, for the purposes of this assessment, the pSPA population during the breeding season was estimated at 45,005 pairs (Table 9-8).

534. If the pSPA puffin population in the breeding season (45,005 pairs) is distributed evenly across the pSPA and the Wind Farm Area overlaps with 1.3% of the total area of the pSPA, then an estimated 1,170 birds from the pSPA puffin population may be displaced, if all birds were displaced. If a 2 km buffer is applied, then the overlap would be 3.4%, and an estimated 3,060 birds from the pSPA puffin population may be displaced.

535. However, based on advice in the Scoping Opinion, the displacement rate for puffin was assumed to be 60%, resulting in 702 birds (359 breeding adults and 343 immature or non-breeding adults) being displaced from the overlapping Wind Farm Area in the breeding season, or 1,836 birds (938 breeding adults and 898 immature or non-breeding adults) from the overlapping Wind Farm Area and 2 km buffer. The above age breakdown of 48.9% immature or non-breeding adults in the breeding season was based on the PVA stable age structure (Table 9-44).

536. Applying the 2% mortality rate recommended in the Scoping Opinion would result in 14 birds (seven breeding adults and seven immature or non-breeding adults) from the pSPA puffin population suffering mortality in the breeding season, if displacement affected just the overlapping Wind Farm Area, or 37 birds (19 breeding adults and 18 immature or non-breeding adults) if displacement affected the overlapping Wind Farm Area and 2km buffer area. This is equivalent to between 0.02% and 0.04% of the pSPA population in the breeding season (51,956 pairs) (Table 9-102).

537. An alternative approach would be to use the mean peak seasonal population of the Wind Farm Area to estimate the number of birds likely to be involved. The three-year peak mean population of puffins recorded in the Wind Farm Area on breeding season baseline surveys was 2,682 birds (Table 9-42). Approximately 32% of the Wind Farm Area overlaps with the pSPA. Assuming that all puffins recorded in the Wind Farm Area during baseline surveys were evenly distributed across the Wind Farm Area, then approximately 32% (858 birds), would be displaced from the overlapping Wind Farm Area, if all birds were displaced. If a 2 km buffer is applied, then the area of overlap with the pSPA would increase to 46%. Therefore, 46% of the 3-year peak mean population of 6,173 puffins recorded in the Wind Farm Area and 2 km buffer on baseline surveys (Table 9-42) could be displaced, which equates to 2,840 individuals, if all birds are displaced.

538. Applying a displacement rate of 60%, as recommended in the Scoping Opinion (Marine Scotland, 2017), would result in 515 puffins (261 breeding adults and 254 immature or non-breeding adults) being affected from the overlapping Wind Farm Area in the breeding season, or 1,704 puffins (862 breeding adults and 842 immature or non-breeding adults) from the overlapping Wind Farm Area and 2 km buffer.

539. Applying the 2% mortality rate recommended in the Scoping Opinion would result in 10 birds (five breeding adults and five immature or non-breeding adults) from the pSPA puffin population suffering mortality in the breeding season, if displacement affected just the overlapping Wind Farm Area, or 34 birds (17 breeding adults and 17 immature or non-breeding adults) if displacement affected the overlapping Wind Farm Area and 2km buffer area. This is equivalent to 0.01% and 0.04% of the pSPA population in the breeding season (45,005 pairs.

540. Using site-specific baseline data, the estimated number of puffins that would die as a result of being displaced within the pSPA is lower than estimated when using the pSPA cited population (Table 9-102).

Table 9-102: Estimated puffin mortality in the Outer Firth of Forth & St Andrews Bay pSPA from displacement impacts in the breeding season

| Season | Wind Farm Area | | Wind Farm Area + 2 km buffer | |
|---|---|---|---|---|
| | No of birds | % of pSPA population | No of birds | % of pSPA population |
| pSPA population estimate | 14 | 0.02 | 37 | 0.04 |
| 3-year peak mean population estimate | 10 | 0.01 | 34 | 0.04 |

#### *9.9.2.5.2 Displacement Impacts in the non-breeding season*

541. Displacement impacts in the non-breeding season within the pSPA were considered for kittiwake, little gull, common gull, black-headed gull, guillemot and razorbill. It was recommended at a meeting between NnG, Marine Scotland, SNH and JNCC to discuss the pSPA designation in October 2016, that for non-breeding season assessments, the populations given in the pSPA site selection document should be used. However, it should be noted that the populations presented in the pSPA site selection document were intended for designation purposes only, and are effectively the minimum numbers likely to be present. This should be borne in mind when reading the following assessment.

542. For kittiwake, little gull, guillemot and razorbill, it was possible to use the two above approaches to estimate mortality from displacement in the non-breeding season. For common gull and black-headed gull it was only possible to estimate mortality from displacement using the cited pSPA population, as site-specific population estimates were not available, due to the low number of birds recorded during baseline surveys.

*Kittiwake*

543. For kittiwake, the estimated population for the pSPA in the non-breeding season is given as 3,191 birds (SNH 2016).

544. If the pSPA kittiwake population in the non-breeding season (3,191 birds) is distributed evenly across the pSPA and the Wind Farm Area overlaps with 1.3% of the total area of the pSPA, then an estimated 41 birds from the pSPA kittiwake population in the non-breeding season may be displaced, if all birds were displaced. If a 2 km buffer is applied, then the overlap would be 3.4%, and an estimated 108 birds from the pSPA kittiwake population in the non-breeding season may be displaced.

545. However, based on advice in the Scoping Opinion, the displacement rate for kittiwake was assumed to be 30%, resulting in 12 birds (eight adults and four immature birds) being displaced from the overlapping Wind Farm Area, or 32 birds (21 adults and 11 immature birds) from the overlapping Wind Farm Area and 2 km buffer. The above age breakdown of 35.2% immature birds in the non-breeding season (Table 9-7) was taken from age data recorded on baseline surveys (Appendix 9.2: Table 5).

546. Applying the 2% mortality rate recommended in the Scoping Opinion would result in zero birds from the pSPA kittiwake population suffering mortality, if displacement affected just the overlapping Wind Farm Area, or one adult, if displacement affected the overlapping Wind Farm Area and 2km buffer area (Table 9-103). This is equivalent to 0.03% of the pSPA population in the non-breeding season (3,191 birds).

547. An alternative approach would be to use the mean peak seasonal population of the Wind Farm Area to estimate the number of birds likely to be involved. The three-year peak mean population of kittiwakes recorded in the Wind Farm Area in the autumn period of the non-breeding season baseline

surveys (1,065 birds) was higher than the peak mean for the spring period (91 birds), so 1,065 birds was used for this assessment (Table 9-12).

548. Approximately 32% of the Wind Farm Area overlaps with the pSPA. Assuming that all kittiwakes recorded during baseline surveys were evenly distributed across the Wind Farm Area, then 32% (341 birds), would be displaced from the overlapping Wind Farm Area, if all birds were displaced. If a 2 km buffer is applied, then the area of overlap with the pSPA would increase to 46%. Therefore, 46% of the 3-year peak mean population of 2,016 kittiwakes recorded in the Wind Farm Area and 2 km buffer on baseline surveys could be displaced (Table 9-12), which equates to 927 individuals, if all birds are displaced.

549. Applying a displacement rate of 30%, as recommended in the Scoping Opinion (Marine Scotland, 2017), would result in 102 kittiwakes (58 adults and 44 immature birds) being affected from the overlapping Wind Farm Area, or 278 kittiwakes (158 adults and 120 immature birds) from the overlapping Wind Farm Area and 2 km buffer. The above age breakdown of 43.1% immature birds in the autumn period of the non-breeding season (September to December) was taken from age data recorded on baseline surveys (Appendix 9.2: Table 5).

550. Applying the 2% mortality rate from the Scoping Opinion would result in two birds (one adult and one immature bird) from the pSPA kittiwake population suffering mortality, if displacement affected just the overlapping Wind Farm Area, or six birds (three adults and three immature birds) if displacement affected the overlapping Wind Farm Area and 2km buffer area. This is equivalent to 0.06% and 0.2% of the pSPA population in the non-breeding season (3,191 birds).

551. Using site-specific baseline data, the number of kittiwakes that may die as a result of being displaced from the pSPA is greater than when estimated using the pSPA cited population (Table 9-103).

Table 9-103: Estimated kittiwake mortality in the Outer Firth of Forth & St Andrews Bay pSPA from displacement impacts in the non-breeding season

| Season | Wind Farm Area | | Wind Farm Area + 2 km buffer | |
|---|---|---|---|---|
| | No of birds | % of pSPA population | No of birds | % of pSPA population |
| **pSPA population estimate** | 0 | 0 | 1 | 0.03 |
| **3-year peak mean population estimate** | 2 | 0.06 | 6 | 0.2 |

552. However, this mortality estimate is considered precautionary, as it is based on 3-year mean peak post-breeding numbers recorded in the Wind Farm Area and 2 km buffer, and is assessed against an artificially low population estimate for the pSPA in the non-breeding season. In addition, based on available evidence of low levels of kittiwake displacement from existing wind farm projects, it is considered that applying a 2 km buffer, using a mortality rate of 2%, and a displacement rate of 30% is also precautionary.

*Little gull*

553. For little gull, the estimated population for the pSPA in the non-breeding season is given as 126 birds (SNH 2016). However, the size of the regional autumn passage population of little gulls is unknown and this presents a constraint in undertaking the assessment. Analysis of ESAS data by Skov *et al*. (1995) identifies a geographically discrete autumn passage concentration in the outer Firth of Forth and Firth of Tay (referred to as Tay Bay by Skov *et al*.). There is uncertainty regarding the current size of this population as the number estimated by Skov *et al*. (450 birds) is far lower than the typical total of about 1,000 birds seen at coastal roost counts in Fife and Lothian (Forrester *et al.,* 2007). Furthermore, survey work commissioned in recent years to inform the proposed offshore wind farms

in the Firth of Forth area has shown that this species is more common than previously appreciated (or numbers have increased), with peak estimates for the NnG Wind Farm Area and 8 km buffer area of 1,756 birds in October of Year 1, 1,352 birds in October of Year 2 and 3,841 birds in September of Year 3 (Appendix 9.2: Table 16), which gives a three-year peak seasonal mean of 2,316 little gulls. The upper limit of 3,000 birds from Forrester *et al.*'s (2007) estimate of 1,500 - 3,000 individuals present between June and November in the Forth and Tay area has been used in this assessment as the best available pSPA population size during autumn passage.

554. If the pSPA little gull population in the non-breeding season (3,000 birds) is distributed evenly across the pSPA and the Wind Farm Area overlaps with 1.3% of the total area of the pSPA, then an estimated 39 birds from the pSPA little gull population in the non-breeding season may be displaced, if all birds were displaced. If a 2 km buffer is applied, then the overlap would be 3.4%, and an estimated 102 birds from the pSPA little gull population in the non-breeding season may be displaced. As no displacement rate for little gull was given in the Scoping Opinion, the displacement rate was assumed to be the same as for kittiwake (30%), resulting in 12 birds being displaced from the overlapping Wind Farm Area, or 31 birds from the overlapping Wind Farm Area and 2 km buffer.

555. As no mortality rate was given in the Scoping Opinion, a rate of 2% was assumed, which would result in zero birds from the pSPA little gull population suffering mortality, if displacement affected just the overlapping Wind Farm Area, or one bird if displacement affected the overlapping Wind Farm Area and 2km buffer area (Table 9-105). This is equivalent to 0.03% of the assumed pSPA population during autumn passage (3,000 birds).

556. An alternative approach would be to use the mean peak seasonal population of the Wind Farm Area to estimate the number of birds likely to be involved. The three-year peak mean population of little gulls recorded in the Wind Farm Area on non-breeding season baseline surveys was 268 birds (Table 9-104).

Table 9-104: Seasonal three-year mean peak estimated numbers of little gulls in the Wind Farm Area (plus 2 km buffer)

| Year | Wind Farm Area | Wind Farm Area + 2km buffer |
|---|---|---|
| | Autumn passage | Autumn passage |
| **Year 1** | 309 | 457 |
| **Year 2** | 41 | 41 |
| **Year 3** | 455 | 986 |
| **3-year mean peak** | 268 | 495 |

557. Approximately 32% of the Wind Farm Area overlaps with the pSPA. Assuming that all little gulls recorded in the Wind Farm Area during baseline surveys were evenly distributed across the Wind Farm Area, then 32% (86 birds), would be displaced from the overlapping Wind Farm Area, if all birds are displaced. If a 2 km buffer is applied, then the area of overlap with the pSPA would increase to 46%. Therefore, 46% of the 3-year peak mean population of 495 little gulls recorded in the Wind Farm Area and 2 km buffer on baseline surveys could be displaced (Table 9-104), which equates to 228 individuals, if all birds are displaced.

558. Assuming a displacement rate of 30%, would result in 26 little gulls being affected from the overlapping Wind Farm Area, or 68 little gulls from the overlapping Wind Farm Area and 2 km buffer.

559. Assuming a 2% mortality rate would result in one bird from the pSPA little gull population suffering mortality, if displacement affected just the overlapping Wind Farm Area, or one bird if displacement

affected the overlapping Wind Farm Area and 2km buffer area. This is equivalent to 0.03% of the assumed pSPA population during autumn passage (3,000 birds).

560. Using site-specific baseline data, the number of little gulls that may die as a result of being displaced from the pSPA within the Wind Farm Area is slightly higher than when estimated using the pSPA cited population (Table 9-105).

Table 9-105: Estimated little gull mortality in the Outer Firth of Forth & St Andrews Bay pSPA from displacement impacts in the non-breeding season

| Season | Wind Farm Area | | Wind Farm Area + 2 km buffer | |
|---|---|---|---|---|
| | No of birds | % of pSPA population | No of birds | % of pSPA population |
| **pSPA population estimate** | 0 | 0 | 1 | 0.03 |
| **3-year peak mean population estimate** | 1 | 0.03 | 1 | 0.03 |

*Guillemot*

561. For guillemot, the estimated population for the pSPA in the non-breeding season is given as 21,968 birds (SNH 2016).

562. If the pSPA guillemot population in the non-breeding season (21,968 birds) is distributed evenly across the pSPA and the Wind Farm Area overlaps with 1.3% of the total area of the pSPA, then an estimated 286 birds from the pSPA guillemot population in the non-breeding season may be displaced, if all birds were displaced. If a 2 km buffer is applied, then the overlap would be 3.4%, and an estimated 747 birds from the pSPA guillemot population in the non-breeding season may be displaced.

563. However, following advice in the Scoping Opinion (Marine Scotland, 2017), the displacement rate for guillemot was assumed to be 60%, resulting in 172 birds (94 adults and 78 immature birds) being displaced from the overlapping Wind Farm Area, or 448 birds (246 adults and 202 immature birds) from the overlapping Wind Farm Area and 2 km buffer. The above age breakdown of 45.1% immature birds in the non-breeding season was based on the PVA stable age structure (Table 9-25).

564. Applying the 1% mortality rate from the Scoping Opinion would result in two birds (one adult and one immature bird) from the pSPA guillemot population dying, if displacement affected just the overlapping Wind Farm Area, or five birds (three adults and two immature birds) if displacement affected the overlapping Wind Farm Area and 2km buffer area (Table 9-106). This is equivalent to between 0.01% and 0.02% of the pSPA population in the non-breeding season (21,968 birds).

565. An alternative approach would be to use the mean peak seasonal population of the Wind Farm Area to estimate the number of birds likely to be involved. The three-year peak mean population of guillemots recorded in the Wind Farm Area on non-breeding season baseline surveys was 3,890 birds (Table 9-23). Approximately 32% of the Wind Farm Area overlaps with the pSPA. Assuming that all guillemots recorded in the Wind Farm Area during baseline surveys were evenly distributed across the Wind Farm Area, then 32% (1,245 birds), would be displaced from the overlapping Wind Farm Area, if all birds are displaced. If a 2 km buffer is applied, then the area of overlap with the pSPA would increase to 46%. Therefore, 46% of the 3-year peak mean population of 7,618 guillemots recorded in the Wind Farm Area and 2 km buffer on baseline surveys could be displaced (Table 9-23), which equates to 3,504 individuals, if all birds are displaced.

566. Applying a displacement rate of 60%, as recommended in the Scoping Opinion (Marine Scotland, 2017), would result in 747 guillemots (380 adults and 367 immature birds) being affected from the

overlapping Wind Farm Area, or 2,102 guillemots (1,154 adults and 948 immature birds) from the overlapping Wind Farm Area and 2 km buffer. The above age breakdown of 45.1% immature birds in the non-breeding season was based on the PVA stable age structure (Table 9-25).

567. Applying the 1% mortality rate recommended in the Scoping Opinion would result in eight birds (four adults and four immature birds) from the pSPA guillemot population suffering mortality, if displacement affected just the overlapping Wind Farm Area, or 21 birds (12 adults and nine immature birds) if displacement affected the overlapping Wind Farm Area and 2km buffer area. This is equivalent to 0.04% and 0.1% of the pSPA population in the non-breeding season (21,968 birds).

568. Using site-specific baseline data, the estimated number of guillemots that may die as a result of being displaced from the pSPA within the Wind Farm Area is greater than when estimated using the pSPA cited population (Table 9-106).

Table 9-106: Estimated guillemot mortality in the Outer Firth of Forth & St Andrews Bay pSPA from displacement impacts in the non-breeding season

| Season | Wind Farm Area | | Wind Farm Area + 2 km buffer | |
|---|---|---|---|---|
| | No of birds | % of pSPA population | No of birds | % of pSPA population |
| pSPA population estimate | 1 | 0.01 | 5 | 0.02 |
| 3-year peak mean population estimate | 8 | 0.04 | 21 | 0.1 |

*Razorbill*

569. For razorbill, the estimated population for the pSPA in the non-breeding season is given as 5,481 birds (SNH 2016).

570. If the pSPA razorbill population in the non-breeding season (5,481 birds) is distributed evenly across the pSPA and the Wind Farm Area overlaps with 1.3% of the total area of the pSPA, then an estimated 71 birds from the pSPA razorbill population in the non-breeding season may be displaced, if all birds were displaced. If a 2 km buffer is applied, then the overlap would be 3.4%, and an estimated 186 birds from the pSPA razorbill population may be displaced.

571. However, based on advice in the Scoping Opinion, the displacement rate for razorbill was assumed to be 60%, resulting in 43 birds (26 adults and 17 immature birds) being displaced from the overlapping Wind Farm Area, or 112 birds (68 adults and 44 immature birds) from the overlapping Wind Farm Area and 2 km buffer. The above age breakdown of 39.3% immature birds in the non-breeding season was based on the PVA stable age structure (Table 9-35).

572. Applying the 1% mortality rate from the Scoping Opinion would result in zero birds from the pSPA razorbill population dying, if displacement affected just the overlapping Wind Farm Area, or one adult if displacement affected the overlapping Wind Farm Area and 2 km buffer area (Table 9-107). This is equivalent to 0.02% of the pSPA population in the non-breeding season (5,481 birds).

573. An alternative approach would be to use the mean peak seasonal population of the Wind Farm Area to estimate the number of birds likely to be involved. The three-year peak mean population of razorbills recorded in the Wind Farm Area on non-breeding season baseline surveys was 1,404 birds (Table 9-33). Approximately 32% of the Wind Farm Area overlaps with the pSPA. Assuming that all razorbills recorded in the Wind Farm Area during baseline surveys were evenly distributed across the Wind Farm Area, then 32% (449 birds), would be displaced from the overlapping Wind Farm Area, if all birds are displaced. If a 2 km buffer is applied, then the area of overlap with the pSPA would increase to 46%. Therefore, 46% of the 3-year peak mean population of 2,536 razorbills recorded in

the Wind Farm Area and 2 km buffer on baseline surveys could be displaced (Table 9-33), which equates to 1,167 individuals, if all birds are displaced.

574. Applying a displacement rate of 60%, as recommended in the Scoping Opinion (Marine Scotland, 2017), would result in 269 razorbills (163 adults and 106 immature birds) being affected from the overlapping Wind Farm Area, or 700 razorbills (425 adults and 275 immature birds) from the overlapping Wind Farm Area and 2 km buffer. The above age breakdown of 39.3% immature birds in the non-breeding season was based on the PVA stable age structure (Table 9-35).

575. Applying the 1% mortality rate from the Scoping Opinion would result in three birds (two adults and one immature bird) from the pSPA razorbill population suffering mortaity, if displacement affected just the overlapping Wind Farm Area, or seven birds (four adults and three immature birds) if displacement affected the overlapping Wind Farm Area and 2km buffer area. This is equivalent to 0.05% and 0.1% of the pSPA population in the non-breeding season (5,481 birds) (Table 9-107).

576. Using site-specific baseline data, the estimated number of razorbills that may die after being displaced from the pSPA within the Wind Farm Area, is greater than when estimated using the pSPA cited population (Table 9-107).

Table 9-107: Estimated razorbill mortality in the Outer Firth of Forth & St Andrews Bay pSPA from displacement impacts in the non-breeding season

| Season | Wind Farm Area | | Wind Farm Area + 2 km buffer | |
|---|---|---|---|---|
| | No of birds | % of pSPA population | No of birds | % of pSPA population |
| **pSPA population estimate** | 0 | 0 | 1 | 0.02 |
| **3-year peak mean population estimate** | 3 | 0.05 | 7 | 0.1 |

*Black-headed gull*

577. For black-headed gull, the estimated population for the pSPA in the non-breeding season is given as 26,835 birds (SNH 2016).

578. If the pSPA black-headed gull population in the non-breeding season (26,835 birds) is distributed evenly across the pSPA and the Wind Farm Area overlaps with 1.3% of the total area of the pSPA, then an estimated 349 birds from the pSPA black-headed gull population in the non-breeding season may be displaced, if all birds were displaced. If a 2 km buffer is applied, then the overlap would be 3.4%, and an estimated 912 birds from the pSPA black-headed gull population in the non-breeding season may be displaced.

579. As no displacement rate for black-headed gull was given in the Scoping Opinion, the displacement rate was assumed to be the same as kittiwake (30%), resulting in 105 birds being displaced from the overlapping Wind Farm Area, or 274 birds from the overlapping Wind Farm Area and 2 km buffer.

580. Assuming a 2% mortality rate would result in two birds from the pSPA black-headed gull population suffering mortality, if displacement affected just the overlapping Wind Farm Area, or six birds if displacement affected the overlapping Wind Farm Area and 2km buffer area. This is equivalent to between 0.01% and 0.02% of the pSPA population (26,835 birds).

*Common gull*

581. For common gull, the estimated population for the pSPA in the non-breeding season is given as 14,647 birds (SNH 2016).

582. If the pSPA common gull population in the non-breeding season (14,647 birds) is distributed evenly across the pSPA and the Wind Farm Area overlaps with 1.3% of the total area of the pSPA, then an estimated 190 birds from the pSPA common gull population in the non-breeding season may be displaced, if all birds were displaced. If a 2 km buffer is applied, then the overlap would be 3.4%, and an estimated 498 birds from the pSPA common gull population in the non-breeding season may be displaced.

583. As no displacement rate for common gull was advised in the Scoping Opinion, the displacement rate was assumed to be the same as kittiwake (30%), resulting in 57 birds being displaced from the overlapping Wind Farm Area, or 149 birds from the overlapping Wind Farm Area and 2 km buffer.

584. Assuming a 2% mortality rate would result in one bird from the pSPA common gull population dying, if displacement affected just the overlapping Wind Farm Area, or three birds if displacement affected the overlapping Wind Farm Area and 2km buffer area. This is equivalent to between 0.01% and 0.02% of the pSPA population (14,647 birds).

#### *9.9.2.5.3 Displacement throughout the year*

585. Displacement impacts were assessed for kittiwake and guillemot in both the breeding and non-breeding seasons, as recommended in the Scoping Opinion (Marine Scotland, 2017) (Table 9-99).

586. For kittiwake, the breeding and non-breeding season displacement assessments were combined, based on the worst-case results from the breeding season (Table 9-100) and non-breeding season (Table 9-103) assessments. Worst-case results were from using the three-year peak mean baseline population for both seasons (Table 9-108).

Table 9-108: Estimated kittiwake mortality in the Outer Firth of Forth & St Andrews Bay pSPA from displacement impacts throughout the year

| Season | Wind Farm Area | | Wind Farm Area + 2 km buffer | |
|---|---|---|---|---|
| | No of birds | % of pSPA population | No of birds | % of pSPA population |
| **Breeding season** | 3 | 0.04 | 6 | 0.08 |
| **Non-breeding season** | 2 | 0.06 | 6 | 0.2 |
| **Total** | 5 | 0.1 | 12 | 0.3 |

587. For guillemot, the breeding and non-breeding season displacement assessments were also combined, based on the worst-case results from the breeding season (Table 9-101) and non-breeding season (Table 9-106) assessments. Worst-case results were from using the three-year peak mean baseline population for both seasons (Table 9-109).

Table 9-109: Estimated guillemot mortality in the Outer Firth of Forth & St Andrews Bay pSPA from displacement impacts throughout the year

| Season | Wind Farm Area | | Wind Farm Area + 2 km buffer | |
|---|---|---|---|---|
| | No of birds | % of pSPA population | No of birds | % of pSPA population |
| **Breeding season** | 4 | 0.01 | 14 | 0.01 |
| **Non-breeding season** | 8 | 0.04 | 21 | 0.1 |
| **Total** | 12 | 0.05 | 35 | 0.1 |

588. Based on the above displacement assessments, there was no evidence that a significant number of birds from the pSPA populations in the breeding or non-breeding seasons would be affected by displacement impacts resulting from the presence of some of the Project turbines within the pSPA. These assessments are considered precautionery, based on the displacement and mortality rates used, and also on the reference populations for the pSPA in the non-breeding season. In particular, it is considered that the use of mortality rates of 1% or 2% outside of the breeding season, when birds are no longer tied to their breeding colony, is precautionary.

589. Therefore, it is concluded that displacement mortality impacts will have no effect on the key Qualifying Interest species from the Outer Firth of Forth & St Andrews Bay pSPA throughout the year. The sensitivity of the Qualifying Interest species to displacement is assessed as high at worst, and the magnitude of any impacts will be negligible. The significance of any impacts is therefore assessed to be **negligible** and not significant in EIA terms.

#### *9.9.2.5.4 Collision Impacts*

590. Collision impacts have been considered for six qualifying interest species for the pSPA, based on advice in the Scoping Opinion (Marine Scotland, 2017). Collision impacts in the breeding season were considered for gannet, kittiwake and herring gull.

*Breeding season*

591. For the following assessment, it is assumed that for each species considered, the pSPA population is spread evenly across the pSPA. For breeding season impacts, the reference pSPA population was taken as the most recent available counts of the breeding populations of the terrestrial SPA breeding colonies that border the pSPA. This approach was agreed at a meeting between NnGOWL, Marine Scotland, SNH and JNCC to discuss the pSPA designation in October 2016.

592. For gannet, the Forth Islands SPA (75,259 pairs) borders the pSPA, therefore, for the purposes of this assessment, the pSPA population during the breeding season was estimated at 75,259 pairs (Table 9-8). Approximately 32% of the Wind Farm Area overlaps with the pSPA.

593. As details of the number of turbines likely to be placed within the part of the Wind Farm Area that overlaps with the pSPA are not yet available, the area of the Wind Farm within the pSPA was applied to results from Collision Rate Modelling, to allow the proportionate affected number of birds of each species to be estimated. Approximately 32% of the Wind Farm Area overlaps with the pSPA.

594. For the worst-case design scenario (54 turbines), a total of 93 gannet collisions (91 adults and two immature birds) were estimated for the breeding season, using an avoidance rate of 98.9% and Band Option 2 (Table 9-53). Assuming that all gannets recorded in the Wind Farm Area during baseline surveys were evenly distributed across the Wind Farm Area, then 32% of all breeding season collisions (30 birds), would occur in the overlapping Wind Farm Area. This estimated mortality is equivalent to 0.02% of the pSPA gannet population in the breeding season (75,259 pairs).

595. For kittiwake, both the Forth Islands SPA (4,663 pairs), and St. Abb's Head to Fast Castle SPA (3,334 pairs) border the pSPA, therefore, for the purposes of this assessment, the pSPA population during the breeding season was estimated at 7,997 pairs (Table 9-8).

596. For the worst case design scenario (54 turbines), nine kittiwake collisions (eight adults and one immature bird) were estimated for the breeding season, using an avoidance rate of 98.9% and Band Option 2 (Table 9-60). Assuming that all kittiwakes recorded in the Wind Farm Area during baseline surveys were evenly distributed across the Wind Farm Area, then 32% of all breeding season collisions (three birds), would occur in the overlapping Wind Farm Area. This estimated mortality is equivalent to 0.02% of the pSPA kittiwake population in the breeding season (7,997 pairs).

597. For herring gull, both the Forth Islands SPA (6,580 pairs), and St. Abb's Head to Fast Castle SPA (325 pairs) border the pSPA, therefore, for the purposes of this assessment, the pSPA population during the breeding season was estimated at 6,905 pairs (Table 9-8). Approximately 32% of the Wind Farm Area overlaps with the pSPA.

598. For the worst-case design scenario (54 turbines), a total of two herring gull collisions (both adults) were estimated for the breeding season, using an avoidance rate of 99.5% and Band Option 2 (Table 9-64). Assuming that all herring gulls recorded in the Wind Farm Area during baseline surveys were evenly distributed across the Wind Farm Area, then 32% of all breeding season collisions (one bird), would occur in the overlapping Wind Farm Area. This estimated mortality is equivalent to 0.01% of the pSPA herring gull population in the breeding season (6,905 pairs).

*Non-breeding season*

599. Collision impacts in the non-breeding season were considered for kittiwake, herring gull, little gull, common gull and black-headed gull.

600. For kittiwake, the estimated population for the pSPA in the non-breeding season is given as 3,191 birds (SNH 2016). Approximately 32% of the Wind Farm Area overlaps with the pSPA.

601. For the worst-case design scenario (54 turbines), 19 kittiwake collisions (12 adults and seven immature bird) were estimated for the non-breeding season, using an avoidance rate of 98.9% and Band Option 2 (Table 9-60). Assuming that all kittiwakes recorded in the Wind Farm Area during baseline surveys were evenly distributed across the Wind Farm Area, then 32% of all non-breeding season collisions (six birds), would occur in the overlapping Wind Farm Area. This estimated mortality is equivalent to 0.2% of the pSPA kittiwake population in the non-breeding season (3,191 birds).

602. For herring gull, the estimated population for the pSPA in the non-breeding season is given as 12,313 birds (SNH 2016). Approximately 32% of the Wind Farm Area overlaps with the pSPA.

603. For the worst case design scenario (54 turbines), four herring gull collisions (three adults and one immature bird) were estimated for the non-breeding season, using an avoidance rate of 99.5% and Band Option 2 (Table 9-64). Assuming that all herring gulls recorded in the Wind Farm Area during baseline surveys were evenly distributed across the Wind Farm Area, then 32% of all non-breeding season collisions (one bird), would occur in the overlapping Wind Farm Area. This estimated mortality is equivalent to 0.01% of the pSPA herring gull population in the non-breeding season (12,313 birds).

604. For the remining three species (little gull, common gull and black-headed gull), no collisions were estimated for the Wind Farm Area over a year (Table 9-70), therefore there will be zero collisions involving birds from the pSPA populations of these species in the non-breeding season.

### *9.9.2.5.5 Collision impacts throughout the year*

605. For kittiwake and herring gull, the breeding and non-breeding season collision assessments were combined, based on the worst-case results from the seasonal assessments. For kittiwake, results

were from the worst case design scenario (54 turbines), using an avoidance rate of 98.9% and Band Option 2 (Table 9-110).

Table 9-110: Estimated kittiwake mortality in the Outer Firth of Forth & St Andrews Bay pSPA from collision impacts throughout the year

| Season | Wind Farm Area | |
|---|---|---|
| | No of birds | % of pSPA population |
| **Breeding season** | 3 | 0.02 |
| **Non-breeding season** | 6 | 0.2 |
| **Total** | 9 | 0.2 |

606. For herring gull, results were from the worst-case design scenario (54 turbines, using an avoidance rate of 99.5% and Band Option 2 (Table 9-111).

Table 9-111: Estimated herring gull mortality in the Outer Firth of Forth & St Andrews Bay pSPA from collision impacts throughout the year

| Season | Wind Farm Area | |
|---|---|---|
| | No of birds | % of pSPA population |
| **Breeding season** | 1 | 0.01 |
| **Non-breeding season** | 1 | 0.01 |
| **Total** | 2 | 0.02 |

607. Based on the above collision assessments, there was no evidence that a significant number of birds from the pSPA populations in the breeding or non-breeding seasons would be affected by collision impacts resulting from the presence of Project turbines within the pSPA. These assessments are considered precautionery, as they are based on the reference populations for the pSPA in the non-breeding season, which is considered artificially low.

608. Therefore, it is concluded that collision mortality impacts will have no effect on the key Qualifying Interest species from the Outer Firth of Forth & St Andrews Bay pSPA throughout the year. The sensitivity of the Qualifying Interest species to collision is assessed as high at worst, and the magnitude of any impacts will be negligible. The significance of any impacts is therefore assessed to be **minor** and not significant in EIA terms.

#### *9.9.2.5.6 Displacement and collision impacts combined*

609. Four species (kittiwake, little gull, black-headed gull and common gull) were considered for both displacement and collision impacts, as recommended in the Scoping Opinion (Marine Scotland, 2017). These assessments were combined, using the worst-case results. The combined worst-case mortality for kittiwake from annual displacement (Table 9-108) and collision impacts (Table 9-110) was 21 birds (0.46% of the pSPA population) (Table 9-112).

Table 9-112: Estimated kittiwake mortality in the Outer Firth of Forth & St Andrews Bay pSPA from displacement and collision impacts throughout the year

| Season | Wind Farm Area | | Wind Farm Area + 2 km buffer | |
|---|---|---|---|---|
| | No of birds | % of pSPA population | No of birds | % of pSPA population |
| **Total displacement** | 5 | 0.1 | 12 | 0.3 |
| **Total collisions** | 9 | 0.2 | 9 | 0.2 |
| **Total** | 14 | 0.3 | 21 | 0.5 |

610. As there was no additional mortality predicted for little gull, black-headed gull and common gull from the pSPA populations arising from collision impacts, the total combined mortality was as presented in the displacement assessment.

611. Based on the above displacement and collision assessments, there was no evidence that a significant number of birds from the pSPA populations in the breeding or non-breeding seasons would be affected by displacement or collision impacts resulting from the presence of some of the Project turbines within the pSPA. These assessments are considered precautionary, based on the displacement and mortality rates used, and also on the reference populations for the pSPA in the non-breeding season. In particular, it is considered that the use of mortality rates of 1% or 2% outside of the breeding season, when birds are no longer tied to their breeding colony, is precautionary.

612. In addition, as highlighted in the Scoping Opinion (Marine Scotland, 2017), for kittiwake, collision risk and displacement are currently considered to be mutually exclusive impacts, and therefore combining mortality estimates for kittiwake displacement and collision should be considered extremely precautionary.

613. Therefore, it is concluded that displacement and collision mortality impacts will have no effect on the key Qualifying Interest species from the Outer Firth of Forth & St Andrews Bay pSPA throughout the year. The sensitivity of the Qualifying Interest species to displacement and collision is assessed as high at worst, and the magnitude of any impacts will be negligible. The significance of any impacts is therefore assessed to be **minor** and not significant in EIA terms.

### 9.9.2.6 Disturbance from helicopters

614. The use of a helicopter is envisaged for operational and maintenance activity, for example when performing turbine resets and addressing minor defects, or to facilitate access by technicians at times when sea states do not permit access by vessels. The use of helicopters is anticipated to be reasonably limited, with approximately 80 round trips to site anticipated per annum.

615. Seabird species vary in their reactions to maintenance activities that are associated with offshore wind farms (particularly ship and helicopter traffic), with Garthe and Hüppop (2004) presenting a scoring system for such disturbance factors, which is used widely in offshore windfarm EIAs. Other similar scoring systems such as Furness and Wade (2012), Furness *et al*. (2013) and Bradbury et al. (2014) were also used in this assessment.

616. Sensitivity to disturbance impacts of helicopter traffic on the key seabird species for the Project are shown in Table 9-113. These rankings are based on sensitivity to both boat and helicopter disturbance, so it is possible that the sensitivities will be lower for just helicopter disturbance. Ranking scores are from one to five, where one is “hardly any escape behaviour” and five is “strong escape behaviour”.

Table 9-113: Key species sensitivity to disturbance from helicopter traffic

| Species | Garthe & Huppop (2004) ranking | Furness & Wade (2012) ranking | Furness *et al.* 2013 ranking | Bradbury *et al.* 2014 ranking | Summary of Sensitivity |
|---|---|---|---|---|---|
| **Gannet** | 2 | 2 | 2 | 2 | Low to Medium |
| **Kittiwake** | 2 | 2 | 2 | 2 | Low to Medium |
| **Herring gull** | 2 | 2 | 2 | 2 | Low to Medium |
| **Guillemot** | 3 | 3 | 3 | 3 | Medium |
| **Razorbill** | 3 | 3 | 3 | 3 | Medium |
| **Puffin** | 2 | 2 | 2 | 2 | Low to Medium |

617. Therefore, it is concluded that helicopter disturbance impacts will have no effect on seabirds in the vicinity of the Project throughout the year. The sensitivity of species to helicopter disturbance is assessed as medium at worst, and the magnitude of any impacts will be negligible. The duration of any such disturbance will be short-term, and temporary. The significance of any impacts is therefore assessed to be **negligible** and not significant in EIA terms.

### 9.9.3 Decommissioning Phase Impacts

618. Towards the end of the operational life of the Project all decommissioning options will be considered. It may be deemed that removal of certain pieces of infrastructure may have a greater environmental impact than leaving in-situ. The potential decommissioning options will be presented to MS-LOT in a Decommissioning Programme for approval prior to construction. The Decommissioning Programme will then be reviewed and amended as required prior to the commencement of any decommissioning activities.

619. Currently, impacts on birds resulting from decommissioning activities are expected to be similar to those during the construction phase, and these impacts have therefore been scoped out of this assessment.

### 9.9.4 Cumulative Impacts

620. Cumulative effects refer to effects upon receptors arising from the Project when considered alongside other proposed developments and activities and any other reasonably foreseeable project(s) proposals. In this context, the term ‘projects’ is considered to refer to any project with comparable effects and is not limited to offshore wind projects.

621. Projects and activities considered within the cumulative impact assessment are presented in the relevant sub sections. There is uncertainty regarding the design envelope of proposed projects, therefore a worst case scenario is applied to each.

622. For the cumulative collision assessment, two scenarios have been assessed to take into account the new and consented design envelopes for the Inch Cape and the Seagreen Offshore Wind Farms. Scenario One incorporates the worst case design envelopes for the proposed Inch Cape and Seagreen projects as detailed in the Scoping Reports submitted to MS-LOT (ICOL, 2017; Seagreen, 2017). Scenario Two incorporates the consented design envelopes as detailed in the existing 2014 consents. Scenario Two is considered to be extremely unlikely to be realised due to advances in turbine technology and the considerably greater costs associated with using a larger number of turbines.

623. For the cumulative displacement assessment, one scenario has been assessed, as population estimates for the existing 2014 consents did not change for the 2017 proposed projects. This assessment is based on displacement and mortality rates that were recommended in the Scoping Opinion (Marine Scotland, 2017).

624. Table 9-114 sets out the potential cumulative impacts and the worst case cumulative design envelope scenario considered within the cumulative impact assessment.

Table 9-114: Cumulative worst-case design envelope scenarios.

| Impact | Worst Case Design Scenario | Justification |
|---|---|---|
| **Cumulative collision impacts** | In the breeding season, the Project and other Forth and Tay wind farms were included.<br>In the non-breeding season, in addition to the Forth & Tay projects, more distant wind farm projects in the UK North Sea were included for kittiwake, and UK North Sea and English Channel for gannet. | Species from breeding SPA colonies are within mean maximum foraging range of Forth and Tay wind farms but not more distant projects.<br>This approach was recommended in the Scoping Opinion (Marine Scotland, 2017). |
| **Cumulative impacts arising from displacement** | In the breeding season, the Project and other Forth and Tay wind farms were included.<br>In the non-breeding season, for guillemot and razorbill, displacement effects from Inch Cape & Seagreen A & B were included. | Displacement and mortality rates followed guidance in Scoping Opinion.<br>This approach was recommended in the Scoping Opinion (Marine Scotland, 2017). |

### 9.9.4.1 Cumulative Construction Phase Impacts

625. It is considered that there will be no significant cumulative disturbance impacts arising from vessels associated with construction activities due to the distances involved between these projects.

626. In addition, there has been a significant reduction in the scale of the Project, and with the other Forth and Tay projects. These combined reductions will reduce the magnitude of impacts. It is also considered unlikely that construction activities for all projects will be undertaken at the same time.

627. The NnG Scoping Report concluded that the cumulative effects arising from the construction phase will therefore be no greater, and likely less than, those previously presented in the Original Application & Addendum, which were considered to be not significant (NnGOWL, 2017). No further assessment of cumulative impacts for the construction phase has been undertaken in this assessment.

### 9.9.4.2 Cumulative Operational Phase Impacts

628. The Scoping Opinion states that for the breeding season, the Cumulative Impact Assessment should consider effects from projects within mean maximum foraging range of the colony SPA under consideration. This has been applied for the following assessments.

629. The approach recommended in the Scoping Opinion for the non-breeding season depended on the species involved. For guillemot and razorbill, the CIA should incorporate non-breeding season displacement effects from the Forth and Tay wind farms (Inch Cape and Seagreen), apportioning effects to SPA and non-SPA colonies in the same manner as the breeding season.

630. For gannet and kittiwake, the CIA should estimate non-breeding season collision effects from the Forth and Tay wind farms (Inch Cape and Seagreen) in isolation, and cumulatively with the other UK wind farms.

631. For herring gull, if the CRM figures indicate an issue in the non-breeding season then the detailed recommendations given in the Scoping Opinion were to be followed (Marine Scotland, 2017). As collision mortality impacts at NnG were considered to have no effect on herring gulls from the four key SPA populations throughout the year (Table 9-66), a cumulative collision assessment was not undertaken for this species.

#### *9.9.4.2.1 Cumulative Displacement Assessment*

*Breeding season*

632. The assessment for the Project on its own considered displacement impacts for four species in the breeding season (kittiwake, guillemot, razorbill and puffin). These four species are also considered for displacement impacts in the Cumulative Impact Assessment.

633. As recommended in the Scoping Opinion, the Cumulative Impact Assessment should consider effects from projects within mean maximum foraging range of the colony SPA under consideration. All four species have a similar mean maximum foraging range and therefore, the same SPAs are considered applicable for these species. The SPAs considered in this cumulative impact assessment are listed in the text for each species.

634. The following projects were considered in the assessment of cumulative displacement impacts for these species (Table 9-115). As the displacement effects and site boundaries are the same for both the 2014 and 2017 Inch Cape and Seagreen projects, only the 2014 consented projects are presented in this section.

635. As recommended in the Scoping Opinion, for the breeding season, the Cumulative Impact Assessment should consider effects from projects within mean maximum foraging range of the colony SPA under consideration (Marine Scotland, 2017). The following projects were therefore included in the Cumulative Impact Assessment for the breeding season (Table 9-115).

Table 9-115: Projects considered for cumulative assessment of displacement impacts in the breeding season

| Project | Status | Data confidence and Information available |
|---|---|---|
| **Inch Cape Offshore Wind Farm** | Consented (2014) | High - published project information available in the public domain. |
| **Inch Cape Offshore Wind Farm** | Pre-application (2017) | High - published project information available in the public domain, supplemented by additional information provided by developer. |
| **Seagreen A Offshore Wind Farm** | Consented (2014) | High - published project information available in the public domain. |
| **Seagreen B Offshore Wind Farm** | Consented (2014) | High - published project information available in the public domain. |
| **Seagreen Phase 1** | Pre-application (2017) | High - published project information available in the public domain. Project boundaries synonymous with the Seagreen A and B Offshore Wind Farm Projects. |

| Project | Status | Data confidence and Information available |
|---|---|---|
| **Kincardine Offshore Wind Farm** | Consented (2017) | High - published project information available in the public domain. |
| **Forthwind Demonstration Project (2 turbines)** | Consented (2016) | High - published project information available in the public domain. |
| **Forthwind Offshore Wind Demonstrator (up to 7 turbines)** | Pre-application | High - published Scoping Report and Scoping Opinion available in the public domain. |
| **Hywind** | Consented (2015) | High - published project information available in the public domain. |

636. As for the Project alone displacement assessment, the assessment of displacement and barrier effects in the breeding season followed the recent SNCB guidance (2017). The Scoping Report recommended that the CEH displacement modelling report (2014) was used as a basis for running a comparative assessment of breeding season effects for kittiwake, puffin, guillemot and razorbill (Marine Scotland, 2017). However, as outputs from this study were presented as changes in adult survival rate and chick survival, they were not comparable with outputs from the displacement matrix approach, which does not measure these parameters.

637. For Inch Cape, numbers of displaced birds in the breeding season were based on seasonal mean peak estimated numbers for the Inch Cape Wind Farm Area and a 2 km buffer, using the season definitions from the Scoping Opinion (Marine Scotland, 2017). This information was circulated by Inch Cape by email on 23/11/2017 and is presented in Appendix 9.4.

638. For Seagreen Phase 1, numbers of displaced birds in the breeding season were based on seasonal mean peak estimated numbers for the Seagreen Phase 1 project, using the season definitions from the Scoping Opinion (Marine Scotland, 2017). This information was circulated by Seagreen by email on 8/12/2017 and is presented in Appendix 9.4.

639. For Kincardine Offshore Wind Farm, figures for the estimated population size for the turbine area and a buffer of 1 km in the breeding season were taken from the Kincardine Offshore Wind Farm Environmental Statement (Atkins 2016). No figures were available for the Wind Farm Area alone. This information is presented in Appendix 9.4.

640. For the Forthwind project (two turbines), relevant information was taken from the Forthwind Environmental Statement (Forthwind, 2015). For the Hywind project, relevant information was taken from the project Environmental Statement (Statoil, 2015). No figures were available for the Wind Farm Area alone.

641. As recommended in the SNCB guidance (2017), only adult birds were considered for the breeding season displacement assessment.

642. For each species, a range of potential displacement is presented (in 10% intervals from 0% to 100%), based on the mean seasonal peak estimated numbers from baseline surveys as matrix tables. Values are presented for the Wind Farm Area and the Wind Farm Area plus a 2 km buffer (if available), as recommended in the SNCB guidance (2017).

643. Mortality of adult birds displaced from the development site (plus buffer) was considered in this assessment. Reduction in productivity of breeding birds was not considered in the assessment, as recommended in the SNCB guidance (2017), due to the lack of empirical evidence on the consequence of displacement to seabirds. Mortality of displaced birds was presented in 1% intervals between 1 and 5%, and 10% intervals between 10% and 100%. The rate of displacement and mortality used in the assessment was based on available published evidence and also on recommendations received in the Scoping Opinion (Marine Scotland, 2017).

644. Displacement and mortality matrices for each species and wind farm project are presented in Appendix 9.4.

*Kittiwake*

645. The four SPAs considered for kittiwake for the cumulative assessment were Buchan Ness to Collieston Coast SPA, Fowlsheugh SPA, Forth Islands SPA and St Abb's Head to Fast Castle SPA. Based on SNH figures, the most recent total combined breeding population estimate for these SPAs is 29,134 pairs (Table 9-8).

646. Seasonal peak mean estimated numbers of kittiwakes for the projects considered in this assessment are presented in Table 9-116. Estimated numbers for NnG were previously presented in Table 9-12. Estimated numbers for Inch Cape and the Seagreen projects are presented in Appendix 9.4. The population of kittiwakes in the Kincardine OWF area and a 1 km buffer in the breeding season was estimated to be 229 birds (Atkins, 2016). A peak of 184 kittiwakes were estimated to be in the potential zone of influence for the Forthwind project (2 turbines) (Arcus, 2015). The population of kittiwakes in the Hywind wind farm and a 1 km buffer in the breeding season was estimated to be 112 birds (Statoil, 2015).

Table 9-116: Peak mean estimated numbers of kittiwakes at Forth and Tay Wind Farms and 2km buffers in the breeding season

| Project | Wind Farm Area | Wind Farm Area + 2 km buffer |
|---|---|---|
| | No of birds | No of birds |
| **NnG** | 1,772 | 2,164 |
| **Inch Cape** | 2,119 | 3,866 |
| **Seagreen A** | 1,458 | N/A |
| **Seagreen B** | 1,777 | N/A |
| **Kincardine OWF** [9] | 229 | N/A |
| **Forthwind (2 turbines)** | 184 | N/A |
| **Hywind** [9] | 112 | N/A |

647. Based on advice received in the Scoping Opinion (Marine Scotland, 2017), it was assumed that there will be 30% displacement of kittiwakes from the Wind Farm Area (and buffer areas) in the breeding season. This assumption was also applied to all projects (Table 9-117).

[9] Based on Wind Farm Area & 1 km buffer

Table 9-117: Number of displaced kittiwakes at Forth and Tay Wind Farms and 2km buffers in the breeding season

| Project | Wind Farm Area | | Wind Farm Area + 2 km buffer | |
|---|---|---|---|---|
| | No of birds | Adults | No of birds | Adults |
| **NnG** | 532 | 496 | 649 | 605 |
| **Inch Cape** | 636 | 594 | 1,166 | 1,089 |
| **Seagreen A** | 437 | 425 | N/A | N/A |
| **Seagreen B** | 533 | 518 | N/A | N/A |
| **Kincardine OWF** [9] | 69 | 66 | N/A | N/A |
| **Forthwind (2 turbines)** | 55 | 55 | N/A | N/A |
| **Hywind**[9] | 112 | 34 | N/A | N/A |

648. However, this estimate includes non-breeding immature birds, as well as breeding adults. During the breeding period, for NnG, 93.2% of aged kittiwakes were adults (Appendix 9.2: Table 5). For Inch Cape, 93.4% of aged kittiwakes were adults in the breeding season (Appendix 9.4). For Seagreen, as 97.2% of all birds recorded on baseline surveys in Seagreen B in June were adults (Seagreen 2012), this ratio was applied to the above figures for both Seagreen projects. These percentages were applied to the estimated numbers of displaced kittiwakes in the breeding season to estimate the maximum number of adults potentially displaced (Table 9-117).

649. In addition, the number of displaced kittiwakes at Kincardine OWF and 1 km buffer in the breeding season is also shown (Atkins 2016) (Table 9-117).

650. For NnG, assuming 30% of all adult kittiwakes were displaced during the breeding season, this would affect an estimated 496 adults in the Wind Farm Area, increasing to 605 adults including the 2 km buffer (Table 9-117).

651. For Inch Cape, assuming 30% of all adult kittiwakes were displaced during the breeding season, this would affect an estimated 594 adults in the Wind Farm Area, increasing to 1,089 adults including the 2 km buffer (Table 9-117).

652. For Seagreen, assuming 30% of all adult kittiwakes were displaced during the breeding season, this would affect an estimated 425 adults in Seagreen A and 518 adults in Seagreen B (Table 9-117). No figures were available for a 2 km buffer for the Seagreen projects.

653. For Kincardine OWF, assuming 30% of all adult kittiwakes were displaced during the breeding season, this would affect an estimated 66 adults in the Wind Farm Area and 1 km buffer (Atkins 2016) (Table 9-117). For the Forthwind project (2 turbines), all 55 displaced birds were assumed to be adults. For Hywind, assuming 30% of all adult kittiwakes were displaced during the breeding season, this would affect an estimated 34 adults in the Wind Farm Area and 1 km buffer (Statoil, 2015).

654. Predicted displacement mortality for kittiwakes in the breeding season, was summed for all projects, applying a mortality rate of 2% as recommended in the Scoping Opinion (Marine Scotland, 2017), (Table 9-118).

Table 9-118: Estimated adult kittiwake mortality from displacement impacts from Forth and Tay Wind Farms on the key breeding SPAs in the UK waters of the North Sea in the breeding season

| Project | Wind Farm Area | | Wind Farm Area + 2 km buffer | |
|---|---|---|---|---|
| | No of adults | % of SPA population | No of adults | % of SPA population |
| NnG | 10 | 0.02 | 12 | 0.02 |
| Inch Cape | 12 | 0.02 | 22 | 0.04 |
| Seagreen A | 9 | 0.02 | 9 | 0.02 |
| Seagreen B | 10 | 0.02 | 10 | 0.02 |
| Kincardine OWF [10] | 1 | 0.002 | 1 | 0.002 |
| Forthwind (2 turbines) | 1 | 0.002 | 1 | 0.002 |
| Hywind [10] | 1 | 0.002 | 1 | 0.002 |
| Total | 44 | 0.09 | 56 | 0.1 |

655. For NNG, 10 adult kittiwakes displaced from the NnG Wind Farm Area, or 12 adults from the NnG Wind Farm Area and 2 km buffer in the breeding season would suffer mortality as a result (Table 9-118). This corresponds to 0.02% of the SPA population within mean maximum foraging range (29,134 pairs), for the Wind Farm Area and 2 km buffer.

656. For Inch Cape, 12 adult kittiwakes displaced from the Wind Farm Area, or 22 adults from the Wind Farm Area and 2 km buffer in the breeding season would suffer mortality as a result (Table 9-118). This corresponds to between 0.02% and 0.04% of the SPA population within mean maximum foraging range (29,134 pairs), for the Wind Farm Area and 2 km buffer.

657. For Seagreen A, nine adult kittiwakes displaced from the Wind Farm Area in the breeding season would suffer mortality as a result (Table 9-118). This corresponds to 0.02% of the SPA population within mean maximum foraging range (29,134 pairs). As no figures were available for a 2 km buffer, the Seagreen A total was repeated for this assessment.

658. For Seagreen B, 10 adult kittiwakes displaced from the Wind Farm Area in the breeding season would suffer mortality as a result (Table 9-118). This corresponds to 0.02% of the SPA population within mean maximum foraging range (29,134 pairs). As no figures were available for a 2 km buffer, the Seagreen B total was repeated for this assessment.

659. For Kincardine OWF, one adult kittiwake displaced from the Kincardine wind farm and 1 km buffer in the breeding season would suffer mortality as a result (Table 9-118). This corresponds to 0.002% of the SPA population within mean maximum foraging range (29,134 pairs). As this was the only figure available, it was repeated for this assessment.

660. For Forthwind (2 turbines), one adult kittiwake displaced from the wind farm in the breeding season would suffer mortality as a result (Table 9-118). This corresponds to 0.002% of the SPA population within mean maximum foraging range (29,134 pairs). As this was the only figure available, it was repeated for this assessment.

661. For Hywind, one adult kittiwake displaced from the wind farm and 1 km buffer in the breeding season would suffer mortality as a result (Table 9-118). This corresponds to 0.002% of the SPA population

[10] Based on Wind Farm Area & 1 km buffer

within mean maximum foraging range (29,134 pairs). As this was the only figure available, it was repeated for this assessment.

662. No additional information was available for displacement estimates for the proposed seven additional Forthwind turbines. However, based on the low number of kittiwakes recorded on baseline surveys for the adjacent two turbine project (Arcus, 2015), no significant displacement effects on kittiwakes in the breeding season are considered likely to arise from the seven turbine project.

663. Cumulative displacement mortality of 44 adult kittiwakes in the combined wind farms corresponds to 0.09% of the SPA adult breeding population (29,134 pairs) (Table 9-8). Cumulative displacement mortality of 56 adults in the combined wind farms and 2 km buffers corresponds to 0.1% of the SPA adult breeding population.

664. For the surviving displaced adult kittiwakes, there could potentially be a detrimental impact on their breeding success, as a result of having to travel further on each trip to forage elsewhere.

665. In comparison, the CEH Displacement model (Searle *et al.*, 2014) estimated that the change in the annual adult kittiwake survival rate for the Forth Islands SPA for the Forth and Tay projects would be -1.97%, based on the homogeneous prey distribution scenario, and -1.82%, based on the heterogeneous prey distribution scenario (Table 9-119).

666. Similarly, for Fowlsheugh SPA, the change in the annual adult survival rates for the Forth and Tay projects were estimated as -0.48% based on the homogeneous prey distribution scenario, and -0.44%, based on the heterogeneous prey distribution scenario.

667. For the St Abb's Head to Fast Castle SPA, the change in the annual adult survival rates for the Forth and Tay projects were estimated as -0.18% based on the homogeneous prey distribution scenario, and -0.22%, based on the heterogeneous prey distribution scenario.

668. The estimated number of adult birds involved was calculated by dividing these survival rates by 100, and then multiplying by the relevant SPA population (Table 9-119). Based on the most recent population counts for these three SPAs (17,652 pairs, or 35,304 individuals), the estimated combined change in adult survival rates corresponds to a mortality of 289 adult kittiwakes based on the homogeneous prey distribution scenario, or 270 adult kittiwakes based on the heterogeneous prey distribution scenario.

Table 9-119: Summary of annual kittiwake displacement mortality for SPAs in foraging range of the Forth and Tay projects, as presented in the CEH displacement model (Searle *et al.*, 2014)

| SPA | Change in annual adult survival | | SPA population | Estimated number of adults | |
|---|---|---|---|---|---|
| | Homogeneous [11] | Heterogeneous[11] | | Homogeneous | Heterogeneous |
| **Forth Islands** | -1.97 | -1.82 | 4,663 pairs | 184 | 170 |
| **Fowlsheugh** | -0.48 | -0.44 | 9,655 pairs | 93 | 85 |
| **St Abb's Head to Fast Castle** | -0.18 | -0.22 | 3,334 pairs | 12 | 15 |
| **Total** | - | - | 17,652 pairs | -289 adults | -270 adults |

669. A worst-case annual estimated mortality of 289 adult kittiwakes corresponds to a maximum of 0.8% of the SPA breeding population within mean maximum foraging range (17,652 pairs), from displacement effects from the Forth and Tay projects and a 1 km buffer. This demonstrates that if

[11] Figures from Table 3.2, Searle *et al.* (2014)

cumulative adult kittiwake mortality from displacement was at this level, the impact would not be significant at the SPA population level.

670. However, this is an annual estimate, based on the homogeneous prey distribution scenario, which is considered highly unrealistic, an assumed 40% displacement rate for NnG and Inch Cape (30% for Seagreen A & B), as well as several other assumptions including the behaviour of seabirds in response to wind farms (including habituation) and the effects of adult body mass change on subsequent survival, which are detailed in the final report for the displacement model (Searle *et al.*, 2014).

671. As previously highlighted, Searle *et al.* (2014) concluded that model outputs are very sensitive to some parameters. The total amount of prey is the most prominent of these, and the report concluded that small changes in this value can have very substantial effects on the model output. The barrier and displacement rates, which were agreed by the Steering Committee, are also likely to be important parameters in determining the magnitude of the response to the wind farm (and the exploratory analyses, which used different scenarios for barrier and displacement rates, suggest that this is indeed the case).

672. However, based on evidence from other operational projects, including a recent study at Westermost Rough offshore wind farm (APEM, 2017), kittiwake displacement is considered to occur at considerably less than 30%, if it occurs at all. As such, it is considered that a displacement rate of 30% as used in this assessment, (or up to 40% as used in the CEH displacement model), represent highly precautionary assumptions.

673. It is concluded that cumulative displacement mortality impacts arising from the assessed projects will have no effect on the breeding SPA populations of kittiwakes within mean maximum foraging range in the breeding season. The sensitivity of kittiwakes to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

*Guillemot*

674. In the breeding season, the mean maximum foraging range of breeding guillemots is 84.2 ± 50.1 km, based on a sample size of five birds (Thaxter et al., 2012). Based on this, four SPAs for breeding guillemots (Buchan Ness to Collieston Coast, Forth Islands, Fowlsheugh and St Abb’s Head to Fast Castle) are within mean maximum foraging range + 1 SD of the Project. These four SPAs have therefore been used as the SPA reference population for this assessment in the breeding season. Based on SNH figures, the most recent total combined population estimate for these four SPAs is 154,131 birds (Table 9-8).

675. Seasonal peak mean estimated numbers of guillemots for the projects considered in this assessment are presented in Table 9-120. Estimated numbers for NnG were previously presented in Table 9-23. Estimated numbers for Inch Cape and Seagreen A and B presented in Appendix 9.4. The population of guillemots in the Kincardine OWF area and a 1 km buffer in the breeding season was estimated to be 632 birds (Atkins, 2016). A peak of 381 guillemots were estimated to be in the potential zone of influence for the Forthwind project (2 turbines) (Arcus, 2015). The population of guillemots in the Hywind wind farm and a 1 km buffer in the breeding season was estimated to be 295 birds (Statoil, 2015).

Table 9-120: Peak mean estimated numbers of guillemots at Forth and Tay Wind Farms, and 2km buffers in the breeding season

| Project | Wind Farm Area | Wind Farm Area + 2 km buffer |
|---|---|---|
| | No of birds | No of birds |
| **NnG** | 2,202 | 4,894 |
| **Inch Cape** | 4,047 | 8,184 |
| **Seagreen A** | 8,006 | N/A |
| **Seagreen B** | 7,074 | N/A |
| **Kincardine OWF**[12] | 632 | N/A |
| **Forthwind (2 turbines)** | 381 | N/A |
| **Hywind** [12] | 215 | N/A |

676. Based on advice received in the Scoping Opinion (Marine Scotland, 2017), it was assumed that there will be 60% displacement of guillemots from the Wind Farm Area (and buffer areas) in the breeding season. This assumption was also applied to all projects (Table 9-121).

Table 9-121: Number of displaced guillemots at Forth and Tay Wind Farms and 2km buffers in the breeding season

| Project | Wind Farm Area | | Wind Farm Area + 2 km buffer | |
|---|---|---|---|---|
| | No of birds | Adults | No of birds | Adults |
| **NnG** | 1,321 | 674 | 2,936 | 1,497 |
| **Inch Cape** | 2,428 | 1,619 | 4,910 | 3,275 |
| **Seagreen A** | 4,804 | 4,242 | N/A | N/A |
| **Seagreen B** | 4,244 | 3,238 | N/A | N/A |
| **Kincardine OWF**[12][13] | 379 | 379 | N/A | N/A |
| **Forthwind (2 turbines)** | 229 | 229 | N/A | N/A |
| **Hywind** [13] | 137 | 137 | N/A | |

677. However, this estimate includes non-breeding immature birds, as well as breeding adults. During the breeding period, for NnG, 51.0% of guillemots were adults, based on the PVA stable age structure (Table 9-25). For Inch Cape, 66.7% of guillemots were adults in the breeding season, based on the PVA stable age structure used in the 2014 consent (ICOL, 2014). For Seagreen A, of 287 birds aged on surveys between April and July, 88.3% were aged as adult (Seagreen 2012). For Seagreen B, of 160 birds aged on surveys between April and July, 76.3% were aged as adult (Seagreen 2012). These percentages were applied to the estimated numbers of displaced guillemots in the breeding season to estimate the maximum number of adults potentially displaced (Table 9-121).

[12] Based on Wind Farm Area & 1 km buffer

[13] Based on Wind Farm Area & 1 km buffer

678. In the absence of any additional information on age breakdown, all displaced guillemots at Kincardine OWF and 1 km buffer and Forthwind in the breeding season were assumed to be adults (Table 9-121).

679. For NnG, assuming 60% of all adult guillemots were displaced during the breeding season, this would affect an estimated 674 adults in the Wind Farm Area, increasing to 1,497 adults including the 2 km buffer (Table 9-121).

680. For Inch Cape, this would affect an estimated 1,619 adults in the Wind Farm Area, increasing to 3,275 adults including the 2 km buffer (Table 9-121).

681. For Seagreen, this would affect an estimated 4,242 adults in Seagreen A and 3,238 adults in Seagreen B (Table 9-121). No figures were available for a 2 km buffer for the Seagreen projects.

682. For Kincardine OWF, this would affect an assumed 379 adults in the Wind Farm Area and 1 km buffer (Table 9-121). For Forthwind (2 turbines), this would affect an assumed 229 adults in the Wind Farm Area. For Hywind, this would affect an assumed 137 adults in the Wind Farm Area and 1 km buffer.

683. Predicted displacement mortality for guillemots in the breeding season, was summed for all projects, applying a mortality rate of 1% as recommended in the Scoping Opinion (Marine Scotland, 2017), (Table 9-122).

Table 9-122: Estimated adult guillemot mortality from displacement impacts from Forth and Tay Wind Farms on the key breeding SPAs in the UK waters of the North Sea in the breeding season

| Project | Wind Farm Area | | Wind Farm Area + 2 km buffer | |
|---|---|---|---|---|
| | No of adults | % of SPA population | No of adults | % of SPA population |
| **NnG** | 7 | 0.005 | 15 | 0.01 |
| **Inch Cape** | 16 | 0.01 | 33 | 0.02 |
| **Seagreen A** | 42 | 0.03 | 42 | 0.03 |
| **Seagreen B** | 32 | 0.02 | 32 | 0.02 |
| **Kincardine OWF** [14] | 4 | 0.003 | 4 | 0.003 |
| **Forthwind (2 turbines)** | 2 | 0.001 | 2 | 0.001 |
| **Hywind** [14] | 1 | 0.001 | 1 | 0.001 |
| **Total** | 104 | 0.07 | 129 | 0.08 |

684. For NnG, seven adult guillemots displaced from the NnG Wind Farm Area, or 15 adults from the NnG Wind Farm Area and 2 km buffer in the breeding season would suffer mortality as a result (Table 9-122). This corresponds to between 0.005% and 0.01% of the SPA population within mean maximum foraging range (154,131 birds), for the Wind Farm Area and 2 km buffer.

685. For Inch Cape, 16 adult guillemots displaced from the Wind Farm Area, or 33 adults from the Wind Farm Area and 2 km buffer in the breeding season would suffer mortality as a result (Table 9-122). This corresponds to between 0.01% and 0.02% of the SPA population within mean maximum foraging range (154,131 birds), for the Wind Farm Area and 2 km buffer.

686. For Seagreen A, 42 adult guillemots displaced from the Wind Farm Area in the breeding season would suffer mortality as a result (Table 9-122). This corresponds to 0.03% of the SPA population within

[14] Based on Wind Farm Area & 1 km buffer

mean maximum foraging range (154,131 birds). As no figures were available for a 2 km buffer, the Seagreen A total was repeated for this assessment.

687. For Seagreen B, 32 adult guillemots displaced from the Wind Farm Area in the breeding season would suffer mortality as a result (Table 9-122). This corresponds to 0.02% of the SPA population within mean maximum foraging range (154,131 birds). As no figures were available for a 2 km buffer, the Seagreen B total was repeated for this assessment.

688. For Kincardine OWF, four adult guillemots displaced from the Kincardine wind farm and 1 km buffer in the breeding season would suffer mortality as a result (Table 9-122). This corresponds to 0.003% of the SPA population within mean maximum foraging range (154,131 birds). As this was the only figure available, it was repeated for this assessment.

689. For Forthwind (2 turbines), two adult guillemots displaced from the wind farm in the breeding season would suffer mortality as a result (Table 9-122). This corresponds to 0.001% of the SPA population within mean maximum foraging range (154,131 birds). As this was the only figure available, it was repeated for this assessment.

690. For Hywind, one adult guillemot displaced from the wind farm and 1 km buffer in the breeding season would suffer mortality as a result (Table 9-122). This corresponds to 0.001% of the SPA population within mean maximum foraging range (154,131 birds). As this was the only figure available, it was repeated for this assessment.

691. No additional information was available for displacement estimates for the proposed seven additional Forthwind turbines. However, based on the low number of guillemots recorded on baseline surveys for the adjacent two turbine project (Arcus, 2015), no significant displacement effects on guillemots in the breeding season are considered likely to arise from the seven turbine project.

692. Cumulative displacement mortality of 104 birds in the combined Wind Farm Areas corresponds to 0.07% of the SPA adult breeding population (153,676 birds) (Table 9-8). Cumulative displacement mortality of 129 birds in the combined wind farms and 2 km buffers corresponds to 0.08% of the SPA adult breeding population.

693. For the surviving displaced adult guillemots, there could potentially be a detrimental impact on their breeding success, as a result of having to travel further on each trip to forage elsewhere.

694. In comparison, the CEH Displacement model (Searle *et al.*, 2014) estimated that the change in the annual adult guillemot survival rate for the Forth Islands SPA would be -0.20, based on the homogeneous prey distribution scenario, and -0.30%, based on the heterogeneous prey distribution scenario, while estimated survival rates for Fowlsheugh SPA were -0.04, based on the homogeneous prey distribution scenario, and -0.10%, based on the heterogeneous prey distribution scenario (Table 9-123).

695. The Forth Islands SPA estimate involved adult guillemots from NnG, while the Fowlsheugh estimate involved adult guillemots from Seagreen B. Comparable estimates for the other SPAs or projects within mean maximum foraging range were not presented in the CEH displacement report (Searle *et al.*, 2014).

696. The estimated number of adult guillemots involved was calculated by dividing these survival rates by 100, and then multiplying by the relevant SPA population (Table 9-123). Based on the most recent population counts for the Forth Islands SPA (28,786 birds) and Fowlsheugh SPA (55,507 birds), the estimated change in adult survival rates corresponds to a combined mortality of 80 adult guillemots based on the homogeneous prey distribution scenario, or 142 adult guillemots based on the heterogeneous prey distribution scenario.

Table 9-123: Summary of annual guillemot displacement mortality for the Forth Islands and Fowlsheugh SPAs, from the Forth and Tay projects, as presented in the CEH displacement model (Searle *et al.*, 2014)

| SPA | Change in annual adult survival | | SPA population | Estimated number of adults | |
|---|---|---|---|---|---|
| | Homogeneous [15] | Heterogeneous[15] | | Homogeneous | Heterogeneous |
| **Forth Islands** | -0.20 | -0.30 | 28,786 birds | -58 adults | -86 adults |
| **Fowlsheugh** | -0.04 | 0.10 | 55,507 birds | -22 adults | +56 adults |
| **Total** | - | - | 84,293 birds | -80 adults | -30 adults |

697. A worst-case annual estimated mortality of 80 adult guillemots corresponds to a maximum of 0.09% of the Forth Islands and Fowlsheugh SPA breeding population (84,293 birds), from displacement effects from NnG and Seagreen B and 1 km buffers. This demonstrates that if adult guillemot mortality from displacement was at this level, the impact would not be significant at the population level for these two SPAs.

698. However, this is an annual estimate, based on the homogeneous prey distribution scenario, an assumed 60% displacement rate, as well as several other assumptions including the behaviour of seabirds in response to wind farms (including habituation) and the effects of adult body mass change on subsequent survival, which are detailed in the final report for the displacement model. As previously highlighted, the barrier and displacement rates, which were agreed by the project Steering Committee, are likely to be important parameters in determining the magnitude of the response to the wind farm (Searle *et al.*, 2014).

699. As stated previously, there is evidence to indicate that the proportion of auks displaced is related to spacing distance between turbines. Overall, based on the available evidence from operational wind farms, and the considerable increase in turbine spacing for the Project compared to existing projects, it is concluded that if displacement does occur, it will be at a lower rate than 60%. The estimated mortality from displacement presented in this cumulative assessment is therefore considered to be very precautionary.

700. It is concluded that cumulative displacement mortality impacts arising from the assessed projects will have no effect on the breeding SPA populations of guillemots within mean maximum foraging range in the breeding season. The sensitivity of guillemots to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

*Razorbill*

701. In the breeding season, the mean maximum foraging range of breeding razorbills is 48.5 ± 35.0 km, based on a sample size of four birds (Thaxter et al., 2012). Based on this, three SPAs for breeding razorbills (Forth Islands, Fowlsheugh and St Abb's Head to Fast Castle) are within mean maximum foraging range + 1 SD of the Project. These three SPAs have therefore been used as the SPA reference population for this assessment in the breeding season. Based on SNH figures, the most recent total combined population estimate for these three SPAs is 15,308 birds (Table 9-8).

702. Seasonal peak mean estimated numbers of razorbills for the projects considered in this assessment are presented in Table 9-124. Estimated numbers for NnG were previously presented in Table 9-33. Estimated numbers for Inch Cape and Seagreen A and B are presented in Appendix 9.4. The population of razorbills in the Kincardine OWF area and a 1 km buffer in the breeding season was estimated to be 22 birds (Atkins, 2016). A peak of 61 razorbills were estimated to be in the potential zone of influence for the Forthwind project (2 turbines) (Arcus, 2015). A peak of 40 razorbills were

[15] Figures from Table 3.2, Searle *et al.* (2014)

estimated to be in the Hywind wind farm area and a 1 km buffer in the breeding season (Statoil, 2015).

Table 9-124: Peak mean estimated numbers of razorbills from Forth and Tay Wind Farms, and 2km buffers in the breeding season

| Project | Wind Farm Area | Wind Farm Area + 2 km buffer |
|---|---|---|
| | No of birds | No of birds |
| **NnG** | 613 | 1,248 |
| **Inch Cape** | 2,591 | 4,671 |
| **Seagreen A** | 1,818 | N/A |
| **Seagreen B** | 652 | N/A |
| **Kincardine OWF** [16] | 22 | N/A |
| **Forthwind (2 turbines)** | 61 | N/A |
| **Hywind** [16] | 40 | N/A |

703. Based on advice received in the Scoping Opinion (Marine Scotland, 2017), it was assumed that there will be 60% displacement of razorbills from the Wind Farm Area (and buffer areas) in the breeding season. This assumption was also applied to all projects (Table 9-125).

Table 9-125: Number of displaced razorbills from Forth and Tay Wind Farms, and 2km buffers in the breeding season

| Project | Wind Farm Area | | Wind Farm Area + 2 km buffer | |
|---|---|---|---|---|
| | No of birds | Adults | No of birds | Adults |
| **NnG** | 368 | 208 | 749 | 422 |
| **Inch Cape** | 1,555 | 1,107 | 2,803 | 1,996 |
| **Seagreen A** | 1,091 | 682 | N/A | N/A |
| **Seagreen B** | 391 | 244 | N/A | N/A |
| **Kincardine OWF** [16] | 13 | 13 | N/A | N/A |
| **Forthwind (2 turbines)** | 37 | 37 | N/A | N/A |
| **Hywind** [16] | 24 | 24 | N/A | N/A |

704. However, this estimate includes non-breeding immature birds, as well as breeding adults. During the breeding period, for NnG, 56.5% of razorbills were adults, based on the PVA stable age structure (Table 9-35). For Inch Cape, 71.2% of razorbills were adults in the breeding season, based on the PVA stable age structure used in the 2014 consent (ICOL, 2014). For Seagreen A, of 40 birds aged on surveys between April and July, 62.5% were aged as adult (Seagreen 2012). For Seagreen B, as there was no age breakdown reported (Seagreen 2012), the age breakdown from Seagreen A was applied (62.5%). These percentages were applied to the estimated numbers of displaced razorbills in the breeding season to estimate the maximum number of adults potentially displaced (Table 9-125).

[16] Based on Wind Farm Area & 1 km buffer

705. In the absence of any additional information on age breakdown, all displaced razorbills at Kincardine OWF and 1 km buffer and Forthwind in the breeding season were assumed to be adults (Table 9-125).

706. For NnG, assuming 60% of all adult razorbills were displaced during the breeding season, this would affect an estimated 208 adults in the Wind Farm Area, increasing to 422 adults including the 2 km buffer (Table 9-125).

707. For Inch Cape, this would affect an estimated 1,107 adults in the Wind Farm Area, increasing to 1,996 adults including the 2 km buffer (Table 9-125). For Seagreen, this would affect an estimated 682 adults in Seagreen A and 244 adults in Seagreen B (Table 9-125). No figures were available for a 2 km buffer for the Seagreen projects.

708. For Kincardine OWF, this would affect an assumed 13 adults in the Wind Farm Area and 1 km buffer (Table 9-125). For Forthwind, this would affect an assumed 37 adults in the Wind Farm Area. For Hywind, this would affect an assumed 24 adults in the Wind Farm Area and 1 km buffer.

709. Predicted displacement mortality for razorbills in the breeding season, was summed for all projects, applying a mortality rate of 1% as recommended in the Scoping Opinion (Marine Scotland, 2017), (Table 9-126).

Table 9-126: Estimated adult razorbill mortality from displacement impacts from Forth and Tay Wind Farms on the key breeding SPAs in the UK waters of the North Sea in the breeding season

| Project | Wind Farm Area | | Wind Farm Area + 2 km buffer | |
|---|---|---|---|---|
| | No of adults | % of SPA population | No of adults | % of SPA population |
| NnG | 2 | 0.01 | 4 | 0.03 |
| Inch Cape | 11 | 0.07 | 20 | 0.1 |
| Seagreen A | 7 | 0.05 | 7 | 0.05 |
| Seagreen B | 2 | 0.01 | 2 | 0.01 |
| Kincardine OWF [17] | 0 | 0 | 0 | 0 |
| Forthwind (2 turbines) | 0 | 0 | 0 | 0 |
| Hywind [17] | 0 | 0 | 0 | 0 |
| Total | 22 | 0.1 | 33 | 0.2 |

710. For NnG, two adult razorbills displaced from the NnG Wind Farm Area, or four adults from the NnG Wind Farm Area and 2 km buffer in the breeding season would suffer mortality as a result (Table 9-126). This corresponds to between 0.01% and 0.03% of the SPA population within mean maximum foraging range (15,298 birds), for the Wind Farm Area and 2 km buffer.

711. For Inch Cape, 11 adult razorbills displaced from the Wind Farm Area, or 20 adults from the Wind Farm Area and 2 km buffer in the breeding season would suffer mortality as a result (Table 9-126). This corresponds to between 0.07% and 0.1% of the SPA population within mean maximum foraging range (15,298 birds), for the Wind Farm Area and 2 km buffer.

712. For Seagreen A, seven adult razorbills displaced from the Wind Farm Area in the breeding season would suffer mortality as a result (Table 9-126). This corresponds to 0.05% of the SPA population

[17] Based on Wind Farm Area & 1 km buffer

within mean maximum foraging range (15,298 birds). As no figures were available for a 2 km buffer, the Seagreen A total was repeated for this assessment.

713. For Seagreen B, two adult razorbills displaced from the Wind Farm Area in the breeding season would suffer mortality as a result (Table 9-126). This corresponds to 0.01% of the SPA population within mean maximum foraging range (15,298 birds). As no figures were available for a 2 km buffer, the Seagreen B total was repeated for this assessment.

714. For Kincardine OWF, Forthwind and Hywind, zero razorbills displaced from the wind farm areas in the breeding season would suffer mortality as a result (Table 9-126).

715. No additional information was available for displacement estimates for the proposed seven additional Forthwind turbines. However, based on the low number of razorbills recorded on baseline surveys for the adjacent two turbine project (Arcus, 2015), no significant displacement effects on razorbills in the breeding season are considered likely to arise from the seven turbine project.

716. Cumulative displacement mortality of 22 birds in the combined wind farms corresponds to 0.1% of the SPA adult breeding population (15,308 birds) (Table 9-8). Cumulative displacement mortality of 33 birds in the combined wind farms and 2 km buffers corresponds to 0.2% of the SPA adult breeding population.

717. For the surviving displaced adult razorbills, there could potentially be a detrimental impact on their breeding success, as a result of having to travel further on each trip to forage elsewhere.

718. In comparison, the CEH Displacement model (Searle *et al*., 2014) estimated that the change in the annual adult razorbill survival rate for the Forth Islands SPA from the Forth and Tay projects combined would be -0.82%, based on the homogeneous prey distribution scenario, and -0.24%, based on the heterogeneous prey distribution scenario (Table 9-127). Note that the total figures are larger than the combined sum of the individual projects. This is as presented in Searle *et al.* (2014). The total estimated number ofadults affected was calculated based on the total figure from Searle et al. (2014), rather than by summing the project totals. Comparable results for other SPAs within mean maximum foraging range were not presented in the CEH displacement report (Searle *et al.*, 2014).

719. The estimated number of adult razorbills involved was calculated by dividing these survival rates by 100, and then multiplying by the relevant SPA population (Table 9-127). Based on the most recent population counts for the Forth Islands SPA (5,815 birds), the estimated combined change in adult survival rates corresponds to a mortality of 48 adult razorbills based on the homogeneous prey distribution scenario, or 14 adult razorbills based on the heterogeneous prey distribution scenario.

Table 9-127: Summary of annual razorbill displacement mortality for the Forth Islands SPA from the Forth and Tay projects, as presented in the CEH displacement model (Searle *et al.*, 2014)

| Project | Change in annual adult survival | | SPA population | Estimated number of adults | |
|---|---|---|---|---|---|
| | Homogeneous[18] | Heterogeneous[18] | | Homogeneous | Heterogeneous |
| **NnG** | -0.10 | -0.09 | 5,815 birds | 6 adults | 5 adults |
| **Inch Cape** | -0.09 | -0.11 | 5,815 birds | 5 adults | 6 adults |
| **Seagreen A** | -0.05 | -0.05 | 5,815 birds | 3 adults | 3 adults |
| **Seagreen B** | -0.09 | -0.01 | 5,815 birds | 5 adults | 1 adult |
| **Total** | -0.82 | -0.24 | 5,815 birds | 48 adults | 14 adults |

[18] Figures from Table 3.2, Searle *et al.* (2014)

720. A worst-case annual estimated mortality of 48 adult razorbills corresponds to a maximum of 0.8% of the Forth Islands SPA breeding population (5,815 birds), from displacement effects from the Forth and Tay projects and 1 km buffers. This demonstrates that if cumulative adult razorbill mortality from displacement was at this level, the impact would not be significant at the population level for this SPA.

721. However, this is an annual estimate, based on the homogeneous prey distribution scenario, which is considered highly unrealistic, an assumed 60% displacement rate, as well as several other assumptions including the behaviour of seabirds in response to wind farms (including habituation) and the effects of adult body mass change on subsequent survival, which are detailed in the final report for the displacement model. As previously highlighted, the barrier and displacement rates, which were agreed by the project Steering Committee, are likely to be important parameters in determining the magnitude of the response to the wind farm (Searle *et al.*, 2014).

722. As stated previously, there is evidence to indicate that the proportion of auks displaced is related to spacing distance between turbines. Overall, based on the available evidence from operational wind farms, and the considerable increase in turbine spacing for the Project compared to existing projects, it is concluded that if displacement does occur, it will be at a lower rate than 60%. The estimated mortality from displacement presented in this cumulative assessment is therefore considered to be very precautionary.

723. It is concluded that cumulative displacement mortality impacts arising from the assessed projects will have no effect on the breeding SPA populations of razorbills within mean maximum foraging range in the breeding season. The sensitivity of razorbills to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

*Puffin*

724. In the breeding season, the mean maximum foraging range of breeding puffins is 105.4 ± 46.0 km, based on a sample size of eight birds (Thaxter et al., 2012). Based on this, one SPA for breeding puffins (Forth Islands), is within mean maximum foraging range + 1 SD of the Project. This SPA has therefore been used as the SPA reference population for this assessment in the breeding season. Based on SNH figures, the most recent population estimate for this SPA is 45,005 pairs (Table 9-8).

725. Seasonal peak mean estimated numbers of puffins for the projects considered in this assessment are presented in Table 9-128. Estimated numbers for NnG were previously presented in Table 9-42. Estimated numbers for Inch Cape and Seagreen A and B are presented in Appendix 9.4. The population of puffins in the Kincardine OWF area and a 1 km buffer in the breeding season was estimated to be 19 birds (Atkins, 2016). A peak of 122 puffins were estimated to be in the potential zone of influence for the Forthwind project (2 turbines) (Arcus, 2015). The population of puffins in the Hywind wind farm area and a 1 km buffer in the breeding season was estimated to be 138 birds (Hywind, 2015).

Table 9-128: Peak mean estimated numbers of puffins at Forth and Tay Wind Farms, and 2km buffers in the breeding season

| Project | Wind Farm Area | Wind Farm Area + 2 km buffer |
|---|---|---|
| | No of birds | No of birds |
| NnG | 2,682 | 6,173 |
| Inch Cape | 3,101 | 5,678 |
| Seagreen A | 2,433 | N/A |
| Seagreen B | 3,505 | N/A |
| Kincardine OWF [19] | 19 | N/A |
| Forthwind (2 turbines) | 122 | N/A |
| Hywind [19] | 138 | N/A |

726. Based on advice received in the Scoping Opinion (Marine Scotland, 2017), it was assumed that there will be 60% displacement of puffins from the Wind Farm Area (and buffer areas) in the breeding season. This assumption was also applied to all projects (Table 9-129).

Table 9-129: Number of displaced puffins at Forth and Tay Wind Farms, and 2km buffers in the breeding season

| Project | Wind Farm Area | | Wind Farm Area + 2 km buffer | |
|---|---|---|---|---|
| | No of birds | Adults | No of birds | Adults |
| NnG | 1,609 | 814 | 3,704 | 1,874 |
| Inch Cape | 1,861 | 1,260 | 3,407 | 2,307 |
| Seagreen A | 1,460 | 1,050 | N/A | N/A |
| Seagreen B | 2,103 | 1,340 | N/A | N/A |
| Kincardine OWF[20] | 11 | 11 | N/A | N/A |
| Forthwind (2 turbines) | 73 | 73 | N/A | N/A |
| Hywind [20] | 83 | 83 | N/A | N/A |

727. However, this estimate includes non-breeding immature birds, as well as breeding adults. During the breeding period, for NnG, 50.6% of puffins were adults, based on the PVA stable age structure (Table 9-44). For Inch Cape, 67.7% of puffins were adults in the breeding season, based on the PVA stable age structure used in the 2014 consent (ICOL, 2014). For Seagreen A, of 114 birds aged on surveys between April and August, 71.9% were aged as adult (Seagreen 2012). For Seagreen B, of 114 birds aged on surveys between April and August, 63.7% were aged as adult (Seagreen 2012). These percentages were applied to the estimated numbers of displaced puffins in the breeding season to estimate the maximum number of adults potentially displaced (Table 9-129).

[19] Based on Wind Farm Area & 1 km buffer

[20] Based on Wind Farm Area & 1 km buffer

728. In the absence of any additional information on age breakdown, all displaced puffins at Kincardine OWF and 1 km buffer, and Forthwind in the breeding season were assumed to be adults (Table 9-129).

729. For NnG, assuming 60% of all adult puffins were displaced during the breeding season, this would affect an estimated 814 adults in the Wind Farm Area, increasing to 1,874 adults including the 2 km buffer (Table 9-129).

730. For Inch Cape, this would affect an estimated 1,260 adults in the Wind Farm Area, increasing to 2,307 adults including the 2 km buffer (Table 9-129).

731. For Seagreen, this would affect an estimated 1,050 adults in Seagreen A and 1,340 adults in Seagreen B (Table 9-129). No figures were available for a 2 km buffer for the Seagreen projects.

732. For Kincardine OWF, this would affect an assumed 11 adults in the Wind Farm Area and 1 km buffer (Table 9-129). For Forthwind (2 turbines), this would affect an assumed 73 adults in the Wind Farm Area. For Hywind, this would affect an assumed 83 adults in the Wind Farm Area and 1 km buffer.

733. Predicted displacement mortality for puffins in the breeding season, was summed for all projects, applying a mortality rate of 2% as recommended in the Scoping Opinion (Marine Scotland, 2017), (Table 9-130).

Table 9-130: Estimated adult puffin mortality from displacement impacts from Forth and Tay Wind Farms on the key breeding SPAs in the UK waters of the North Sea in the breeding season

| Project | Wind Farm Area | | Wind Farm Area + 2 km buffer | |
|---|---|---|---|---|
| | No of adults | % of SPA population | No of adults | % of SPA population |
| **NnG** | 16 | 0.02 | 37 | 0.04 |
| **Inch Cape** | 25 | 0.03 | 46 | 0.05 |
| **Seagreen A** | 21 | 0.02 | 21 | 0.02 |
| **Seagreen B** | 27 | 0.03 | 27 | 0.03 |
| **Kincardine OWF** [21] | 0 | 0 | 0 | 0 |
| **Forthwind (2 turbines)** | 1 | 0.001 | 1 | 0.001 |
| **Hywind** [21] | 2 | 0.002 | 2 | 0.002 |
| **Total** | 92 | 0.1 | 134 | 0.1 |

734. For NnG, 16 adult puffins displaced from the NnG Wind Farm Area, or 37 adults from the NnG Wind Farm Area and 2 km buffer in the breeding season would suffer mortality as a result (Table 9-130). This corresponds to between 0.02% and 0.04% of the SPA population within mean maximum foraging range (45,005 pairs), for the Wind Farm Area and 2 km buffer.

735. For Inch Cape, 25 adult puffins displaced from the Wind Farm Area, or 46 adults from the Wind Farm Area and 2 km buffer in the breeding season would suffer mortality as a result (Table 9-130). This corresponds to between 0.03% and 0.05% of the SPA population within mean maximum foraging range (45,005 pairs), for the Wind Farm Area and 2 km buffer.

736. For Seagreen A, 21 adult puffins displaced from the Wind Farm Area in the breeding season would suffer mortality as a result (Table 9-130). This corresponds to 0.02% of the SPA population within

[21] Based on Wind Farm Area & 1 km buffer

mean maximum foraging range (45,005 pairs). As no figures were available for a 2 km buffer, the Seagreen A total was repeated for this assessment.

737. For Seagreen B, 27 adult puffins displaced from the Wind Farm Area in the breeding season would suffer mortality as a result (Table 9-130). This corresponds to 0.03% of the SPA population within mean maximum foraging range (45,005 pairs). As no figures were available for a 2 km buffer, the Seagreen B total was repeated for this assessment.

738. For Kincardine OWF, zero puffins displaced from the Kincardine wind farm and 1 km buffer in the breeding season would suffer mortality as a result (Table 9-130).

739. For Forthwind (2 turbines), one adult puffin displaced from the Wind Farm Area in the breeding season would suffer mortality as a result (Table 9-130). This corresponds to 0.001% of the SPA population within mean maximum foraging range (45,005 pairs).

740. For Hywind, two adult puffins displaced from the wind farm and 1 km buffer in the breeding season would suffer mortality as a result (Table 9-130). This corresponds to 0.002% of the SPA population within mean maximum foraging range (45,005 pairs).

741. No additional information was available for displacement estimates for the proposed seven additional Forthwind turbines. However, based on the low number of puffins recorded on baseline surveys for the adjacent two turbine project (Arcus, 2015), no significant displacement effects on puffins in the breeding season are considered likely to arise from the seven turbine project. No additional information was available for displacement estimates for the current proposed seven additional Forthwind turbines. No significant displacement effects on puffins in the breeding season were considered likely to arise from these two projects.

742. Cumulative displacement mortality of 92 birds in the combined wind farms corresponds to 0.1% of the SPA adult breeding population (45,005 pairs) (Table 9-8). Cumulative displacement mortality of 134 birds in the combined wind farms and 2 km buffers also corresponds to 0.1% of the SPA adult breeding population.

743. For the surviving displaced adult puffins, there could potentially be a detrimental impact on their breeding success, as a result of having to travel further on each trip to forage elsewhere.

744. In comparison, the CEH Displacement model (Searle *et al.*, 2014) estimated that the change in the annual adult puffin survival rate for the Forth Islands SPA for the Forth and Tay projects combined would be -3.32%, based on the homogeneous prey distribution scenario, and +0.04%, based on the heterogeneous prey distribution scenario (Table 9-131). Note that the total figures are larger than the combined sum of the individual projects. This is as presented in Searle *et al.* (2014). The total estimated number ofadults affected was calculated based on the total figure from Searle *et al.* (2014), rather than by summing the project totals.

745. The estimated number of adult puffins involved was calculated by dividing these survival rates by 100, and then multiplying by the Forth Islands SPA population (Table 9-131). Based on the most recent population counts for the Forth Islands SPA (45,005 pairs, or 90,010 birds), the estimated combined change in adult survival rates corresponds to a mortality of 3,181 adult puffins based on the homogeneous prey distribution scenario, or an increase of 38 adult puffins based on the heterogeneous prey distribution scenario.

Table 9-131: Summary of annual puffin displacement mortality for the Forth Islands SPA from the Forth and Tay projects, as presented in the CEH displacement model (Searle *et al.*, 2014)

| Project | Change in annual adult survival | | SPA population | Estimated number of adults | |
|---|---|---|---|---|---|
| | Homogeneous[22] | Heterogeneous[22] | | Homogeneous | Heterogeneous |
| **NnG** | -0.46 | -0.64 | 45,005 pairs | -414 adults | -576 adults |
| **Inch Cape** | -1.44 | -0.13 | 45,005 pairs | -1,296 adults | -117 adults |
| **Seagreen A** | -1.15 | +0.31 | 45,005 pairs | -1,035 adults | +279 adults |
| **Seagreen B** | -0.17 | +0.36 | 45,005 pairs | -153 adults | +324 adults |
| **Total** | -3.32 | +0.04 | 45,005 pairs | -2,988 adults | +36 adults |

746. A worst-case annual estimated mortality of 2,988 adult puffins corresponds to a maximum of 3.3% of the Forth Islands SPA breeding population (45,005 pairs), from displacement effects from the Forth and Tay projects and 1 km buffers. This demonstrates that if cumulative adult puffin mortality from displacement was at this level, the impact would be moderately significant at the population level for this SPA, based on the sensitivity and magnitude criteria used in this assessment (Section 9.5.1).

747. However, this is an annual estimate, based on the homogeneous prey distribution scenario, which is considered highly unrealistic, an assumed 60% displacement rate, as well as several other assumptions including the behaviour of seabirds in response to wind farms (including habituation) and the effects of adult body mass change on subsequent survival, which are detailed in the final report for the displacement model (Searle *et al.*, 2014).

748. As previously highlighted, Searle *et al.*, (2014) discuss the implications of the assumptions made regarding homogeneous and heterogeneous prey distribution. The report states that both methods rely on assumptions that are unlikely to be realistic in practice, and that considerable caution is needed in cases where bird distributions were inferred from GPS data for small numbers of birds, as was the case with puffin. The modelling for puffins was based on a sample size of seven tagged puffins in 2012, however, it was found that the tagged birds behaved differently from a set of 'control' birds that were not tagged (Harris *et al*., 2012). As a result, displacement model outputs for puffin were considered unreliable by the SNCBs and MSS (Marine Scotland, 2014a).

749. However, as stated previously, there is evidence to indicate that the proportion of auks displaced is related to spacing distance between turbines. Overall, based on the available evidence from operational wind farms, and the considerable increase in turbine spacing for the Project compared to existing projects, it is concluded that if displacement does occur, it will be at a lower rate than 60%. The estimated mortality from displacement presented in this cumulative assessment is therefore considered to be very precautionary.

750. It is concluded that cumulative displacement mortality impacts arising from the assessed projects will have no effect on the breeding SPA populations of puffins within mean maximum foraging range in the breeding season. The sensitivity of puffins to displacement is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

*Non-breeding season*

751. As recommended in the Scoping Opinion, for guillemot and razorbill, the CIA has incorporated non-breeding season displacement effects from the Forth and Tay wind farms (Inch Cape and Seagreen), apportioning effects as to SPA and non-SPA colonies in the same manner as for the breeding season.

[22] Figures from Table 3.2, Searle *et al.* (2014)

752. The following projects were considered in the assessment of cumulative displacement impacts for these two species, based on recommendations in the Scoping Opinion (Marine Scotland, 2017) (Table 9-132). As the displacement effects and site boundaries are the same for both the 2014 and 2017 Inch Cape and Seagreen projects, only the 2014 consented projects are presented in this section.

Table 9-132: Projects considered for cumulative assessment of displacement impacts in the non-breeding season

| Project | Status | Information available |
|---|---|---|
| **Inch Cape Offshore Wind Farm** | Consented (2014) | Published project information available in the public domain. |
| **Seagreen A Offshore Wind Farm** | Consented (2014) | Published project information available in the public domain. |
| **Seagreen B Offshore Wind Farm** | Consented (2014) | Published project information available in the public domain. |

753. As for the breeding season, the cumulative assessment of displacement and barrier effects in the non-breeding season followed the recent SNCB guidance (2017).

754. For Inch Cape, numbers of displaced birds in the non-breeding season were based on seasonal mean peak estimated numbers for the Inch Cape Wind Farm Area and a 2 km buffer, using the season definitions from the Scoping Opinion (Marine Scotland, 2017). This information was circulated by Inch Cape by email on 23/11/2017 and is presented in Appendix 9.4.

755. For Seagreen A & B, numbers of displaced birds in the non-breeding season were based on seasonal mean peak estimated numbers for the Seagreen A & B projects, using the season definitions from the Scoping Opinion (Marine Scotland, 2017). This information was circulated by Seagreen by email on 8/12/2017 and is presented in Appendix 9.4.

756. Displacement and mortality matrices for each species and wind farm project are presented in Appendix 9.4.

*Guillemot*

757. The non-breeding season for guillemot was defined in the Scoping Opinion as mid-August to March (Marine Scotland, 2017), and in the BDMPS review as August to February (Furness 2015). Although there are slight differences in these definitions, it was considered these would not make a significant difference to the assessment, and so the Scoping Opinion definitions were followed.

758. Four SPAs for breeding guillemots (Buchan Ness to Collieston Coast, Forth Islands, Fowlsheugh and St Abb's Head to Fast Castle) were used as the SPA reference population for this assessment in the non-breeding season, as recommended in the Scoping Opinion (Marine Scotland, 2017). Based on SNH figures, the most recent total combined population estimate for these four SPAs is 154,131 birds (Table 9-8).

759. Seasonal peak mean estimated numbers of guillemots for the projects considered in this assessment are presented in Table 9-133. Estimated numbers for NnG were previously presented in Table 9-23. Estimated numbers for Inch Cape and Seagreen A and B are presented in Appendix 9.4.

Table 9-133: Peak mean estimated numbers of guillemots at NnG, Inch Cape and Seagreen A & B, and 2km buffers in the non-breeding season

| Project | Wind Farm Area | Wind Farm Area + 2 km buffer |
|---|---|---|
| | No of birds | No of birds |
| **NnG** | 3,890 | 7,618 |
| **Inch Cape** | 2,009 | 3,912 |
| **Seagreen A** | 4,027 | N/A |
| **Seagreen B** | 4,450 | N/A |

760. Based on advice received in the Scoping Opinion (Marine Scotland, 2017), it was assumed that there will be 60% displacement of guillemots from the Wind Farm Area (and buffer areas) in the non-breeding season. This assumption was also applied to all projects (Table 9-134).

Table 9-134: Number of displaced guillemots at Forth and Tay Wind Farms and 2km buffers in the non-breeding season

| Project | Wind Farm Area | Wind Farm Area + 2 km buffer |
|---|---|---|
| | No of birds | No of birds |
| **NnG** | 2,334 | 4,571 |
| **Inch Cape** | 1,205 | 2,347 |
| **Seagreen A** | 2,416 | N/A |
| **Seagreen B** | 2,670 | N/A |

761. For NnG, assuming 60% of all guillemots were displaced from the Wind Farm Area during the non-breeding season (mid-August to March), this would affect an estimated 2,334 birds (1,281 adults and 1,053 immatures) (Table 9-134) and 4,571 birds (2,509 adults and 2,062 immature birds) including the 2 km buffer. The above age breakdown of 54.8% adult birds in the non-breeding season was based on the PVA stable age structure (Table 9-25).

762. For Inch Cape, this would affect an estimated 1,205 birds, increasing to 2,347 birds including the 2 km buffer (Table 9-134).

763. For Seagreen A, this would affect an estimated 2,416 birds, and 2,670 birds for Seagreen B (Table 9-134). No figures were available for a 2 km buffer for Seagreen A or B.

764. Predicted displacement mortality for guillemots in the non-breeding season, was summed for all projects, applying a mortality rate of 1% as recommended in the Scoping Opinion (Marine Scotland, 2017), (Table 9-135).

Table 9-135: Estimated guillemot mortality from displacement impacts from Forth and Tay Wind Farms on the key breeding SPAs in the UK waters of the North Sea in the non-breeding season

| Project | Wind Farm Area | | Wind Farm Area + 2 km buffer | |
|---|---|---|---|---|
| | No of birds | % of SPA population | No of birds | % of SPA population |
| **NnG** | 23 | 0.01 | 46 | 0.03 |
| **Inch Cape** | 12 | 0.01 | 23 | 0.01 |
| **Seagreen A** | 24 | 0.02 | 24 | 0.02 |
| **Seagreen B** | 27 | 0.02 | 27 | 0.02 |
| **Total** | 86 | 0.06 | 120 | 0.08 |

765. For NnG, 23 guillemots (adults and immatures) displaced from the NnG Wind Farm Area, or 46 birds from the NnG Wind Farm Area and 2 km buffer in the non-breeding season would suffer mortality as a result (Table 9-135). This corresponds to between 0.01% and 0.03% of the SPA population within mean maximum foraging range (154,131 birds), for the Wind Farm Area and 2 km buffer.

766. For Inch Cape, 12 guillemots displaced from the Wind Farm Area, or 23 adults from the Wind Farm Area and 2 km buffer in the non-breeding season would suffer mortality as a result (Table 9-135). This corresponds to 0.01% of the SPA population within mean maximum foraging range (154,131 birds), for the Wind Farm Area and 2 km buffer.

767. For Seagreen A, 24 guillemots displaced from the Wind Farm Area in the non-breeding season would suffer mortality as a result (Table 9-135). This corresponds to 0.02% of the SPA population within mean maximum foraging range (154,131 birds). As no figures were available for a 2 km buffer, the Seagreen A total was repeated for this assessment.

768. For Seagreen B, 27 guillemots displaced from the Wind Farm Area in the non-breeding season would suffer mortality as a result (Table 9-135). This corresponds to 0.02% of the SPA population within mean maximum foraging range (154,131 birds). As no figures were available for a 2 km buffer, the Seagreen B total was repeated for this assessment.

769. For the surviving displaced guillemots, there would be minimal impact from displacement, as foraging birds are not tied to a breeding colony at this time of year and so would be able to find food outside of the Wind Farm Areas. The assumption of 1% mortality from displacement effects in the non-breeding season is considered an over-estimate, as outside of the breeding season guillemots are no longer limited in their foraging range by having to return to the colony. As birds are free to forage over a wider area, any displacement effects are considerably less likely to have any mortality impact. In addition, this assessment is also precautionary in assuming that birds from other colonies outside of these four SPAs do not occur in the Wind Farm Area during the non-breeding period.

770. In addition, it should be noted that as highlighted in the Scoping Opinion (Marine Scotland, 2017), using the reference population for the SPA breeding population to assess non-breeding season impacts is likely to be extremely precautionary.

771. It is concluded that cumulative displacement mortality impacts arising from the assessed projects will have no effect on the breeding SPA populations of guillemots within mean maximum foraging range in the non-breeding season. The sensitivity of guillemots to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

*Razorbill*

772. The non-breeding season was defined in the Scoping Opinion as mid-August to March (Table 9-7) (Marine Scotland. However, there are three seasons presented in the BDMPS review for the “non-breeding season”, defined as follows: Autumn (August to October), Winter (November and December) and Spring (January to March) (Furness 2015). As the population estimates given in the BDMPS report are the same for the Autumn and Spring periods, these populations have been used as SPA reference populations, and the non-breeding season was taken as mid-August to March, as defined in the Scoping Opinion.

773. Three SPAs for breeding razorbills (Forth Islands, Fowlsheugh and St Abb’s Head to Fast Castle) were used as the SPA reference population for this assessment in the non-breeding season. Based on SNH figures, the most recent total combined population estimate for these three SPAs is 15,298 birds (Table 9-8).

774. Seasonal peak mean estimated numbers of razorbills for the projects considered in this assessment are presented in Table 9-136. Estimated numbers for NnG were previously presented in Table 9-33. Estimated numbers for Inch Cape and Seagreen A and B are presented in Appendix 9.4.

Table 9-136: Peak mean estimated numbers of razorbills at Forth and Tay Wind Farms, and 2km buffers in the non-breeding season

| Project | Wind Farm Area | Wind Farm Area + 2 km buffer |
|---|---|---|
| | No of birds | No of birds |
| NnG | 1,404 | 3,101 |
| Inch Cape | 2,154 | 4,905 |
| Seagreen A | 823 | N/A |
| Seagreen B | 1,131 | N/A |

775. Based on advice received in the Scoping Opinion (Marine Scotland, 2017), it was assumed that there will be 60% displacement of razorbills from the Wind Farm Area (and buffer areas) in the non-breeding season. This assumption was also applied to all projects (Table 9-137).

Table 9-137: Number of displaced razorbills from Forth and Tay Wind Farms, and 2km buffers in the non-breeding season

| Project | Wind Farm Area | Wind Farm Area + 2 km buffer |
|---|---|---|
| | No of birds | No of birds |
| NnG | 842 | 1,861 |
| Inch Cape | 1,292 | 2,943 |
| Seagreen A | 494 | N/A |
| Seagreen B | 679 | N/A |

776. For NnG, assuming 60% of all razorbills were displaced from the Wind Farm Area during the non-breeding season (mid-August to March), this would affect an estimated 842 birds (511 adults and 331 immatures) (Table 9-137) and 1,861 birds including the 2 km buffer (1,130 adults and 731 immatures). The above age breakdown of 60.8% adult birds in the non-breeding season was based on the PVA stable age structure (Table 9-35).

777. For Inch Cape, this would affect an estimated 1,292 birds, increasing to 2,943 birds including the 2 km buffer (Table 9-137). For Seagreen A, this would affect an estimated 494 birds, and for Seagreen B this would affect 679 birds (Table 9-137). No figures were available for a 2 km buffer for Seagreen A or B.

778. Predicted displacement mortality for razorbills in the non-breeding season, was summed for all projects, applying a mortality rate of 1% as recommended in the Scoping Opinion (Marine Scotland, 2017), (Table 9-138).

Table 9-138: Estimated razorbill mortality from displacement impacts from Forth and Tay Wind Farms on the key breeding SPAs in the UK waters of the North Sea in the non-breeding season

| Project | Wind Farm Area | | Wind Farm Area + 2 km buffer | |
|---|---|---|---|---|
| | No of birds | % of SPA population | No of birds | % of SPA population |
| NnG | 8 | 0.05 | 19 | 0.1 |
| Inch Cape | 13 | 0.08 | 29 | 0.2 |
| Seagreen A | 5 | 0.03 | 5 | 0.03 |
| Seagreen B | 7 | 0.05 | 7 | 0.05 |
| Total | 33 | 0.2 | 60 | 0.4 |

779. For NnG, eight razorbills (adults and immatures) displaced from the NnG Wind Farm Area, or 19 birds from the NnG Wind Farm Area and 2 km buffer in the non-breeding season would suffer mortality as a result (Table 9-138). This corresponds to between 0.05% and 0.1% of the SPA population within mean maximum foraging range (15,298 birds), for the Wind Farm Area and 2 km buffer.

780. For Inch Cape, 13 razorbills displaced from the Wind Farm Area, or 29 adults from the Wind Farm Area and 2 km buffer in the non-breeding season would suffer mortality as a result (Table 9-138). This corresponds to between 0.08% and 0.2% of the SPA population within mean maximum foraging range (15,298 birds), for the Wind Farm Area and 2 km buffer.

781. For Seagreen A, five razorbills displaced from the Wind Farm Area in the non-breeding season would suffer mortality as a result (Table 9-138). This corresponds to 0.03% of the SPA population within mean maximum foraging range (15,298 birds). As no figures were available for a 2 km buffer, the Seagreen A total was repeated for this assessment.

782. For Seagreen B, seven razorbills displaced from the Wind Farm Area in the non-breeding season would suffer mortality as a result (Table 9-138). This corresponds to 0.05% of the SPA population within mean maximum foraging range (15,298 birds). As no figures were available for a 2 km buffer, the Seagreen B total was repeated for this assessment.

783. For the surviving displaced razorbills, there would be minimal impact from displacement, as foraging birds are not tied to a breeding colony at this time of year and so would be able to find food outside of the wind farms. The assumption of 1% mortality from displacement effects in the non-breeding season is considered an over-estimate, as outside of the breeding season razorbills are no longer limited in their foraging range by having to return to the colony. As birds are free to forage over a wider area, any displacement effects are considerably less likely to have any mortality impact. In addition, this assessment is also precautionary in assuming that birds from other colonies outside of these four SPAs do not occur in the Wind Farm Area during the non-breeding period.

784. In addition, it should be noted that as highlighted in the Scoping Opinion (Marine Scotland, 2017), using the reference population for the SPA breeding population to assess non-breeding season impacts is likely to be extremely precautionary.

785. It is concluded that cumulative displacement mortality impacts arising from the assessed projects will have no effect on the breeding SPA populations of razorbills within mean maximum foraging range in the non-breeding season. The sensitivity of razorbills to displacement is assessed as medium and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **negligible** and not significant in EIA terms.

### *9.9.4.2.2 Cumulative collision risk modelling*

786. The Scoping Opinion (Marine Scotland 2017) stated that for gannet and kittiwake, the CIA should estimate non-breeding season collision effects from the Forth and Tay wind farms (Inch Cape and Seagreen) in isolation and cumulatively with other relevant UK wind farms. The cumulative collision assessment for the Forth and Tay Wind Farms is presented below.

787. As outlined previously, there were two scenarios considered for the cumulative collision risk modelling. Scenario One incorporates the design envelopes for the proposed Inch Cape and Seagreen projects as detailed in the Scoping Reports submitted to MS-LOT (ICOL, 2017; Seagreen, 2017). Scenario Two incorporates the consented design envelopes as detailed in the respective project consents.

788. For the Project, the cumulative CRM assessment estimated the number of potential collisions per season for NnG based on 54 turbines (worst-case design scenario). The minimum height for the turbine blades above the sea surface is 32.0 m at mean sea level (MSL) (35 m LAT).

789. For Scenario One, turbine parameters were provided by Inch Cape and Seagreen for their 2017 design scenarios.

790. For Inch Cape, the cumulative CRM assessment was based on using 40 turbines with a rotor diameter of 250m and a minimum rotor height of 27.6m, rather than the design option of 70 turbines with a rotor diameter of 167m, and a minimum rotor height of 32.6m. This was because the 40 turbine option resulted in higher collisions for both gannet and kittiwake.

791. For Seagreen Phase 1, at the time of the cumulative CRM assessment, limited turbine information was available for the new design. The assessment used 120 turbines (the maximum in the Seagreen Scoping Report), a rotor diameter of 167m (based on the NnG worst case) and a minimum rotor height of 27.5m MSL. Full details of the turbine parameters and bird parameters used in the CRM assessment are provided in Appendix 9.3.

792. For Scenario 2, which was based on the 2014 consented projects, CRM figures for Inch Cape and Seagreen were circulated by Marine Scotland in an email dated 11th October 2017. Inch Cape subsequently circulated a revised CRM spreadsheet for the 2014 turbine parameters, based on the seasonal breakdown and avoidance rates advised in the Scoping Opinion (Marine Scotland, 2017), which was used in this assessment. This spreadsheet is included in Appendix 9.3.

793. Two species (gannet and kittiwake) were considered for the cumulative collision risk modelling, on the basis of collision risk modelling for the Project alone. Based on the low estimated collision numbers of herring gull, lesser black-backed gull and great black-backed gull for the Project alone, it was concluded that there would be no significant cumulative collison risk for these three species.

*Gannet – breeding season*

794. For the purposes of this assessment, all gannets in the breeding season were assumed to be from the Forth Islands SPA, as recommended in the Scoping Opinion (Marine Scotland, 2017). This SPA has therefore been used as the SPA reference population for this assessment in the breeding season (75,259 pairs).

795. Predicted cumulative gannet mortality in the breeding season (mid-March to September) for the Project and additional collisions based on 2017 proposed turbine figures for Inch Cape, Seagreen

Phase 1 (Scenario One) is shown in Table 9-139. This is based on the Project worst case scenario (54 turbines), Band Model Option 2 and an avoidance rate of 98.9%.

Table 9-139: Estimated cumulative number of gannet collisions in the breeding season for Scenario One: NnG (2017 design) and proposed Forth and Tay Wind Farms (2017 design), based on Band Model Option 2 and an avoidance rate of 98.9%

| | Band Option 2 all birds | % of SPA population | Band Option 2 adults | % of SPA population |
|---|---|---|---|---|
| **NnG (2017)** | 93 ± 16.9 | 0.06 | 91 | 0.06 |
| **Inch Cape (2017)** | 115 ± 20.9 | 0.08 | 112 | 0.07 |
| **Seagreen Phase 1 (2017)** | 326 ± 59.4 | 0.2 | 317 | 0.2 |
| **Total** | 534 ± 97.2 | 0.3 | 520 | 0.3 |

796. Based on Scenario One, there will be an estimated 534 gannet collisions (adults and immatures) each breeding season, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.3% of the breeding population (75,259 pairs) of the key SPA (Forth Islands) (Table 9-8).

797. However, this estimate includes non-breeding immature birds, as well as breeding adults. During the breeding period, for NnG, 97.5% of aged gannets were adults (Appendix 9.2: Table 3) Based on this, 91 collisions at NnG involved adult birds in the breeding season (Table 9-139). For Inch Cape, 97.1% of aged gannets were adults in the breeding season (Appendix 9.4). Based on this, 112 collisions at Inch Cape involved adult birds in the breeding season. Based on the original application for Seagreen A, the proportion of adults from aged birds in the breeding season was 96.7%, while for Seagreen B, the proportion of adults in the breeding season was 97.8% (Seagreen 2012). This gives an average ratio of 97.3% for both Seagreen projects, which gives a total of 317 adult collisions in the breeding season.

798. Considering only adult gannets, there will be an estimated 520 collisions each breeding season, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.3% of the breeding population (75,259 pairs) of the key SPA (Forth Islands) (Table 9-8).

799. However, as highlighted in the NnG collision assessment (Section 9.9.2.3), Appendix 9.7 presents maps of breeding adult gannets tracked from the Bass Rock in the breeding season in 2010, 2011, 2012 and 2015. This gannet data was made available by Keith Hamer of the University of Leeds. The maps demonstrate that adult birds travel a considerable distance from the Bass Rock colony, and that the Forth and Tay projects are not a key foraging area for gannets in the breeding season.

800. In addition, the consistent reports of high avoidance of gannets from offshore wind farms in a variety of different study situations in European marine areas indicates that it is likely that this is how breeding birds from the Bass Rock colony will respond to the Forth and Tay projects. Correspondingly, the estimated cumulative number of gannet collisions presented here is therefore considered an over-estimate.

801. Predicted cumulative gannet mortality in the breeding season (mid-March to September) for the Project and additional collisions based on 2014 consented figures (Scenario Two) is shown in Table 9-140. This is based on the Project worst case scenario (54 turbines), Band Model Option 2 and an avoidance rate of 98.9%.

Table 9-140: Estimated cumulative number of gannet collisions in the breeding season for Scenario Two: NnG (2017 design) and previously consented Forth and Tay Wind Farms (2014 design), based on Band Model Option 2 and an avoidance rate of 98.9%

| | Band Option 2 all birds | % of SPA population | Band Option 2 adults | % of SPA population |
|---|---|---|---|---|
| **NnG (2017)** | 93 ± 16.9 | 0.06 | 91 | 0.06 |
| **Inch Cape (2014)** | 384 | 0.3 | 375 | 0.25 |
| **Seagreen A (2014)** | 423 | 0.3 | 409 | 0.27 |
| **Seagreen B (2014)** | 266 | 0.2 | 260 | 0.17 |
| **Total** | 1,166 | 0.9 | 1,135 | 0.75 |

802. Based on Scenario Two, there will be an estimated 1,166 gannet collisions (adults and immatures) each breeding season, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.9% of the breeding population (adults) of the key SPA (Forth Islands) (75,259 pairs) (Table 9-8).

803. However, this estimate includes non-breeding immature birds, as well as breeding adults. During the breeding period, for NnG, 97.5% of aged gannets were adults (Appendix 9.2: Table 3) Based on this, 91 collisions at NnG involved adult birds in the breeding season (Table 9-140). For Inch Cape, 97.7% of aged gannets were adults in the breeding season (Appendix 9.4). Based on this, 375 collisions at Inch Cape involved adult birds in the breeding season. For Seagreen A, the proportion of adults from aged birds in the breeding season was 96.7% (Seagreen 2012), which gives a total of 409 adults in the breeding season. For Seagreen B, the proportion of adults in the breeding season was 97.8% (Seagreen 2012), which gives a total of 260 adult collisions in the breeding season.

804. Considering only adult gannets, there will be an estimated 1,135 collisions each breeding season, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.75% of the breeding population (75,259 pairs) of the key SPA (Forth Islands) (Table 9-8).

805. Based on either Scenario One or Two, it is concluded that cumulative collision mortality impacts at NnG, Inch Cape and Seagreen A & B will have no effect on the breeding SPA population of gannets within mean maximum foraging range in the breeding season. The sensitivity of gannets to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

*Gannet – non-breeding season*

806. The non-breeding season for gannet was defined in the Scoping Opinion as Autumn – October to November; and Spring – December to mid-March (Table 9-7) (Marine Scotland, 2017). In the BDMPS review, the non-breeding season is defined as Autumn migration (September to November), and Spring migration (December to March) (Furness 2015). Although there are slight differences in these definitions, it was considered these would not make a significant difference to the assessment, and so the Scoping Opinion definitions were followed.

807. For the purposes of this assessment, all gannets in the non-breeding season were assumed to be from the Forth Islands SPA, as recommended in the Scoping Opinion (Marine Scotland, 2017). This SPA has therefore been used as the SPA reference population for this assessment in the non-breeding season (75,259 pairs).

808. Predicted cumulative gannet mortality in the autumn (September to November) and spring (December to March) periods of the non-breeding season for the Project and additional collisions based on 2017 proposed turbine figures for Inch Cape, Seagreen Phase 1 (Scenario One) is shown in Table 9-141. This is based on the Project worst case scenario (54 turbines), Band Model Option 2 and

an avoidance rate of 98.9%. Estimated collision numbers for NnG were previously presented in Table 9-55 and Table 9-57. Estimated collision numbers for Inch Cape and the Seagreen projects are presented in Appendix 9.3.

Table 9-141: Estimated cumulative number of gannet collisions in the autumn and spring periods of the non-breeding season for Scenario One: NnG (2017 design) and proposed Forth and Tay Wind Farms (2017 design), based on Band Model Option 2 and an avoidance rate of 98.9%

| | Band Option 2 | % of SPA population |
|---|---|---|
| **Autumn period of non-breeding season (October to November)** | | |
| **NnG (2017)** | 7 ± 1.3 | 0.004 |
| **Inch Cape (2017)** | 6 ± 1.3 | 0.003 |
| **Seagreen Phase 1 (2017)** | 19 ± 3.4 | 0.01 |
| **Total** | 32 ± 6.0 | 0.02 |
| **Spring period of non-breeding season (December to mid-March)** | | |
| **NnG (2017)** | 7 ± 1.3 | 0.003 |
| **Inch Cape (2017)** | 4 ± 0.8 | 0.002 |
| **Seagreen Phase 1 (2017)** | 20 ± 3.6 | 0.009 |
| **Total** | 31 ± 5.7 | 0.01 |
| **Combined non-breeding season total** | | |
| **NnG (2017)** | 14 ± 2.6 | 0.007 |
| **Inch Cape (2017)** | 10 ± 2.1 | 0.005 |
| **Seagreen Phase 1 (2017)** | 39 ± 7.0 | 0.02 |
| **Total** | 63 ± 11.7 | 0.03 |

809. Based on Scenario One, there will be an estimated 32 gannet collisions (adults and immatures) in the autumn period of the non-breeding season, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.02% of the North Sea and Channel population from the key SPA (Forth Islands) (191,857 adults and immature birds) in the autumn period of the non-breeding season (Furness, 2015).

810. In the spring period of the non-breeding season, there will be an estimated 31 gannet collisions (adults and immatures), which corresponds to 0.01% of the North Sea and Channel population from the key SPA (Forth Islands) (226,482 adults and immature birds) in the spring period of the non-breeding season (Furness, 2015).

811. Overall, there will be an estimated 63 gannet collisions (adults and immatures), which corresponds to 0.03% of the North Sea and Channel population from the key SPA (Forth Islands) in the autumn and spring periods of the non-breeding season (Furness, 2015). This assessment is precautionary as it assumes that gannets from other colonies outside of the Forth Islands SPA do not occur in the Wind Farm Area during the non-breeding period.

812. Predicted cumulative gannet mortality in the autumn (October to November) and spring (December to mid-March) periods of the non-breeding season for the Project and additional collisions based on 2014 consented figures (Scenario Two) is shown in Table 9-142. This is based on the Project worst case scenario (54 turbines), Band Model Option 2 and an avoidance rate of 98.9%. Estimated collision

numbers for NnG were previously presented in Table 9-55 and Table 9-57. Estimated collision numbers for Inch Cape and the Seagreen projects are presented in Appendix 9.3.

Table 9-142: Estimated cumulative number of gannet collisions in the autumn and spring periods of the non-breeding season for Scenario Two: NnG (2017 design) and previously consented Forth and Tay Wind Farms (2014 design), based on 54 turbines, Band Model Option 2 and an avoidance rate of 98.9%

| | Band Option 2 | % of SPA population |
|---|---|---|
| **Autumn period of non-breeding season (October to November)** | | |
| **NnG (2017)** | 7 ± 1.3 | 0.004 |
| **Inch Cape (2014)** | 15 | 0.008 |
| **Seagreen A (2014)** | 11 | 0.006 |
| **Seagreen B (2014)** | 6 | 0.003 |
| **Total** | 39 | 0.02 |
| **Spring period of non-breeding season (December to mid-March)** | | |
| **NnG (2017)** | 7 ± 1.3 | 0.003 |
| **Inch Cape (2014)** | 11 | 0.005 |
| **Seagreen A (2014)** | 12 | 0.005 |
| **Seagreen B (2014)** | 6 | 0.003 |
| **Total** | 36 | 0.02 |
| **Combined non-breeding season total** | | |
| **NnG (2017)** | 14 ± 2.6 | 0.007 |
| **Inch Cape (2014)** | 26 | 0.013 |
| **Seagreen A (2014)** | 23 | 0.011 |
| **Seagreen B (2014)** | 12 | 0.006 |
| **Total** | 75 | 0.04 |

813. Based on Scenario Two, there will be an estimated 39 gannet collisions (adults and immatures) in the autumn period of the non-breeding season, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.02% of the North Sea and Channel population from the key SPA (191,857 adults and immature birds) in the autumn period of the non-breeding season (Furness, 2015).

814. In the spring period of the non-breeding season, there will be an estimated 36 gannet collisions (adults and immatures), which corresponds to 0.02% of the North Sea and Channel population from the key SPA (226,482 adults and immature birds) in the spring period of the non-breeding season (Furness, 2015).

815. Overall, there will be an estimated 75 gannet collisions (adults and immatures), which corresponds to 0.04% of the North Sea and Channel population from the key SPA (Forth Islands) in the autumn and spring periods of the non-breeding season (Furness, 2015). This assessment is precautionary as it assumes that gannets from other colonies outside of the Forth Islands SPA do not occur in the Wind Farm Area during the non-breeding period.

816. Based on either Scenario One or Two, it is concluded that cumulative collision mortality impacts at NnG, Inch Cape and Seagreen A & B will have no effect on the breeding SPA population of gannets within mean maximum foraging range in the non-breeding season. The sensitivity of gannets to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

*Assessment of cumulative collision mortality throughout the year*

817. For Scenario One, predicted cumulative gannet mortality from all seasons from collision impacts as calculated above, was summed for the whole year for the worst case design scenario (54 turbines) (Table 9-143).

Table 9-143: Estimated cumulative number of gannet collisions throughout the year for Scenario One: NnG (2017 design) and proposed Forth and Tay Wind Farms (2017 design), based on 54 turbines, Band Model Option 2 and an avoidance rate of 98.9%

| | Band Option 2 | % of SPA population |
|---|---|---|
| **Breeding season total (mid-March to September) - Adults** | | |
| **NnG (2017)** | 91 | 0.06 |
| **Inch Cape (2017)** | 112 | 0.07 |
| **Seagreen Phase 1 (2017)** | 317 | 0.2 |
| **Total** | 520 | 0.33 |
| **Combined non-breeding season total (October to mid-March)** | | |
| **NnG (2017)** | 14 ± 2.6 | 0.007 |
| **Inch Cape (2017)** | 10 ± 2.1 | 0.005 |
| **Seagreen Phase 1 (2017)** | 39 ± 7.0 | 0.02 |
| **Total** | 63 ± 11.7 | 0.03 |
| **Annual total** | | |
| **NnG (2017)** | 105 | 0.067 |
| **Inch Cape (2017)** | 122 | 0.075 |
| **Seagreen Phase 1 (2017)** | 356 | 0.22 |
| **Total** | 583 | 0.4 |

818. Based on Scenario One, there will be an estimated 583 gannet collisions (adults and immatures) throughout the year, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.4% of the North Sea and Channel population from the key SPA (Forth Islands) based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015). This assessment is precautionary as it assumes that gannets from other colonies outside of the Forth Islands SPA do not occur in the Wind Farm Area during the non-breeding period.

819. For Scenario Two, predicted cumulative gannet mortality from all seasons from collision impacts as calculated above, was summed for the whole year for the worst case scenario (54 turbines) (Table 9-144).

Table 9-144: Estimated cumulative number of gannet collisions throughout the year for Scenario Two: NnG (2017 design) and previously consented Forth and Tay Wind Farms (2014 design), based on 54 turbines, Band Model Option 2 and an avoidance rate of 98.9%

| | Band Option 2 | % of SPA population |
|---|---|---|
| **Breeding season total (mid-March to September) - Adults** | | |
| **NnG (2017)** | 91 | 0.06 |
| **Inch Cape (2014)** | 375 | 0.25 |
| **Seagreen A (2014)** | 409 | 0.27 |
| **Seagreen B (2014)** | 260 | 0.17 |
| **Total** | 1,135 | 0.75 |
| **Combined non-breeding season total (October to mid-March)** | | |
| **NnG (2017)** | 14 ± 2.6 | 0.007 |
| **Inch Cape (2014)** | 26 | 0.013 |
| **Seagreen A (2014)** | 23 | 0.011 |
| **Seagreen B (2014)** | 12 | 0.006 |
| **Total** | 75 | 0.04 |
| **Annual total** | | |
| **NnG (2017)** | 105 | 0.067 |
| **Inch Cape (2014)** | 401 | 0.263 |
| **Seagreen A (2014)** | 432 | 0.281 |
| **Seagreen B (2014)** | 272 | 0.176 |
| **Total** | 1,210 | 0.8 |

820. Based on Scenario Two, there will be an estimated 1,210 gannet collisions (adults and immatures) throughout the year, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.8% of the North Sea and Channel population from the key SPA (Forth Islands) based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015). This assessment is precautionary as it assumes that gannets from other colonies outside of the Forth Islands SPA do not occur in the Wind Farm Area during the non-breeding period.

821. Based on either Scenario One or Two, it is concluded that cumulative collision mortality impacts at NnG, Inch Cape and Seagreen A & B will have no effect on the breeding SPA population of gannets within mean maximum foraging range throughout the year. The sensitivity of gannets to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

*Kittiwake – breeding season*

822. The four SPAs considered for kittiwake for the cumulative assessment were Buchan Ness to Collieston Coast SPA, Fowlsheugh SPA, Forth Islands SPA and St Abb's Head to Fast Castle SPA. Based on SNH figures, the most recent total combined breeding population estimate for these SPAs is 29,134 pairs (Table 9-8).

823. Predicted cumulative kittiwake mortality in the breeding season (mid-April to August) for the Project and additional collisions based on 2017 proposed turbine figures for Inch Cape, Phase 1 (Scenario One) is shown in Table 9-145. This is based on the Project worst case scenario (54 turbines), Band Model Option 2 and an avoidance rate of 98.9%. Estimated collision numbers for NnG were previously presented in Table 9-63. Estimated collision numbers for Inch Cape and the Seagreen projects are presented in Appendix 9.3.

Table 9-145: Estimated cumulative number of kittiwake collisions in the breeding season for Scenario One: NnG (2017 design) and proposed Forth and Tay Wind Farms (2017 design), based on Band Model Option 2 and an avoidance rate of 98.9%

| | Band Option 2 all birds | % of SPA population | Band Option 2 adults | % of SPA population |
|---|---|---|---|---|
| **NnG (2017)** | 9 ± 1.6 | 0.02 | 8 | 0.01 |
| **Inch Cape (2017)** | 43 ± 7.9 | 0.07 | 39 | 0.07 |
| **Seagreen Phase 1 (2017)** | 119 ± 21.7 | 0.2 | 116 | 0.2 |
| **Total** | 171 ± 31.2 | 0.3 | 163 | 0.3 |

824. Based on Scenario One, there will be an estimated 171 kittiwake collisions (adults and immatures) each breeding season, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.3% of the breeding population (adults) for the four key SPAs (29,134 pairs), based on breeding colony counts (Table 9-8).

825. However, this estimate includes non-breeding immature birds, as well as breeding adults. During the breeding period, for NnG, 93.2% of aged kittiwakes were adults (Appendix 9.2: Table 5) Based on this, eight collisions NnG involved adult birds in the breeding season (Table 9-145). For Inch Cape, 91.3% of aged kittiwakes were adults in the breeding season (Appendix 9.4). Based on this, 39 collisions at Inch Cape involved adult birds in the breeding season. Based on the original application for Seagreen, as 97.2% of all birds recorded on baseline surveys in Seagreen B in June were adults (Seagreen 2012), this ratio was applied to the above figures for Seagreen Phase 1. This gave a total of 116 adult collisions for Seagreen Phase 1 in the breeding season.

826. Considering only adult kittiwakes, there will be an estimated 163 collisions each breeding season, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.3% of the breeding population (adults) for the four key SPAs (29,134 pairs), based on breeding colony counts (Table 9-8).

827. Predicted cumulative kittiwake mortality in the breeding season (mid-April to August) for the Project and additional collisions based on 2014 consented figures (Scenario Two) is shown in Table 9-146. This is based on the Project worst case scenario (54 turbines), Band Model Option 2 and an avoidance rate of 98.9%. Estimated collision numbers for NnG were previously presented in Table 9-63. Estimated collision numbers for Inch Cape and the Seagreen projects are presented in Appendix 9.3.

Table 9-146: Estimated cumulative number of kittiwake collisions in the breeding season for Scenario Two: NnG (2017 design) and previously consented Forth and Tay Wind Farms (2014 design), based on Band Model Option 2 and an avoidance rate of 98.9% ± 2 SD

| | Band Option 2 all birds | % of SPA population | Band Option 2 adults | % of SPA population |
|---|---|---|---|---|
| **NnG (2017)** | 9 ± 1.6 | 0.02 | 8 | 0.01 |
| **Inch Cape (2017)** | 149 | 0.3 | 136 | 0.2 |
| **Seagreen A (2014)** | 126 | 0.2 | 122 | 0.2 |
| **Seagreen B (2014)** | 135 | 0.2 | 131 | 0.2 |
| **Total** | 419 | 0.7 | 397 | 0.6 |

828. Based on Scenario Two, there will be an estimated 419 kittiwake collisions (adults and immatures) each breeding season, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.7% of the breeding population (adults) for the four key SPAs (29,134 pairs), based on breeding colony counts (Table 9-8).

829. However, this estimate includes non-breeding immature birds, as well as breeding adults. During the breeding period, for NnG, 93.2% of aged kittiwakes were adults (Appendix 9.2: Table 5) Based on this, eight collisions NnG involved adult birds in the breeding season (Table 9-146). For Inch Cape, 91.3% of aged kittiwakes were adults in the breeding season (Appendix 9.4). Based on this, 136 collisions at Inch Cape involved adult birds in the breeding season. For Seagreen, as 97.2% of all birds recorded on baseline surveys in Seagreen B in June were adults (Seagreen 2012), this ratio was applied to the above figures for both Seagreen projects. This gave a total of 122 adult collisions for Seagreen A and 131 adults for Seagreen B in the breeding season.

830. Considering only adult kittiwakes, there will be an estimated 397 collisions each breeding season, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.6% of the breeding population (adults) for the four key SPAs (29,134 pairs), based on breeding colony counts (Table 9-8).

831. Based on either Scenario One or Two, it is concluded that cumulative collision mortality impacts at NnG, Inch Cape and Seagreen A & B will have no effect on the breeding SPA population of kittiwakes within mean maximum foraging range in the breeding season. The sensitivity of kittiwakes to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

*Kittiwake – non-breeding season*

832. The non-breeding season for kittiwake was defined in the Scoping Opinion as Autumn – September to December; and Spring – January to mid-April (Table 9-7) (Marine Scotland, 2017). In the BDMPS review, the non-breeding season was defined as Autumn migration (August to December), and Spring migration (January to April) (Furness 2015). Although there are slight differences in these definitions, it was considered these would not make a significant difference to the assessment, and so the Scoping Opinion definitions were followed.

833. Predicted cumulative kittiwake mortality in the autumn and spring periods of the non-breeding season for the Project and additional collisions based on 2017 proposed turbine figures for Inch Cape and Seagreen Phase 1 (Scenario One) is shown in Table 9-147. This is based on the Project worst case scenario (54 turbines), Band Model Option 2 and an avoidance rate of 98.9%. Estimated collision numbers for NnG were previously presented in Table 9-63. Estimated collision numbers for Inch Cape and the Seagreen projects are presented in Appendix 9.3.

Table 9-147: Estimated cumulative number of kittiwake collisions in the autumn and spring periods of the non-breeding season for Scenario One: NnG (2017 design) and proposed Forth and Tay Wind Farms (2017 design), based on Band Model Option 2 and an avoidance rate of 98.9%

| | Band Option 2 | % of SPA population |
|---|---|---|
| **Autumn period of non-breeding season (September to December)** | | |
| **NnG (2017)** | 17 ± 3.1 | 0.03 |
| **Inch Cape (2017)** | 30 ± 5.5 | 0.06 |
| **Seagreen Phase 1 (2017)** | 151 ± 27.4 | 0.3 |
| **Total** | 198 ± 36.0 | 0.4 |
| **Spring period of non-breeding season (January to mid-April)** | | |
| **NnG (2017)** | 2 ± 0.3 | 0.004 |
| **Inch Cape (2017)** | 6 ± 1.2 | 0.01 |
| **Seagreen Phase 1 (2017)** | 80 ± 14.5 | 0.2 |
| **Total** | 88 ± 16.0 | 0.2 |
| **Combined non-breeding season total** | | |
| **NnG (2017)** | 19 ± 3.4 | 0.034 |
| **Inch Cape (2017)** | 36 ± 6.7 | 0.07 |
| **Seagreen Phase 1 (2017)** | 231 ± 41.9 | 0.5 |
| **Total** | 286 ± 52.0 | 0.6 |

834. Based on Scenario One, there will be an estimated 198 kittiwake collisions (adults and immatures) in the autumn period of the non-breeding season, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.4% of the North Sea population from the key SPAs (54,039 adults and immature birds) in the autumn period of the non-breeding season (Furness, 2015) (Table 9-18).

835. In the spring period of the non-breeding season, there will be an estimated 88 kittiwake collisions (adults and immatures), which corresponds to 0.2% of the North Sea population from the key SPAs (49,044 adults and immature birds) in the spring period of the non-breeding season (Furness, 2015) (Table 9-21).

836. Overall, there will be an estimated 286 kittiwake collisions (adults and immatures), which corresponds to 0.6% of the North Sea population from the key SPAs in the autumn and spring periods of the non-breeding season (Furness, 2015). This assessment is precautionary as it assumes that kittiwakes from other colonies outside of these four SPAs do not occur in the Wind Farm Area during the non-breeding period.

837. Based on Scenario One (2017 design scenarios), it is concluded that cumulative collision mortality impacts at NnG, Inch Cape and Seagreen Phase 1 will have no effect on the breeding SPA population of kittiwakes within mean maximum foraging range in the non-breeding season. The sensitivity of kittiwakes to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

838. Predicted cumulative kittiwake mortality in the autumn and spring periods of the non-breeding season for the Project and additional collisions based on 2014 consented figures (Scenario Two) is

shown in Table 9-148. This is based on the Project worst case scenario (54 turbines), Band Model Option 2 and an avoidance rate of 98.9%. Estimated collision numbers for NnG were previously presented in Table 9-63. Estimated collision numbers for Inch Cape and the Seagreen projects are presented in Appendix 9.3.

Table 9-148: Estimated cumulative number of kittiwake collisions in the autumn and spring periods of the non-breeding season for Scenario Two: NnG (2017 design) and previously consented Forth and Tay Wind Farms (2014 design), based on Band Model Option 2 and an avoidance rate of 98.9%

| | Band Option 2 | % of SPA population |
|---|---|---|
| **Autumn period of non-breeding season (September to December)** | | |
| **NnG (2017)** | 17 ± 3.1 | 0.03% |
| **Inch Cape (2014)** | 80 | 0.1 |
| **Seagreen A (2014)** | 217 | 0.4 |
| **Seagreen B (2014)** | 123 | 0.2 |
| **Total** | 437 | 0.7 |
| **Spring period of non-breeding season (January to mid-April)** | | |
| **NnG (2017)** | 2 ± 0.3 | 0.004% |
| **Inch Cape (2014)** | 18 | 0.04 |
| **Seagreen A (2014)** | 78 | 0.2 |
| **Seagreen B (2014)** | 104 | 0.2 |
| **Total** | 202 | 0.4 |
| **Combined non-breeding season total** | | |
| **NnG (2017)** | 19 ± 3.4 | 0.034 |
| **Inch Cape (2014)** | 98 | 0.14 |
| **Seagreen A (2014)** | 295 | 0.6 |
| **Seagreen B (2014)** | 227 | 0.4 |
| **Total** | 639 | 1.2 |

839. Based on Scenario Two, there will be an estimated 437 kittiwake collisions (adults and immatures) in the autumn period of the non-breeding season, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.7% of the North Sea population from the key SPAs (54,039 adults and immature birds) in the autumn period of the non-breeding season (Furness, 2015) (Table 9-18).

840. In the spring period of the non-breeding season, there will be an estimated 202 kittiwake collisions (adults and immatures), which corresponds to 0.4% of the North Sea population from the key SPAs (49,044 adults and immature birds) in the spring period of the non-breeding season (Furness, 2015) (Table 9-21).

841. Overall, there will be an estimated 639 kittiwake collisions (adults and immatures), which corresponds to 1.2% of the North Sea population from the key SPAs in the autumn and spring periods of the non-breeding season, based on the BDMPS review (Furness, 2015). This assessment is

precautionary as it assumes that kittiwakes from other colonies outside of these four SPAs do not occur in the Wind Farm Area during the non-breeding period.

842. Based on Scenario Two (2014 consent scenarios), it is concluded that cumulative collision mortality impacts at NnG, Inch Cape and Seagreen A & B will have a moderate effect on the breeding SPA population of kittiwakes within mean maximum foraging range in the non-breeding season. The sensitivity of kittiwakes to collision is assessed as high and the magnitude of any impacts will be low. The significance of this impact is therefore assessed to be **moderate** and **significant** in EIA terms.

*Assessment of cumulative collision mortality throughout the year*

843. For Scenario One, predicted cumulative kittiwake mortality from all seasons from collision impacts as calculated above, was summed for the whole year for the worst case scenario (54 turbines) (Table 9-149).

Table 9-149: Estimated cumulative number of kittiwake collisions throughout the year for Scenario One: NnG (2017 design) and proposed Forth and Tay Wind Farms (2017 design), based on 54 turbines, Band Model Option 2 and an avoidance rate of 98.9%

| | Band Option 2 | % of SPA population |
|---|---|---|
| **Breeding season total (mid-April to August) – Adults** | | |
| **NnG (2017)** | 8 | 0.01 |
| **Inch Cape (2017)** | 39 | 0.07 |
| **Seagreen Phase 1 (2017)** | 116 | 0.2 |
| **Total** | 163 | 0.3 |
| **Combined non-breeding season total (September to mid-April)** | | |
| **NnG (2017)** | 19 ± 3.4 | 0.034 |
| **Inch Cape (2017)** | 36 ± 6.7 | 0.07 |
| **Seagreen Phase 1 (2017)** | 231 ± 41.9 | 0.5 |
| **Total** | 286 ± 52.0 | 0.6 |
| **Annual total** | | |
| **NnG (2017)** | 27 | 0.044 |
| **Inch Cape (2017)** | 75 | 0.14 |
| **Seagreen Phase 1 (2017)** | 347 | 0.7 |
| **Total** | 449 | 0.9 |

844. Based on Scenario One, there will be an estimated 449 kittiwake collisions (adults and immatures) throughout the year, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.9% of the North Sea population from the key SPAs based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015). This assessment is precautionary as it assumes that kittiwakes from other colonies outside of these four SPAs do not occur in the Wind Farm Area during the non-breeding period.

845. Based on Scenario One (2017 design scenarios), it is concluded that cumulative collision mortality impacts at NnG, Inch Cape and Seagreen Phase 1 will have no effect on the breeding SPA population of kittiwakes within mean maximum foraging range throughout the year. The sensitivity of kittiwakes

to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

846. For Scenario Two, predicted cumulative kittiwake mortality from all seasons from collision impacts as calculated above, was summed for the whole year for the worst case scenario (54 turbines) (Table 9-150).

Table 9-150: Estimated cumulative number of kittiwake collisions throughout the year for Scenario Two: NnG (2017 design) and previously consented Forth and Tay Wind Farms (2014 design), based on 54 turbines, Band Model Option 2 and an avoidance rate of 98.9%

| | Band Option 2 | % of SPA population |
|---|---|---|
| **Breeding season total (mid-April to August) - Adults** | | |
| **NnG (2017)** | 8 | 0.01 |
| **Inch Cape (2014)** | 136 | 0.2 |
| **Seagreen A (2014)** | 122 | 0.2 |
| **Seagreen B (2014)** | 131 | 0.2 |
| **Total** | 397 | 0.6 |
| **Combined non-breeding season total (September to mid-April)** | | |
| **NnG (2017)** | 19 ± 3.4 | 0.034 |
| **Inch Cape (2014)** | 98 | 0.14 |
| **Seagreen A (2014)** | 295 | 0.6 |
| **Seagreen B (2014)** | 227 | 0.4 |
| **Total** | 639 | 1.2 |
| **Annual total** | | |
| **NnG (2017)** | 27 | 0.044 |
| **Inch Cape (2014)** | 234 | 0.34 |
| **Seagreen A (2014)** | 417 | 0.8 |
| **Seagreen B (2014)** | 358 | 0.6 |
| **Total** | 1,036 | 1.8 |

847. Based on Scenario Two, there will be an estimated 1,036 kittiwake collisions (adults and immatures) throughout the year, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 1.8% of the North Sea population from the key SPAs based on breeding colony counts (Table 9-8) and on non-breeding season population estimates (Furness 2015). This assessment is precautionary as it assumes that kittiwakes from other colonies outside of these four SPAs do not occur in the Wind Farm Area during the non-breeding period.

848. Based on Scenario Two (2014 consent scenarios), it is concluded that cumulative collision mortality impacts at NnG, Inch Cape and Seagreen A & B will have a moderate effect on the breeding SPA population of kittiwakes within mean maximum foraging range throughout the year. The sensitivity of kittiwakes to collision is assessed as high and the magnitude of any impacts will be low. The significance of this impact is therefore assessed to be **moderate** and **significant** in EIA terms.

*Cumulative collisions for the Project, the other Forth and Tay wind farms and other UK offshore wind farms in the North Sea and English Channel*

849. The Scoping Opinion (Marine Scotland, 2017) stated that for gannet and kittiwake, the CIA should estimate non-breeding season collision effects from the Forth and Tay wind farms (Inch Cape and Seagreen) in isolation and in combination with the other UK wind farms. The cumulative collision assessment for the Forth and Tay Wind Farms together with other UK offshore wind farms is presented below.

850. Figures for NnG are taken from this assessment, and are based on the worst-case design scenario (54 turbines). As outlined previously, there were two scenarios considered for Forth and Tay projects. Scenario one incorporates the 2017 design envelopes for the proposed Inch Cape and Seagreen projects (ICOL, 2017; Seagreen, 2017), and Scenario two incorporates the consented 2014 design envelopes. This assessment is based on the worst-case design scenario from 2014.

*Cumulative non-breeding season assessment for gannet*

851. This part of the assessment is based on the approach recommended by SNH that was recently circulated by Marine Scotland (SNH, 2017). This approach was based on estimated turbine numbers from the recent Headroom Estimates report (Crown Estate 2017), and recommended applying factors to any change in turbine number published elsewhere e.g. changes made during the PINS process, to reduce the estimated number of collisions accordingly.

852. A slightly different approach was used for this part of the assessment. As the Crown Estate report included a review of changes in proposed/built project turbine numbers, based on best available information e.g. developer websites, this was used as a basis for revising collision estimates. However, the Crown Estate report only presented estimated annual collisions, whereas estimated collisions for the non-breeding season were required for this part of the assessment.

853. The draft Hornsea 3 HRA report (Dong Energy, 2017), presents both annual and breeding season collision estimates for the UK North Sea and English Channel Wind Farms used in this assessment. The annual totals were compared to both the original and revised estimates in the Crown Estate report. Where there was good reason given in the Crown Estate report, e.g. information on likely turbine number from the developer websites, the revised Crown Estate estimate was selected. Where there was no information on changes in project number, the most conservative estimate from the three data sources was selected. The selected collision estimate for gannet for each project is highlighted in bold in Table 9-151.

Table 9-151: Comparison of estimated number of gannet collisions in the non-breeding season for UK North Sea and English Channel Wind Farms used in this assessment

| Project | Original TCE report estimate | Revised TCE estimate | Hornsea 3 HRA estimate | Reason for selection |
|---|---|---|---|---|
| **East Anglia 3** | **49** | 49 | 48 | TCE report more conservative |
| **East Anglia 1** | 213 | **96** | 68 | Revised TCE estimate used. SPR planning building 102 turbines, not 240 |
| **Hornsea 3** | - | - | **15** | Hornsea 3 HRA estimate only one available |
| **Blyth Demonstrator** | 8 | 8 | **9** | H3 HRA more conservative |
| **Dogger Creke Beck A&B** | 32 | 32 | **121** | H3 HRA more conservative |
| **Dogger Teeside A&B** | 31 | 31 | **136** | H3 HRA more conservative |

| Project | Original TCE report estimate | Revised TCE estimate | Hornsea 3 HRA estimate | Reason for selection |
|---|---|---|---|---|
| **Dudgeon** | 80 | **37** | 37 | Revised TCE estimate used. Up to 67 turbines, not 168 |
| **Hornsea 1** | 66 | **38** | 38 | Revised TCE estimate used. Up to 174 turbines, not 240 |
| **Hornsea 2** | **27** | 27 | 18 | TCE report more conservative |
| **Humber Gateway** | 5 | **2** | 4 | Revised TCE estimate used. 73 turbines built, not 83 |
| **Lincs** | **5** | 5 | 5 | No difference |
| **Race Bank** | 50 | **26** | 50 | Revised TCE estimate used. Dong website says up to 91 turbines, not 206 |
| **Sheringham Shoal** | 17 | 17 | **18** | H3 HRA estimate more conservative |
| **Teeside** | 7 | **5** | 7 | Revised TCE estimate used. Built 27 turbines, not 30 |
| **Triton Knoll** | 121 | **39** | 122 | Revised TCE estimate used. 100 turbines likely, not 288 |
| **Westermost Rough** | **1** | 1 | 1 | No difference |
| **Aberdeen demonstrator** | **9** | 9 | 9 | No difference |
| **Beatrice** | 96 | **58** | 42 | Revised TCE estimate used. Up to 84 turbines, not 125 |
| **Galloper** | 62 | **27** | 62 | Revised TCE estimate used. Up to 56 turbines, not 140 |
| **Greater Gabbard** | **28** | 28 | 28 | No difference |
| **Kentish Flats** | **3** | 3 | 3 | No difference |
| **London Array** | 6 | **2** | 6 | Revised TCE estimate used. Up to 175 turbines, not 341 |
| **Moray Firth 1** | **125** | 125 | 18 | TCE report more conservative |
| **Thanet** | **1** | 1 | 1 | No difference |
| **Rampion** | 102 | **70** | 70 | Revised TCE estimate used. Up to 116 turbines, not 175 |

854. To calculate non-breeding gannet collisions, the selected annual gannet collision estimate for each project was multiplied by the ratio of breeding to annual gannet collision estimates from the draft Hornsea 3 HRA (Table 9-152).

Table 9-152: Estimated number of gannet collisions in the non-breeding season for UK North Sea and English Channel Wind Farms used in this assessment

| Project | Annual collision estimate | Hornsea H3 non-breeding estimates | Hornsea H3 annual estimate | Hornsea H3 ratio | Estimated non-breeding season collisions |
|---|---|---|---|---|---|
| **East Anglia 3** | 49 | 35 | 48 | 0.73 | 36 |
| **East Anglia 1** | 96 | 66 | 68 | 0.97 | 93 |
| **Hornsea 3** | 15 | 9 | 15 | 0.6 | 9 |
| **Blyth Demonstrator** | 9 | 5 | 9 | 0.56 | 5 |
| **Dogger Creke Beck A&B** | 121 | 80 | 121 | 0.66 | 80 |
| **Dogger Teeside A&B** | 136 | 68 | 136 | 0.5 | 68 |
| **Dudgeon** | 37 | 27 | 37 | 0.73 | 27 |
| **Hornsea 1** | 38 | 31 | 38 | 0.82 | 31 |
| **Hornsea 2** | 27 | 13 | 18 | 0.72 | 20 |
| **Humber Gateway** | 2 | 2 | 4 | 0.5 | 1 |
| **Lincs** | 5 | 3 | 5 | 0.6 | 3 |
| **Race Bank** | 26 | 16 | 50 | 0.32 | 8 |
| **Sheringham Shoal** | 18 | 4 | 18 | 0.22 | 4 |
| **Teeside** | 5 | 2 | 7 | 0.29 | 1 |
| **Triton Knoll** | 39 | 95 | 122 | 0.78 | 30 |
| **Westermost Rough** | 1 | 1 | 1 | 1 | 1 |
| **Aberdeen demonstrator** | 9 | 5 | 9 | 0.56 | 5 |
| **Beatrice** | 58 | 25 | 42 | 0.6 | 35 |
| **Galloper** | 27 | 44 | 62 | 0.71 | 19 |
| **Greater Gabbard** | 28 | 14 | 28 | 0.5 | 14 |
| **Kentish Flats** | 3 | 0 | 3 | 0 | 0 |
| **London Array** | 2 | 3 | 6 | 0.5 | 1 |

| Project | Annual collision estimate | Hornsea H3 non-breeding estimates | Hornsea H3 annual estimate | Hornsea H3 ratio | Estimated non-breeding season collisions |
|---|---|---|---|---|---|
| **Moray Firth 1** | 125 | 6 | 18 | 0.33 | 42 |
| **Thanet** | 1 | 0 | 1 | 0 | 0 |
| **Rampion** | 70 | 70 | 70 | 1 | 70 |
| **Total** | 947 | 624 | 936 | - | 603 |

855. As a sense check comparing this revised approach to the method recommended by SNH (SNH, 2017), the non-breeding season collision estimates for gannet at East Anglia 1 and Beatrice were compared to the worked example provided in the SNH guidance (Table 9-153). Estimates were very similar.

Table 9-153: Comparison of estimated number of gannet collisions in the non-breeding season for two UK North Sea Wind Farms based on SNH method and revised SNH method used in this assessment

| **Project** | **Estimated collisions SNH method** | **Estimated collisions Revised SNH method** |
|---|---|---|
| **Beatrice** | 35.4 | 35 |
| **East Anglia 1** | 93.7 | 93 |

856. The draft Hornsea 3 HRA provides a breakdown of the non-breeding season into the post-breeding season (autumn) and the pre-breeding season (spring) for the offshore UK wind farms used in this assessment. The estimated collisions for the non-breeding season from Table 9-152 (final column) were therefore divided using the same ratio, to get the estimated number of collisions in the autumn and spring periods (Table 9-154).

Table 9-154: Estimated number of gannet collisions in the autumn and spring periods of the non-breeding season for UK North Sea and English Channel Wind Farms used in this assessment

| Project | Estimated non-breeding season collisions | Hornsea 3 Autumn estimates | Hornsea 3 non-breeding estimates | Hornsea H3 non-breeding ratio | Estimated autumn collisions | Estimated spring collisions |
|---|---|---|---|---|---|---|
| **East Anglia 3** | 36 | 33 | 35 | 0.94 | 34 | 2 |
| **East Anglia 1** | 93 | 64 | 66 | 0.97 | 90 | 3 |
| **Hornsea 3** | 9 | 3 | 9 | 0.33 | 3 | 6 |
| **Blyth Demonstrator** | 5 | 2 | 5 | 0.4 | 2 | 3 |
| **Dogger Creke Beck A&B** | 80 | 48 | 80 | 0.6 | 48 | 32 |
| **Dogger Teeside A&B** | 68 | 34 | 68 | 0.5 | 34 | 34 |
| **Dudgeon** | 27 | 18 | 27 | 0.67 | 18 | 9 |

| Project | Estimated non-breeding season collisions | Hornsea 3 Autumn estimates | Hornsea 3 non-breeding estimates | Hornsea H3 non-breeding ratio | Estimated autumn collisions | Estimated spring collisions |
|---|---|---|---|---|---|---|
| **Hornsea 1** | 31 | 18 | 31 | 0.58 | 18 | 13 |
| **Hornsea 2** | 20 | 9 | 13 | 0.69 | 14 | 6 |
| **Humber Gateway** | 1 | 1 | 2 | 0.5 | 0.5 | 0.5 |
| **Lincs** | 3 | 1 | 3 | 0.33 | 1 | 2 |
| **Race Bank** | 8 | 12 | 16 | 0.75 | 6 | 2 |
| **Sheringham Shoal** | 4 | 3 | 4 | 0.75 | 3 | 1 |
| **Teeside** | 1 | 2 | 2 | 1 | 1 | 0 |
| **Triton Knoll** | 30 | 64 | 95 | 0.67 | 20 | 10 |
| **Westermost Rough** | 1 | 0 | 1 | 0 | 0 | 1 |
| **Aberdeen demonstrator** | 5 | 5 | 5 | 1 | 5 | 0 |
| **Beatrice** | 35 | 21 | 25 | 0.84 | 29 | 6 |
| **Galloper** | 19 | 31 | 44 | 0.7 | 13 | 6 |
| **Greater Gabbard** | 14 | 9 | 14 | 0.64 | 9 | 5 |
| **Kentish Flats** | 0 | 0 | 0 | 0 | 0 | 0 |
| **London Array** | 1 | 1 | 3 | 0.33 | 0 | 1 |
| **Moray Firth 1** | 42 | 5 | 6 | 0.83 | 35 | 7 |
| **Thanet** | 0 | 0 | 0 | 0 | 0 | 0 |
| **Rampion** | 70 | 35 | 70 | 0.5 | 35 | 35 |
| **Total** | 603 | - | 624 | - | 419 | 185 |

857. Following the SNH approach, the next stage is to adjust the total collisions attributed to the Forth Islands SPA for each period (autumn and spring) by the age proportions and the proportional representation of each SPA colony within the BDMPS for that period. As recommended in the SNH approach, the ratio of adult (55%) to immature birds (45%) was taken from the stable age structure percentages as reported in Furness (2015.)

858. The proportion of adult and immature gannets from the SPA colony within the BDMPS for the autumn and spring periods was calculated by dividing the estimated number of adult and immature gannets from the Forth Islands SPA by the total estimated BDMPS population (Table 9-155).

Table 9-155: Proportion of adult and immature birds from Forth Islands SPA in the North Sea and English Channel in the autumn and spring periods of the non-breeding season

| SPA | Estimated number of adults in UK N Sea & Channel in autumn period | Estimated number of immature birds in UK N Sea & Channel in autumn period | Estimated number of adults in UK N Sea & Channel in spring period | Estimated number of immature birds in UK N Sea & Channel in spring period |
|---|---|---|---|---|
| **Forth Islands SPA** | 110,964 | 80,893 | 77,675 | 35,952 |
| **Total BDMPS** | 242,340 | 213,959 | 163,701 | 84,684 |
| **Proportion from SPA** | 0.46 | 0.38 | 0.47 | 0.42 |

859. Estimated gannet collisions for the autumn period of the non-breeding season for NnG and the other Forth and Tay projects based on the worst-case option (Scenario Two – NnG 2017 and 2014 consents for Inch Cape and Seagreen A and B) (Table 9-142), were also included with the autumn period non-breeding season estimated collisions for the UK North Sea wind farms (Table 9-156).

860. The proportions of adults and immature birds were then used to calculate the numbers of adult gannets from the Forth Islands SPA involved in collisions at each of the UK North Sea and English Channel offshore wind farms in the autumn period of the non-breeding season (Table 9-156). This was repeated for immature birds in the autumn period (Table 9-157).

861. As the seasonal period definitions used in Furness (2015) do not match the definitions in the SNH guidance, the approach recommended by SNH is to assume a flat rate of collisions during the season, and to recalculate according to the relative lengths of the periods. For gannet, the autumn post breeding period in the BDMPS report (Furness 2015) is 12 weeks from September to November. The SNH recommendation is from October to November, which is 30 days less than the BDMPS autumn period. As such, a proportionate recalculation based on the relative length of time in the two periods is required. Therefore 0.67 multiplied by the number of collisions in autumn is the final value required. This recalculation is shown in the final columns of Table 9-156 and Table 9-157.

Table 9-156: Estimated cumulative number of adult gannets from the Forth Islands SPA involved in collisions at NnG (2017 design), proposed Forth and Tay Wind Farms (2014 design), and other UK North Sea and English Channel Wind Farms in the autumn period of the non-breeding season

| Project | Estimated autumn collisions (all ages) | Proportion of adult birds | Proportion from SPA | Number of adults from Forth Islands SPA | Corrected number of adults from Forth Islands SPA |
|---|---|---|---|---|---|
| **NnG (2017)** | 7 | 0.55 | 0.46 | 2 | 1 |
| **Inch Cape (2014)** | 15 | 0.55 | 0.46 | 4 | 3 |
| **Seagreen A (2014)** | 11 | 0.55 | 0.46 | 3 | 2 |
| **Seagreen B (2014)** | 6 | 0.55 | 0.46 | 2 | 1 |
| **East Anglia 3** | 34 | 0.55 | 0.46 | 9 | 6 |
| **East Anglia 1** | 90 | 0.55 | 0.46 | 23 | 15 |

| Project | Estimated autumn collisions (all ages) | Proportion of adult birds | Proportion from SPA | Number of adults from Forth Islands SPA | Corrected number of adults from Forth Islands SPA |
|---|---|---|---|---|---|
| Hornsea 3 | 3 | 0.55 | 0.46 | 1 | 1 |
| Blyth Demonstrator | 2 | 0.55 | 0.46 | 1 | 0 |
| Dogger Creke Beck A&B | 48 | 0.55 | 0.46 | 12 | 8 |
| Dogger Teeside A&B | 34 | 0.55 | 0.46 | 9 | 6 |
| Dudgeon | 18 | 0.55 | 0.46 | 5 | 3 |
| Hornsea 1 | 18 | 0.55 | 0.46 | 5 | 3 |
| Hornsea 2 | 14 | 0.55 | 0.46 | 4 | 2 |
| Humber Gateway | 0.5 | 0.55 | 0.46 | 0 | 0 |
| Lincs | 1 | 0.55 | 0.46 | 0 | 0 |
| Race Bank | 6 | 0.55 | 0.46 | 2 | 1 |
| Sheringham Shoal | 3 | 0.55 | 0.46 | 1 | 1 |
| Teeside | 1 | 0.55 | 0.46 | 0 | 0 |
| Triton Knoll | 20 | 0.55 | 0.46 | 5 | 3 |
| Westermost Rough | 0 | 0.55 | 0.46 | 0 | 0 |
| Aberdeen demonstrator | 5 | 0.55 | 0.46 | 1 | 1 |
| Beatrice | 29 | 0.55 | 0.46 | 7 | 5 |
| Galloper | 13 | 0.55 | 0.46 | 3 | 2 |
| Greater Gabbard | 9 | 0.55 | 0.46 | 2 | 2 |
| Kentish Flats | 0 | 0.55 | 0.46 | 0 | 0 |
| London Array | 0 | 0.55 | 0.46 | 0 | 0 |
| Moray Firth 1 | 35 | 0.55 | 0.46 | 9 | 6 |
| Thanet | 0 | 0.55 | 0.46 | 0 | 0 |
| Rampion | 35 | 0.55 | 0.46 | 9 | 6 |
| **Total** | **457.5** | - | - | **119** | **78** |

Table 9-157: Estimated cumulative number of immature gannets from the Forth Islands SPA involved in collisions at NnG (2017 design), proposed Forth and Tay Wind Farms (2014 design), and other UK North Sea and English Channel Wind Farms in the autumn period of the non-breeding season

| Project | Estimated autumn collisions (all ages) | Proportion of immature birds | Proportion from SPA | Number of immature birds from Forth Islands SPA | Corrected number of immature birds from Forth Islands SPA |
|---|---|---|---|---|---|
| NnG (2017) | 7 | 0.45 | 0.38 | 1 | 1 |
| Inch Cape (2014) | 15 | 0.45 | 0.38 | 3 | 2 |
| Seagreen A (2014) | 11 | 0.45 | 0.38 | 2 | 1 |
| Seagreen B (2014) | 6 | 0.45 | 0.38 | 1 | 1 |
| East Anglia 3 | 34 | 0.45 | 0.38 | 6 | 4 |
| East Anglia 1 | 90 | 0.45 | 0.38 | 15 | 10 |
| Hornsea 3 | 3 | 0.45 | 0.38 | 1 | 0 |
| Blyth Demonstrator | 2 | 0.45 | 0.38 | 0 | 0 |
| Dogger Creke Beck A&B | 48 | 0.45 | 0.38 | 8 | 5 |
| Dogger Teeside A&B | 34 | 0.45 | 0.38 | 6 | 4 |
| Dudgeon | 18 | 0.45 | 0.38 | 3 | 2 |
| Hornsea 1 | 18 | 0.45 | 0.38 | 3 | 2 |
| Hornsea 2 | 14 | 0.45 | 0.38 | 2 | 2 |
| Humber Gateway | 0.5 | 0.45 | 0.38 | 0 | 0 |
| Lincs | 1 | 0.45 | 0.38 | 0 | 0 |
| Race Bank | 6 | 0.45 | 0.38 | 1 | 1 |
| Sheringham Shoal | 3 | 0.45 | 0.38 | 1 | 0 |
| Teeside | 1 | 0.45 | 0.38 | 0 | 0 |
| Triton Knoll | 20 | 0.45 | 0.38 | 3 | 2 |
| Westermost Rough | 0 | 0.45 | 0.38 | 0 | 0 |
| Aberdeen demonstrator | 5 | 0.45 | 0.38 | 1 | 1 |
| Beatrice | 29 | 0.45 | 0.38 | 5 | 3 |
| Galloper | 13 | 0.45 | 0.38 | 2 | 1 |
| Greater Gabbard | 9 | 0.45 | 0.38 | 2 | 1 |

| Project | Estimated autumn collisions (all ages) | Proportion of immature birds | Proportion from SPA | Number of immature birds from Forth Islands SPA | Corrected number of immature birds from Forth Islands SPA |
|---|---|---|---|---|---|
| **Kentish Flats** | 0 | 0.45 | 0.38 | 0 | 0 |
| **London Array** | 0 | 0.45 | 0.38 | 0 | 0 |
| **Moray Firth 1** | 35 | 0.45 | 0.38 | 6 | 4 |
| **Thanet** | 0 | 0.45 | 0.38 | 0 | 0 |
| **Rampion** | 35 | 0.45 | 0.38 | 6 | 4 |
| **Total** | **457.5** | - | - | **78** | **51** |

862. This was also repeated for adults (Table 9-158) and immature birds (Table 9-159) in the spring period.

863. In Spring, the BDMPS report (Furness 2015) uses a 16 week period – December to March, whereas the SNH recommended period is January to mid-March – equivalent to a 10 week period. A proportionate recalculation based on relative length of time in the two periods is required. Therefore 10/16 or 0.625 multiplied by the number of collisions in spring is the final value required. This recalculation is shown in the final columns of Table 9-158 and Table 9-159.

Table 9-158: Estimated cumulative number of adult gannets from the Forth Islands SPA involved in collisions at NnG (2017 design), proposed Forth and Tay Wind Farms (2014 design), and other UK North Sea and English Channel Wind Farms in the spring period of the non-breeding season

| Project | Estimated spring collisions (all ages) | Proportion of adult birds | Proportion from SPA | Number of adults from Forth Islands SPA | Corrected number of adults from Forth Islands SPA |
|---|---|---|---|---|---|
| **NnG (2017)** | 7 | 0.55 | 0.47 | 2 | 1 |
| **Inch Cape (2014)** | 11 | 0.55 | 0.47 | 4 | 3 |
| **Seagreen A (2014)** | 12 | 0.55 | 0.47 | 3 | 2 |
| **Seagreen B (2014)** | 6 | 0.55 | 0.47 | 2 | 1 |
| **East Anglia 3** | 2 | 0.55 | 0.47 | 1 | 0 |
| **East Anglia 1** | 3 | 0.55 | 0.47 | 1 | 1 |
| **Hornsea 3** | 6 | 0.55 | 0.47 | 2 | 1 |
| **Blyth Demonstrator** | 3 | 0.55 | 0.47 | 1 | 1 |
| **Dogger Creke Beck A&B** | 32 | 0.55 | 0.47 | 8 | 6 |
| **Dogger Teeside A&B** | 34 | 0.55 | 0.47 | 9 | 6 |
| **Dudgeon** | 9 | 0.55 | 0.47 | 2 | 2 |

| Project | Estimated spring collisions (all ages) | Proportion of adult birds | Proportion from SPA | Number of adults from Forth Islands SPA | Corrected number of adults from Forth Islands SPA |
|---|---|---|---|---|---|
| **Hornsea 1** | 13 | 0.55 | 0.47 | 3 | 2 |
| **Hornsea 2** | 6 | 0.55 | 0.47 | 2 | 1 |
| **Humber Gateway** | 0.5 | 0.55 | 0.47 | 0 | 0 |
| **Lincs** | 2 | 0.55 | 0.47 | 1 | 0 |
| **Race Bank** | 2 | 0.55 | 0.47 | 1 | 0 |
| **Sheringham Shoal** | 1 | 0.55 | 0.47 | 0 | 0 |
| **Teeside** | 0 | 0.55 | 0.47 | 0 | 0 |
| **Triton Knoll** | 10 | 0.55 | 0.47 | 3 | 2 |
| **Westermost Rough** | 1 | 0.55 | 0.47 | 0 | 0 |
| **Aberdeen demonstrator** | 0 | 0.55 | 0.47 | 0 | 0 |
| **Beatrice** | 6 | 0.55 | 0.47 | 2 | 1 |
| **Galloper** | 6 | 0.55 | 0.47 | 2 | 1 |
| **Greater Gabbard** | 5 | 0.55 | 0.47 | 1 | 1 |
| **Kentish Flats** | 0 | 0.55 | 0.47 | 0 | 0 |
| **London Array** | 1 | 0.55 | 0.47 | 0 | 0 |
| **Moray Firth 1** | 7 | 0.55 | 0.47 | 2 | 1 |
| **Thanet** | 0 | 0.55 | 0.47 | 0 | 0 |
| **Rampion** | 35 | 0.55 | 0.47 | 9 | 6 |
| **Total** | **220.5** | - | - | **61** | **39** |

Table 9-159: Estimated cumulative number of immature gannets from the Forth Islands SPA involved in collisions at NnG (2017 design), proposed Forth and Tay Wind Farms (2014 design), and other UK North Sea and English Channel Wind Farms in the spring period of the non-breeding season

| Project | Estimated spring collisions (all ages) | Proportion of immature birds | Proportion from SPA | Number of immature birds from Forth Islands SPA | Corrected number of immature birds from Forth Islands SPA |
|---|---|---|---|---|---|
| **NnG (2017)** | 7 | 0.45 | 0.42 | 1 | 1 |
| **Inch Cape (2014)** | 11 | 0.45 | 0.42 | 2 | 1 |
| **Seagreen A (2014)** | 12 | 0.45 | 0.42 | 2 | 1 |
| **Seagreen B (2014)** | 6 | 0.45 | 0.42 | 1 | 1 |
| **East Anglia 3** | 2 | 0.45 | 0.42 | 0 | 0 |
| **East Anglia 1** | 3 | 0.45 | 0.42 | 1 | 0 |
| **Hornsea 3** | 6 | 0.45 | 0.42 | 1 | 1 |
| **Blyth Demonstrator** | 3 | 0.45 | 0.42 | 1 | 0 |
| **Dogger Creke Beck A&B** | 32 | 0.45 | 0.42 | 5 | 4 |
| **Dogger Teeside A&B** | 34 | 0.45 | 0.42 | 6 | 4 |
| **Dudgeon** | 9 | 0.45 | 0.42 | 2 | 1 |
| **Hornsea 1** | 13 | 0.45 | 0.42 | 2 | 1 |
| **Hornsea 2** | 6 | 0.45 | 0.42 | 1 | 1 |
| **Humber Gateway** | 0.5 | 0.45 | 0.42 | 0 | 0 |
| **Lincs** | 2 | 0.45 | 0.42 | 0 | 0 |
| **Race Bank** | 2 | 0.45 | 0.42 | 0 | 0 |
| **Sheringham Shoal** | 1 | 0.45 | 0.42 | 0 | 0 |
| **Teeside** | 0 | 0.45 | 0.42 | 0 | 0 |
| **Triton Knoll** | 10 | 0.45 | 0.42 | 2 | 1 |
| **Westermost Rough** | 1 | 0.45 | 0.42 | 0 | 0 |
| **Aberdeen demonstrator** | 0 | 0.45 | 0.42 | 0 | 0 |
| **Beatrice** | 6 | 0.45 | 0.42 | 1 | 1 |
| **Galloper** | 6 | 0.45 | 0.42 | 1 | 1 |
| **Greater Gabbard** | 5 | 0.45 | 0.42 | 1 | 1 |

| Project | Estimated spring collisions (all ages) | Proportion of immature birds | Proportion from SPA | Number of immature birds from Forth Islands SPA | Corrected number of immature birds from Forth Islands SPA |
|---|---|---|---|---|---|
| Kentish Flats | 0 | 0.45 | 0.42 | 0 | 0 |
| London Array | 1 | 0.45 | 0.42 | 0 | 0 |
| Moray Firth 1 | 7 | 0.45 | 0.42 | 1 | 1 |
| Thanet | 0 | 0.45 | 0.42 | 0 | 0 |
| Rampion | 35 | 0.45 | 0.42 | 6 | 4 |
| **Total** | **220.5** | - | - | **37** | **25** |

864. The combined estimated numbers of gannets (adults and immature birds) from the Forth Islands SPA involved with collisions at UK offshore wind farms in the UK North Sea and English Channel are shown in Table 9-160.

Table 9-160: Estimated cumulative number of gannets (all ages) from the Forth Islands SPA involved in collisions at NnG (2017 design), proposed Forth and Tay Wind Farms (2014 design), and other UK North Sea and English Channel Wind Farms in the autumn and spring periods of the non-breeding season

| Project | Number of adults from Forth Islands SPA in autumn period | Number of immature birds from Forth Islands in autumn period | Number of adults from Forth Islands SPA in spring period | Number of immature birds from Forth Islands in spring period | Total number of birds in non-breeding season |
|---|---|---|---|---|---|
| NnG (2017) | 1 | 1 | 1 | 1 | 4 |
| Inch Cape (2014) | 3 | 2 | 3 | 1 | 10 |
| Seagreen A (2014) | 2 | 1 | 2 | 1 | 6 |
| Seagreen B (2014) | 1 | 1 | 1 | 1 | 4 |
| Other UK OWFs in North Sea & Channel | 71 | 46 | 32 | 21 | 170 |
| **Total** | **78** | **51** | **39** | **25** | **193** |

865. The cumulative estimated number of collisions involving gannets from the Forth Islands SPA in the autumn period of the non-breeding season is 129 adults and immature birds (Table 9-160). This corresponds to 0.07% of the North Sea and English Channel population from the key SPA (Forth Islands) in the autumn period of the non-breeding season (191,857 birds) (Furness, 2015).

866. The cumulative estimated number of collisions involving gannets from the Forth Islands SPA in the spring period of the non-breeding season is 64 adults and immature birds (Table 9-160). This corresponds to 0.06% of the North Sea and English Channel population from the key SPA (Forth Islands) in the spring period of the non-breeding season (113,627 birds) (Furness, 2015).

867. Using the SNH approach (SNH, 2017), a cumulative total of 193 gannets (117 adults and 76 immature birds) from the Forth Islands SPA are estimated to be involved in collisions based on Scenario Two (NnG (2017 design), the consented Forth and Tay Wind Farms (2014 design)), and the other UK North

Sea and English Channel Wind Farms in the autumn and spring periods of the non-breeding season (Table 9-160). This corresponds to 0.1% of the North Sea and English Channel population from the key SPA (Forth Islands) in the autumn and spring periods of the non-breeding season (Furness, 2015).

868. Based on the SNH approach, it is concluded that cumulative collision mortality impacts at NnG, Inch Cape and Seagreen A & B and the other UK North Sea and English Channel Wind Farms will have no effect on the breeding SPA population of gannets within mean maximum foraging range in the non-breeding season. The sensitivity of gannets to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

*Cumulative non-breeding season assessment for kittiwake*

869. This process was then repeated for kittiwake. As before, estimated annual totals for kittiwake collisions in the draft Hornsea 3 HRA were compared to both the original and revised estimates in the Crown Estate report. Where there was good reason given in the Crown Estate report, e.g. information on likely turbine number from the developer websites, the revised Crown Estate estimate was selected. Where there was no information on changes in project number, the most conservative estimate was selected. The selected collision estimate for kittiwake for each project is highlighted in bold in Table 9-161.

Table 9-161: Comparison of estimated number of kittiwake collisions in the non-breeding season for UK North Sea Wind Farms used in this assessment

| Project | Original TCE report estimate | Revised TCE estimate | Hornsea 3 HRA estimate | Reason for selection |
|---|---|---|---|---|
| **East Anglia 3** | **113** | 113 | 89 | TCE report more conservative |
| **East Anglia 1** | 314 | **141** | 24 | Revised TCE estimate used. SPR planning building 102 turbines, not 240 |
| **Hornsea 3** | - | - | **124** | Hornsea 3 HRA estimate only one available |
| **Blyth Demonstrator** | **5** | 5 | 4 | TCE report more conservative |
| **Dogger Creke Beck A&B** | **719** | 719 | 218 | TCE report more conservative |
| **Dogger Teeside A&B** | **533** | 533 | 135 | TCE report more conservative |
| **Dudgeon** | 0 | 0 | 0 | Revised TCE estimate used. Up to 67 turbines, not 168 |
| **Hornsea 1** | 123 | **73** | 21 | Revised TCE estimate used. Up to 174 turbines, not 240 |
| **Hornsea 2** | **27** | 27 | 4 | TCE report more conservative |
| **Humber Gateway** | 8 | **3** | 6 | Revised TCE estimate used. 73 turbines built, not 83 |
| **Lincs** | **3** | 3 | 2 | TCE report more conservative |
| **Race Bank** | 31 | **19** | 23 | Revised TCE estimate used. Orsted website says up to 91 turbines, not 206 |
| **Teeside** | 81 | **55** | 56 | Revised TCE estimate used. built 27 turbines, not 30 |

| Project | Original TCE report estimate | Revised TCE estimate | Hornsea 3 HRA estimate | Reason for selection |
|---|---|---|---|---|
| **Triton Knoll** | 209 | **71** | 152 | Revised TCE estimate used. 100 turbines likely, not 288 |
| **Westermost Rough** | **1** | 1 | 0 | TCE report more conservative |
| **Aberdeen demonstrator** | 19 | **14** | 14 | Revised TCE estimate used. Slightly different turbine specifications to original consent |
| **Beatrice** | 145 | **80** | 18 | Revised TCE estimate used. Up to 84 turbines, not 125 |
| **Galloper** | 66 | **28** | 48 | Revised TCE estimate used. Up to 56 turbines, not 140 |
| **Greater Gabbard** | 28 | **29** | 20 | Revised TCE report more conservative |
| **Kentish Flats Extension** | **2** | 2 | 2 | No difference |
| **London Array** | 6 | **2** | 4 | Revised TCE estimate used. Up to 175 turbines, not 341 |
| **Moray Firth 1** | **45** | 45 | 43 | TCE report more conservative |
| **Thanet** | **1** | 1 | 1 | No difference |

870. To calculate non-breeding kittiwake collisions, the selected annual kittiwake collision estimate for each UK project was multiplied by the ratio of breeding to annual kittiwake collision estimates from the draft Hornsea 3 HRA (Table 9-162).

Table 9-162: Estimated number of kittiwake collisions in the non-breeding season for UK North Sea Wind Farms used in this assessment

| Project | Annual collision estimate | Hornsea H3 non-breeding estimates | Hornsea H3 annual estimate | Hornsea H3 ratio | Estimated non-breeding collisions |
|---|---|---|---|---|---|
| **East Anglia 3** | 113 | 79 | 89 | 0.89 | 100 |
| **East Anglia 1** | 141 | 23 | 24 | 0.96 | 135 |
| **Hornsea 3** | 124 | 43 | 124 | 0.35 | 43 |
| **Blyth Demonstrator** | 5 | 3 | 4 | 0.75 | 4 |
| **Dogger Creke Beck A&B** | 719 | 131 | 218 | 0.60 | 432 |
| **Dogger Teeside A&B** | 533 | 43 | 135 | 0.32 | 170 |
| **Dudgeon** | 0 | 0 | 0 | 0.00 | 0 |
| **Hornsea 1** | 73 | 13 | 21 | 0.62 | 45 |
| **Hornsea 2** | 27 | 2 | 4 | 0.50 | 14 |
| **Humber Gateway** | 3 | 4 | 6 | 0.67 | 2 |
| **Lincs** | 3 | 1 | 2 | 0.50 | 2 |

| Project | Annual collision estimate | Hornsea H3 non-breeding estimates | Hornsea H3 annual estimate | Hornsea H3 ratio | Estimated non-breeding collisions |
|---|---|---|---|---|---|
| Race Bank | 19 | 22 | 23 | 0.96 | 18 |
| Teeside | 55 | 19 | 56 | 0.34 | 19 |
| Triton Knoll | 71 | 134 | 152 | 0.88 | 63 |
| Westermost Rough | 1 | 0 | 0 | 0.00 | 0 |
| Aberdeen demonstrator | 14 | 4 | 14 | 0.29 | 4 |
| Beatrice | 80 | 3 | 18 | 0.17 | 13 |
| Galloper | 28 | 40 | 48 | 0.83 | 23 |
| Greater Gabbard | 29 | 17 | 20 | 0.85 | 25 |
| Kentish Flats | 2 | 1 | 2 | 0.50 | 1 |
| London Array | 2 | 3 | 4 | 0.75 | 2 |
| Moray Firth 1 | 45 | 8 | 43 | 0.19 | 8 |
| Thanet | 1 | 1 | 1 | 1.00 | 1 |
| Total | 2,088 | 594 | 1,008 | - | 1,124 |

871. The draft Hornsea 3 HRA provides a breakdown of the non-breeding season into the post-breeding season (autumn) and the pre-breeding season (spring) for the offshore UK wind farms used in this assessment. The estimated kittiwake collisions for the non-breeding season were therefore divided using the same ratio, to get the estimated number of kittiwake collisions in the autumn and spring periods (Table 9-163).

Table 9-163: Estimated number of kittiwake collisions in the autumn and spring periods of the non-breeding season for UK North Sea Wind Farms used in this assessment

| Project | Estimated non-breeding season collisions | Hornsea 3 Autumn estimate | Hornsea 3 non-breeding estimate | Hornsea H3 non-breeding ratio | Estimated autumn collisions | Estimated spring collisions |
|---|---|---|---|---|---|---|
| East Anglia 3 | 113 | 54 | 79 | 0.68 | 77 | 36 |
| East Anglia 1 | 141 | 17 | 23 | 0.74 | 104 | 37 |
| Hornsea 3 | 124 | 37 | 43 | 0.86 | 107 | 17 |
| Blyth Demonstrator | 5 | 2 | 3 | 0.67 | 3 | 2 |
| Dogger Creke Beck A&B | 719 | 41 | 131 | 0.31 | 223 | 496 |
| Dogger Teeside A&B | 533 | 27 | 43 | 0.63 | 336 | 197 |
| Dudgeon | 0 | 0 | 0 | 0.00 | 0 | 0 |
| Hornsea 1 | 73 | 9 | 13 | 0.69 | 50 | 23 |

| Project | Estimated non-breeding season collisions | Hornsea 3 Autumn estimate | Hornsea 3 non-breeding estimate | Hornsea H3 non-breeding ratio | Estimated autumn collisions | Estimated spring collisions |
|---|---|---|---|---|---|---|
| Hornsea 2 | 27 | 1 | 2 | 0.50 | 13.5 | 13.5 |
| Humber Gateway | 3 | 2 | 4 | 0.50 | 1.5 | 1.5 |
| Lincs | 3 | 1 | 1 | 1.00 | 3 | 0 |
| Race Bank | 19 | 17 | 22 | 0.77 | 15 | 4 |
| Teeside | 55 | 17 | 19 | 0.89 | 49 | 6 |
| Triton Knoll | 71 | 101 | 134 | 0.75 | 53 | 18 |
| Westermost Rough | 1 | 0 | 0 | 0.00 | 1 | 0 |
| Aberdeen demonstrator | 14 | 4 | 4 | 1.00 | 14 | 0 |
| Beatrice | 80 | 1 | 3 | 0.33 | 26 | 54 |
| Galloper | 28 | 20 | 40 | 0.50 | 14 | 14 |
| Greater Gabbard | 29 | 11 | 17 | 0.65 | 19 | 10 |
| Kentish Flats | 2 | 1 | 1 | 1.00 | 2 | 0 |
| London Array | 2 | 2 | 3 | 0.67 | 1 | 1 |
| Moray Firth 1 | 45 | 2 | 8 | 0.25 | 11 | 34 |
| Thanet | 1 | 0 | 1 | 0.00 | 1 | 0 |
| Total | 2,088 | | | | 1,124 | 964 |

872. Following the SNH approach, the next stage is to adjust the total collisions attributed to the four SPAs being considered in this assessment (Table 9-8) for each period (autumn and spring) by the age proportions and the proportional representation of each SPA colony within the BDMPS for that period.  As recommended in the SNH approach, the ratio of adult (53%) to immature birds (47%) was taken from the stable age structure percentages as reported in Furness (2015.)

873. The proportion of adult and immature kittiwakes from the SPA colonies within the BDMPS for the autumn and spring periods was calculated by dividing the estimated number of adult and immature kittiwakes from each SPA by the total estimated BDMPS population (Table 9-164).

Table 9-164: Proportion of adult and immature kittiwakes from key SPAs in the North Sea in the autumn and spring periods of the non-breeding season

| SPA | Estimated number of adults in UK N Sea in autumn period | Estimated number of immature birds in UK N Sea in autumn period | Estimated number of adults in UK N Sea in spring period | Estimated number of immature birds in UK N Sea in spring period |
|---|---|---|---|---|
| **Buchan Ness to Collieston Coast SPA** | | | | |
| **Estimated number of birds** | 15,050 | 8,830 | 15,050 | 6,622 |
| **Total BDMPS** | 480,815 | 349,122 | 375,815 | 252,001 |
| **Proportion from SPA** | 0.03 | 0.03 | 0.04 | 0.03 |
| **Fowlsheugh SPA** | | | | |
| **Estimated number of birds** | 11,204 | 6,573 | 11,204 | 4,930 |
| **Total BDMPS** | 480,815 | 349,122 | 375,815 | 252,001 |
| **Proportion from SPA** | 0.02 | 0.02 | 0.03 | 0.02 |
| **Forth Islands SPA** | | | | |
| **Estimated number of birds** | 3,720 | 2,182 | 3,720 | 1,637 |
| **Total BDMPS** | 480,815 | 349,122 | 375,815 | 252,001 |
| **Proportion from SPA** | 0.008 | 0.006 | 0.01 | 0.006 |
| **St Abb's Head to Fast Castle SPA** | | | | |
| **Estimated number of birds** | 4,084 | 2,396 | 4,084 | 1,797 |
| **Total BDMPS** | 480,815 | 349,122 | 375,815 | 252,001 |
| **Proportion from SPA** | 0.008 | 0.007 | 0.01 | 0.007 |

874. Estimated kittiwake collisions for the non-breeding season for NnG and the other Forth and Tay projects based on the worst-case option (Scenario Two – NnG 2017 and 2014 consents for Inch Cape and Seagreen A and B) (Table 9-148), were also included with the non-breeding season estimated collisions for the UK North Sea wind farms (Table 9-165).

875. The proportions of adults and immature birds were then used to calculate the numbers of adult kittiwakes from the four SPAs (Table 9-164) involved in collisions at each of the UK North Sea offshore wind farms in the autumn period of the non-breeding season (Table 9-165). The number of autumn collisions was multiplied by the proportion of adults (53%) (Furness, 2015), and by the proportion of adults from each SPA (Table 9-164).

876. As the seasonal period definitions used in Furness (2015) do not match the definitions in the SNH guidance, the approach recommended by SNH is to assume a flat rate of collisions during the season, and to recalculate according to the relative lengths of the periods. For kittiwake, the autumn post breeding period in the BDMPS report (Furness 2015) is 20 weeks from August to December. The SNH recommendation is from September to December, which is 16 weeks. As such, a proportionate

recalculation based on the relative length of time in the two periods is required. Therefore 0.8 multiplied by the number of collisions in autumn is the final value required. These recalculations are shown in Appendix 9.9: Cumulative Impact Assessment additional calculations.

Table 9-165: Estimated cumulative number of adult kittiwakes from the Forth Islands SPA involved in collisions at NnG (2017 design), proposed Forth and Tay Wind Farms (2014 design), and other UK North Sea Wind Farms in the autumn period of the non-breeding season

| Project | Estimated collisions (all ages) | Number of adults from Buchan Ness to Collieston SPA | Number of adults from Fowlsheugh SPA | Number of adults from Forth Islands SPA | Number of adults from St Abb's to Fast Castle SPA |
|---|---|---|---|---|---|
| **NnG (2017)** | 17 | 0.22 | 0.14 | 0.06 | 0.06 |
| **Inch Cape (2014)** | 80 | 1.02 | 0.68 | 0.27 | 0.27 |
| **Seagreen A (2014)** | 217 | 2.76 | 1.84 | 0.74 | 0.74 |
| **Seagreen B (2014)** | 123 | 1.56 | 1.04 | 0.42 | 0.42 |
| **East Anglia 3** | 77 | 0.98 | 0.65 | 0.26 | 0.26 |
| **East Anglia 1** | 104 | 1.32 | 0.88 | 0.35 | 0.35 |
| **Hornsea 3** | 107 | 1.36 | 0.91 | 0.36 | 0.36 |
| **Blyth Demonstrator** | 3 | 0.04 | 0.03 | 0.01 | 0.01 |
| **Dogger Creke Beck A&B** | 223 | 2.84 | 1.89 | 0.76 | 0.76 |
| **Dogger Teeside A&B** | 336 | 4.27 | 2.85 | 1.14 | 1.14 |
| **Dudgeon** | 0 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Hornsea 1** | 50 | 0.64 | 0.42 | 0.17 | 0.17 |
| **Hornsea 2** | 13.5 | 0.17 | 0.11 | 0.05 | 0.05 |
| **Humber Gateway** | 1.5 | 0.02 | 0.01 | 0.01 | 0.01 |
| **Lincs** | 3 | 0.04 | 0.03 | 0.01 | 0.01 |
| **Race Bank** | 15 | 0.19 | 0.13 | 0.05 | 0.05 |
| **Teeside** | 49 | 0.62 | 0.42 | 0.17 | 0.17 |
| **Triton Knoll** | 53 | 0.67 | 0.45 | 0.18 | 0.18 |
| **Westermost Rough** | 1 | 0.01 | 0.01 | 0.00 | 0.00 |
| **Aberdeen demonstrator** | 14 | 0.18 | 0.12 | 0.05 | 0.05 |
| **Beatrice** | 26 | 0.33 | 0.22 | 0.09 | 0.09 |
| **Galloper** | 14 | 0.18 | 0.12 | 0.05 | 0.05 |
| **Greater Gabbard** | 19 | 0.24 | 0.16 | 0.06 | 0.06 |
| **Kentish Flats** | 2 | 0.03 | 0.02 | 0.01 | 0.01 |

| Project | Estimated collisions (all ages) | Number of adults from Buchan Ness to Collieston SPA | Number of adults from Fowlsheugh SPA | Number of adults from Forth Islands SPA | Number of adults from St Abb's to Fast Castle SPA |
|---|---|---|---|---|---|
| London Array | 1 | 0.01 | 0.01 | 0.00 | 0.00 |
| Moray Firth 1 | 11 | 0.14 | 0.09 | 0.04 | 0.04 |
| Thanet | 1 | 0.01 | 0.01 | 0.00 | 0.00 |
| **Total** | **1,561** | **19.85** | **13** | **5** | **5** |

877. This was repeated for immature birds in the autumn period (Table 9-157), and also for adults in the spring period (Table 9-158) and immature birds in the spring period (Table 9-159). For the immature birds, the number of seasonal collisions was multiplied by the proportion of immature birds (47%) (Furness, 2015), and by the proportion of immature birds from each SPA (Table 9-164).

Table 9-166: Estimated cumulative number of immature kittiwakes from the key SPAs involved in collisions at NnG (2017 design), proposed Forth and Tay Wind Farms (2014 design), and other UK North Sea Wind Farms in the autumn period of the non-breeding season

| Project | Estimated collisions (all ages) | Number of immature birds from Buchan Ness to Collieston SPA | Number of immature birds from Fowlsheugh SPA | Number of immature birds from Forth Islands SPA | Number of immature birds from St Abb's to Fast Castle SPA |
|---|---|---|---|---|---|
| NnG (2017) | 17 | 0.19 | 0.13 | 0.04 | 0.04 |
| Inch Cape (2014) | 80 | 0.90 | 0.60 | 0.18 | 0.21 |
| Seagreen A (2014) | 217 | 2.45 | 1.63 | 0.49 | 0.57 |
| Seagreen B (2014) | 123 | 1.39 | 0.92 | 0.28 | 0.32 |
| East Anglia 3 | 77 | 0.87 | 0.58 | 0.17 | 0.20 |
| East Anglia 1 | 104 | 1.17 | 0.78 | 0.23 | 0.27 |
| Hornsea 3 | 107 | 1.21 | 0.80 | 0.24 | 0.28 |
| Blyth Demonstrator | 3 | 0.03 | 0.02 | 0.01 | 0.01 |
| Dogger Creke Beck A&B | 223 | 2.52 | 1.68 | 0.50 | 0.59 |
| Dogger Teeside A&B | 336 | 3.79 | 2.53 | 0.76 | 0.88 |
| Dudgeon | 0 | 0.00 | 0.00 | 0.00 | 0.00 |
| Hornsea 1 | 50 | 0.56 | 0.38 | 0.11 | 0.13 |
| Hornsea 2 | 13.5 | 0.15 | 0.10 | 0.03 | 0.04 |
| Humber Gateway | 1.5 | 0.02 | 0.01 | 0.00 | 0.00 |
| Lincs | 3 | 0.03 | 0.02 | 0.01 | 0.01 |
| Race Bank | 15 | 0.17 | 0.11 | 0.03 | 0.04 |
| Teeside | 49 | 0.55 | 0.37 | 0.11 | 0.13 |

| Project | Estimated collisions (all ages) | Number of immature birds from Buchan Ness to Collieston SPA | Number of immature birds from Fowlsheugh SPA | Number of immature birds from Forth Islands SPA | Number of immature birds from St Abb's to Fast Castle SPA |
|---|---|---|---|---|---|
| **Triton Knoll** | 53 | 0.60 | 0.40 | 0.12 | 0.14 |
| **Westermost Rough** | 1 | 0.01 | 0.01 | 0.00 | 0.00 |
| **Aberdeen demonstrator** | 14 | 0.16 | 0.11 | 0.03 | 0.04 |
| **Beatrice** | 26 | 0.29 | 0.20 | 0.06 | 0.07 |
| **Galloper** | 14 | 0.16 | 0.11 | 0.03 | 0.04 |
| **Greater Gabbard** | 19 | 0.21 | 0.14 | 0.04 | 0.05 |
| **Kentish Flats** | 2 | 0.02 | 0.02 | 0.00 | 0.01 |
| **London Array** | 1 | 0.01 | 0.01 | 0.00 | 0.00 |
| **Moray Firth 1** | 11 | 0.12 | 0.08 | 0.02 | 0.03 |
| **Thanet** | 1 | 0.01 | 0.01 | 0.00 | 0.00 |
| **Total** | **1,561** | **17.59** | **12** | **4** | **4** |

878. For kittiwake, the spring migration period in the BDMPS report (Furness 2015) is 16 weeks from January to April inclusive. The SNH recommendation is from January to mid-April, which is 14 weeks. As such, a proportionate recalculation based on the relative length of time in the two periods is required. Therefore 0.875 multiplied by the number of collisions in spring is the final value required. These recalculations are shown in Appendix 9.9.

Table 9-167: Estimated cumulative number of adult kittiwakes from the Forth Islands SPA involved in collisions at NnG (2017 design), proposed Forth and Tay Wind Farms (2014 design), and other UK North Sea Wind Farms in the spring period of the non-breeding season

| Project | Estimated collisions (all ages) | Number of adults from Buchan Ness to Collieston SPA | Number of adults from Fowlsheugh SPA | Number of adults from Forth Islands SPA | Number of adults from St Abb's to Fast Castle SPA |
|---|---|---|---|---|---|
| **NnG (2017)** | 2 | 0.02 | 0.02 | 0.01 | 0.01 |
| **Inch Cape (2014)** | 18 | 0.21 | 0.16 | 0.05 | 0.05 |
| **Seagreen A (2014)** | 78 | 0.90 | 0.68 | 0.23 | 0.23 |
| **Seagreen B (2014)** | 104 | 1.21 | 0.90 | 0.30 | 0.30 |
| **East Anglia 3** | 36 | 0.42 | 0.31 | 0.10 | 0.10 |
| **East Anglia 1** | 37 | 0.43 | 0.32 | 0.11 | 0.11 |
| **Hornsea 3** | 17 | 0.20 | 0.15 | 0.05 | 0.05 |
| **Blyth Demonstrator** | 2 | 0.02 | 0.02 | 0.01 | 0.01 |
| **Dogger Creke Beck A&B** | 496 | 5.75 | 4.31 | 1.44 | 1.44 |

| Project | Estimated collisions (all ages) | Number of adults from Buchan Ness to Collieston SPA | Number of adults from Fowlsheugh SPA | Number of adults from Forth Islands SPA | Number of adults from St Abb's to Fast Castle SPA |
|---|---|---|---|---|---|
| **Dogger Teeside A&B** | 197 | 2.28 | 1.71 | 0.57 | 0.57 |
| **Dudgeon** | 0 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Hornsea 1** | 23 | 0.27 | 0.20 | 0.07 | 0.07 |
| **Hornsea 2** | 13.5 | 0.16 | 0.12 | 0.04 | 0.04 |
| **Humber Gateway** | 1.5 | 0.02 | 0.01 | 0.00 | 0.00 |
| **Lincs** | 0 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Race Bank** | 4 | 0.05 | 0.03 | 0.01 | 0.01 |
| **Teeside** | 6 | 0.07 | 0.05 | 0.02 | 0.02 |
| **Triton Knoll** | 18 | 0.21 | 0.16 | 0.05 | 0.05 |
| **Westermost Rough** | 0 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Aberdeen demonstrator** | 0 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Beatrice** | 54 | 0.63 | 0.47 | 0.16 | 0.16 |
| **Galloper** | 14 | 0.16 | 0.12 | 0.04 | 0.04 |
| **Greater Gabbard** | 10 | 0.12 | 0.09 | 0.03 | 0.03 |
| **Kentish Flats** | 0 | 0.00 | 0.00 | 0.00 | 0.00 |
| **London Array** | 1 | 0.01 | 0.01 | 0.00 | 0.00 |
| **Moray Firth 1** | 34 | 0.39 | 0.30 | 0.10 | 0.10 |
| **Thanet** | 0 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total** | **1,166** | **14** | **10** | **3** | **3** |

Table 9-168: Estimated cumulative number of immature kittiwakes from the key SPAs involved in collisions at NnG (2017 design), proposed Forth and Tay Wind Farms (2014 design), and other UK North Sea Wind Farms in the spring period of the non-breeding season

| Project | Estimated collisions (all ages) | Number of immature birds from Buchan Ness to Collieston SPA | Number of immature birds from Fowlsheugh SPA | | Number of immature birds from St Abb's to Fast Castle SPA |
|---|---|---|---|---|---|
| **NnG (2017)** | 2 | 0.02 | 0.01 | 0.00 | 0.00 |
| **Inch Cape (2014)** | 24 | 0.14 | 0.09 | 0.03 | 0.03 |
| **Seagreen A (2014)** | 93 | 0.60 | 0.40 | 0.12 | 0.14 |

| Project | Estimated collisions (all ages) | Number of immature birds from Buchan Ness to Collieston SPA | Number of immature birds from Fowlsheugh SPA | | Number of immature birds from St Abb's to Fast Castle SPA |
|---|---|---|---|---|---|
| **Seagreen B (2014)** | 114 | 0.80 | 0.53 | 0.16 | 0.19 |
| **East Anglia 3** | 36 | 0.28 | 0.19 | 0.06 | 0.06 |
| **East Anglia 1** | 37 | 0.29 | 0.19 | 0.06 | 0.07 |
| **Hornsea 3** | 17 | 0.13 | 0.09 | 0.03 | 0.03 |
| **Blyth Demonstrator** | 2 | 0.02 | 0.01 | 0.00 | 0.00 |
| **Dogger Creke Beck A&B** | 496 | 3.82 | 2.55 | 0.76 | 0.89 |
| **Dogger Teeside A&B** | 197 | 1.52 | 1.01 | 0.30 | 0.35 |
| **Dudgeon** | 0 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Hornsea 1** | 23 | 0.18 | 0.12 | 0.04 | 0.04 |
| **Hornsea 2** | 13.5 | 0.10 | 0.07 | 0.02 | 0.02 |
| **Humber Gateway** | 1.5 | 0.01 | 0.01 | 0.00 | 0.00 |
| **Lincs** | 0 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Race Bank** | 4 | 0.03 | 0.02 | 0.01 | 0.01 |
| **Teeside** | 6 | 0.05 | 0.03 | 0.01 | 0.01 |
| **Triton Knoll** | 18 | 0.14 | 0.09 | 0.03 | 0.03 |
| **Westermost Rough** | 0 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Aberdeen demonstrator** | 0 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Beatrice** | 54 | 0.42 | 0.28 | 0.08 | 0.10 |
| **Galloper** | 14 | 0.11 | 0.07 | 0.02 | 0.03 |
| **Greater Gabbard** | 10 | 0.08 | 0.05 | 0.02 | 0.02 |
| **Kentish Flats** | 0 | 0.00 | 0.00 | 0.00 | 0.00 |
| **London Array** | 1 | 0.01 | 0.01 | 0.00 | 0.00 |
| **Moray Firth 1** | 34 | 0.26 | 0.17 | 0.05 | 0.06 |
| **Thanet** | 0 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total** | **1,166** | **9** | **6** | **2** | **2** |

879. The combined estimated numbers of kittiwakes (adults and immature birds) from Buchan Ness to Collieston Coast SPA involved with collisions at UK offshore wind farms in the UK North Sea are shown in Table 9-169.

Table 9-169: Estimated cumulative number of kittiwakes (all ages) from the Buchan Ness to Collieston Coast SPA involved in collisions at NnG (2017 design), consented Forth and Tay Wind Farms (2014 design), and other UK North Sea Wind Farms in the autumn and spring periods of the non-breeding season

| Project | Number of adults from Buchan Ness to Collieston Coast SPA in autumn period | Number of immature birds from Buchan Ness to Collieston Coast SPA in autumn period | Number of adults from Buchan Ness to Collieston Coast SPA in spring period | Number of immature birds from Buchan Ness to Collieston Coast SPA in spring period | Total number of birds in non-breeding season |
|---|---|---|---|---|---|
| **NnG (2017)** | 0.22 | 0.19 | 0.02 | 0.02 | 0.45 |
| **Inch Cape (2014)** | 1.02 | 0.9 | 0.21 | 0.14 | 2.27 |
| **Seagreen A (2014)** | 2.76 | 2.45 | 0.90 | 0.60 | 6.71 |
| **Seagreen B (2014)** | 1.56 | 1.39 | 1.21 | 0.80 | 4.96 |
| **Other UK OWFs in North Sea & Channel** | 14.29 | 12.66 | 11.19 | 7.45 | 45.59 |
| **Total** | **19.85** | **17.59** | **13.53** | **9.01** | **59.98** |

880. The cumulative estimated number of collisions involving kittiwakes from the Buchan Ness to Collieston Coast SPA in the autumn period of the non-breeding season is 37 adults and immature birds (Table 9-169). This corresponds to 0.15% of the North Sea population for this SPA in the autumn period of the non-breeding season (23,880 birds) (Furness, 2015).

881. The cumulative estimated number of collisions involving kittiwakes from the Buchan Ness to Collieston Coast SPA in the spring period of the non-breeding season is 23 adults and immature birds (Table 9-169). This corresponds to 0.1% of the North Sea population for this SPA in the spring period of the non-breeding season (21,673 birds) (Furness, 2015).

882. Using the SNH approach (SNH, 2017), a cumulative total of 60 kittiwakes (33 adults and 27 immature birds) from the Buchan Ness to Collieston Coast SPA are estimated to be involved in collisions based on Scenario Two (NnG (2017 design), the proposed Forth and Tay Wind Farms (2014 design)), and the other UK North Sea Wind Farms in the autumn and spring periods of the non-breeding season (Table 9-169). This corresponds to 0.25% of the North Sea population for this SPA in the autumn and spring periods of the non-breeding season (Furness, 2015).

883. The combined estimated numbers of kittiwakes (adults and immature birds) from Fowlsheugh SPA involved with collisions at UK offshore wind farms in the UK North Sea are shown in Table 9-170.

Table 9-170: Estimated cumulative number of kittiwakes (all ages) from Fowlsheugh SPA involved in collisions at NnG (2017 design), consented Forth and Tay Wind Farms (2014 design), and other UK North Sea Wind Farms in the autumn and spring periods of the non-breeding season

| Project | Number of adults from Fowlsheugh SPA in autumn period | Number of immature birds from Fowlsheugh SPA in autumn period | Number of adults from Fowlsheugh SPA in spring period | Number of immature birds from Fowlsheugh SPA in spring period | Total number of birds in non-breeding season |
|---|---|---|---|---|---|
| **NnG (2017)** | 0.14 | 0.13 | 0.02 | 0.01 | 0.3 |
| **Inch Cape (2014)** | 0.68 | 0.60 | 0.16 | 0.09 | 1.53 |

| Project | Number of adults from Fowlsheugh SPA in autumn period | Number of immature birds from Fowlsheugh SPA in autumn period | Number of adults from Fowlsheugh SPA in spring period | Number of immature birds from Fowlsheugh SPA in spring period | Total number of birds in non-breeding season |
|---|---|---|---|---|---|
| **Seagreen A (2014)** | 1.84 | 1.63 | 0.68 | 0.40 | 4.55 |
| **Seagreen B (2014)** | 1.04 | 0.92 | 0.90 | 0.53 | 3.39 |
| **Other UK OWFs in North Sea & Channel** | 9.54 | 8.47 | 8.38 | 4.96 | 31.55 |
| **Total** | **13.24** | **11.75** | **10.14** | **5.99** | **41.32** |

884. The cumulative estimated number of collisions involving kittiwakes from Fowlsheugh SPA in the autumn period of the non-breeding season is 25 adults and immature birds (Table 9-170). This corresponds to 0.1% of the North Sea population for this SPA in the autumn period of the non-breeding season (17,778 birds) (Furness, 2015).

885. The cumulative estimated number of collisions involving kittiwakes from Fowlsheugh SPA in the spring period of the non-breeding season is 16 adults and immature birds (Table 9-170). This corresponds to 0.1% of the North Sea population for this SPA in the spring period of the non-breeding season (16,134 birds) (Furness, 2015).

886. Using the SNH approach (SNH, 2017), a cumulative total of 41 kittiwakes (23 adults and 18 immature birds) from Fowlsheugh SPA are estimated to be involved in collisions based on Scenario Two (NnG (2017 design), the proposed Forth and Tay Wind Farms (2014 design)), and the other UK North Sea Wind Farms in the autumn and spring periods of the non-breeding season (Table 9-170). This corresponds to 0.2% of the North Sea population for this SPA in the autumn and spring periods of the non-breeding season (Furness, 2015).

887. The combined estimated numbers of kittiwakes (adults and immature birds) from Forth Islands SPA involved with collisions at UK offshore wind farms in the UK North Sea are shown in Table 9-171.

Table 9-171: Estimated cumulative number of kittiwakes (all ages) from Forth Islands SPA involved in collisions at NnG (2017 design), proposed Forth and Tay Wind Farms (2014 design), and other UK North Sea Wind Farms in the autumn and spring periods of the non-breeding season

| Project | Number of adults from Forth Islands SPA in autumn period | Number of immature birds from Forth Islands SPA in autumn period | Number of adults from Forth Islands SPA in spring period | Number of immature birds from Forth Islands SPA in spring period | Total number of birds in non-breeding season |
|---|---|---|---|---|---|
| **NnG (2017)** | 0.06 | 0.04 | 0.01 | 0 | 0.11 |
| **Inch Cape (2014)** | 0.27 | 0.18 | 0.05 | 0.03 | 0.53 |
| **Seagreen A (2014)** | 0.74 | 0.49 | 0.23 | 0.12 | 1.58 |
| **Seagreen B (2014)** | 0.42 | 0.28 | 0.30 | 0.16 | 1.16 |
| **Other UK OWFs in North Sea & Channel** | 3.82 | 2.50 | 2.8 | 1.49 | 10.61 |
| **Total** | **5.31** | **3.49** | **3.39** | **1.8** | **13.99** |

888. The cumulative estimated number of collisions involving kittiwakes from the Forth Islands SPA in the autumn period of the non-breeding season is nine adults and immature birds (Table 9-171). This corresponds to 0.15% of the North Sea population for this SPA in the autumn period of the non-breeding season (5,902 birds) (Furness, 2015).

889. The cumulative estimated number of collisions involving kittiwakes from the Forth Islands SPA in the spring period of the non-breeding season is five adults and immature birds (Table 9-171). This corresponds to 0.09% of the North Sea population for this SPA in the spring period of the non-breeding season (5,357 birds) (Furness, 2015).

890. Using the SNH approach (SNH, 2017), a cumulative total of 14 kittiwakes (nine adults and five immature birds) from Forth Islands SPA are estimated to be involved in collisions based on Scenario Two (NnG (2017 design), the proposed Forth and Tay Wind Farms (2014 design)), and the other UK North Sea Wind Farms in the autumn and spring periods of the non-breeding season (Table 9-171). This corresponds to 0.24% of the North Sea population for this SPA in the autumn and spring periods of the non-breeding season (Furness, 2015).

891. The combined estimated numbers of kittiwakes (adults and immature birds) from St Abbs Head to Fast Castle SPA involved with collisions at UK offshore wind farms in the UK North Sea are shown in Table 9-172.

Table 9-172: Estimated cumulative number of kittiwakes (all ages) from St Abbs Head to Fast Castle SPA involved in collisions at NnG (2017 design), proposed Forth and Tay Wind Farms (2014 design), and other UK North Sea Wind Farms in the autumn and spring periods of the non-breeding season

| Project | Number of adults from St Abbs Head to Fast Castle SPA in autumn period | Number of immature birds from St Abbs Head to Fast Castle SPA in autumn period | Number of adults from St Abbs Head to Fast Castle SPA in spring period | Number of immature birds from St Abbs Head to Fast Castle SPA in spring period | Total number of birds in non-breeding season |
|---|---|---|---|---|---|
| **NnG (2017)** | 0.06 | 0.04 | 0.01 | 0 | 0.11 |
| **Inch Cape (2014)** | 0.27 | 0.21 | 0.05 | 0.03 | 0.56 |
| **Seagreen A (2014)** | 0.74 | 0.57 | 0.23 | 0.14 | 1.68 |
| **Seagreen B (2014)** | 0.42 | 0.32 | 0.30 | 0.19 | 1.23 |
| **Other UK OWFs in North Sea & Channel** | 3.82 | 2.96 | 2.8 | 1.72 | 11.30 |
| **Total** | **5.31** | **4.1** | **3.39** | **2.08** | **14.88** |

892. The cumulative estimated number of collisions involving kittiwakes from St Abbs Head to Fast Castle SPA in the autumn period of the non-breeding season is nine adults and immature birds (Table 9-172). This corresponds to 0.1% of the North Sea population for this SPA in the autumn period of the non-breeding season (6,479 birds) (Furness, 2015).

893. The cumulative estimated number of collisions involving kittiwakes from St Abbs Head to Fast Castle SPA in the spring period of the non-breeding season is six adults and immature birds (Table 9-172). This corresponds to 0.09% of the North Sea population for this SPA in the spring period of the non-breeding season (5,880 birds) (Furness, 2015).

894. Using the SNH approach (SNH, 2017), a cumulative total of 15 kittiwakes (nine adults and six immature birds) from St Abbs Head to Fast Castle SPA are estimated to be involved in collisions based on Scenario Two (NnG (2017 design), the proposed Forth and Tay Wind Farms (2014 design)), and the

other UK North Sea Wind Farms in the autumn and spring periods of the non-breeding season (Table 9-172). This corresponds to 0.19% of the North Sea population for this SPA in the autumn and spring periods of the non-breeding season (Furness, 2015).

895. The combined estimated numbers of kittiwakes (adults and immature birds) from all four SPAs involved with collisions at UK offshore wind farms in the UK North Sea are shown in Table 9-173.

Table 9-173: Estimated cumulative number of kittiwakes (all ages) from St Abbs Head to Fast Castle SPA involved in collisions at NnG (2017 design), proposed Forth and Tay Wind Farms (2014 design), and other UK North Sea Wind Farms in the autumn and spring periods of the non-breeding season

| Project | Total number of birds from Buchan Ness to Collieston Coast SPA in non-breeding period | Total number of birds from Fowlsheugh SPA in non-breeding period | Total number of birds from Forth Islands SPA in non-breeding period | Total number of birds from St Abbs Head to Fast Castle SPA in non-breeding period | Total number of birds in non-breeding season |
|---|---|---|---|---|---|
| **NnG (2017)** | 0.45 | 0.3 | 0.11 | 0.11 | 0.97 |
| **Inch Cape (2014)** | 2.27 | 1.53 | 0.53 | 0.56 | 4.89 |
| **Seagreen A (2014)** | 6.71 | 4.55 | 1.58 | 1.68 | 14.52 |
| **Seagreen B (2014)** | 4.96 | 3.39 | 1.16 | 1.23 | 10.74 |
| **Other UK OWFs in North Sea & Channel** | 45.59 | 31.55 | 10.61 | 11.30 | 99.05 |
| **Total** | **59.98** | **41.32** | **13.99** | **14.88** | **130.17** |

896. Using the SNH approach (SNH, 2017), a cumulative total of 130 kittiwakes from the four SPAs are estimated to be involved in collisions from Scenario Two (NnG (2017 design), the proposed Forth and Tay Wind Farms (2014 design)), and the other UK North Sea Wind Farms in the non-breeding season each year (Table 9-173). This corresponds to 0.9% of the North Sea population for these four SPAs in the autumn and spring periods of the non-breeding season (Furness, 2015).

897. Based on the SNH approach, it is concluded that cumulative collision mortality impacts at NnG, Inch Cape and Seagreen A & B and the other UK North Sea Wind Farms will have no effect on the breeding SPA population of kittiwakes within mean maximum foraging range in the non-breeding season. The sensitivity of kittiwakes to collision is assessed as high and the magnitude of any impacts will be negligible. The significance of this impact is therefore assessed to be **minor** and not significant in EIA terms.

### 9.9.5 PVA for NnG, Inch Cape and Seagreen A & B

898. This section presents the results of the Population Viability Analysis on NnG cumulatively with the Inch Cape and Seagreen A and B projects, as well as with other offshore wind farm projects in the UK North Sea and English Channel. For the purposes of clarity, in this section NnG refers to the 2017 design scenario for the Project, while “F&T” refers to Inch Cape, Seagreen and Seagreen B.

899. Methods for the PVA are presented in Appendix 9.8.

**Scenarios**

900. For the cumulative assessment, effects from collisions and displacement were apportioned to the relevant SPA populations based on the scenarios outlined in Table 9-72. In summary, these covered cumulative collision impacts for NnG, Inch Cape, and Seagreen projects and other UK offshore wind

projects in the North Sea and English Channel for gannet and kittiwake. For guillemot, razorbill and puffin, the PVA covered cumulative displacement effects for NnG, Inch Cape and Seagreen Phase 1 or Seagreen A and B. Further details are presented in Appendix 9.8.

901. Effects from NnG were based on collision rate modelling using Band Option 2 and displacement figures following SNCB guidance (Table 9-73). Apportioning for the relevant populations was based on a two-step process: (i) proportion in SPAs, and (ii) across the relevant SPA populations. Further information is provided in Appendix 9.8.

902. For the 2017 Inch Cape and Seagreen Phase 1 design scenarios (Scenario One), collision rate estimates were based on figures from 2017 proposals using Band Option 2. These were combined with estimates from NnG (54 turbines, Table 9-73). Displacement figures followed SNCB guidance. Apportioning for the relevant populations was based on a two-step process: (i) proportion in SPAs, and (ii) across the relevant SPA populations (Table 9-174).

Table 9-174: Effects applied to population models for NnG Worst-case design scenario (54 turbines) and Inch Cape & Seagreen 2017 design scenarios. Unless indicated as refering to adults (ad), effects are applied using the stable age structure.

| Species | Population | Collisions | Displacement | Collisions & Displacement (year round) | Collisions and displacement (breeding season) |
|---|---|---|---|---|---|
| **Gannet** | Forth Islands | 595 | | | |
| **Kittiwake** | Forth Islands | 80 | | 11 ad + 80 | |
| **Kittiwake** | Fowlsheugh | 166 | | 22 ad + 166 | |
| **Puffin** | Forth Islands | | 107 ad | | |
| **Guillemot** | Forth Islands | | 15 ad + 21 | | |
| **Guillemot** | Fowlsheugh | | 30 ad + 41 | | |
| **Razorbill** | Forth Islands | | 8 ad + 17 | | |
| **Razorbill** | Fowlsheugh | | 11 ad + 22 | | |

903. For the 2014 Inch Cape and Seagreen A and B design scenarios (Scenario Two), collision rate estimates were based on figures from 2014 proposals using Band Option 2 . These were combined with estimates from NnG (54 turbines, Table 9-73). Displacement figures followed SNCB guidance. Apportioning for the relevant populations was based on a two-step process: (i) proportion in SPAs, and (ii) across the relevant SPA populations (Table 9-175).

Table 9-175: Effects applied to population models for NnG Worst-case design scenario (54 turbines) and Inch Cape & Seagreen 2014 design scenarios. Unless indicated as refering to adults (ad), effects are applied using the stable age structure.

| Species | Population | Collisions | Displacement | Collisions & Displacement (year round) | Collisions and displacement (breeding season) |
|---|---|---|---|---|---|
| **Gannet** | Forth Islands | 1,302 | | | |
| **Kittiwake** | Forth Islands | 228 | | 11 ad + 228 | |
| **Kittiwake** | Fowlsheugh | 473 | | 22 ad + 473 | |

| Species | Population | Collisions | Displacement | Collisions & Displacement (year round) | Collisions and displacement (breeding season) |
|---|---|---|---|---|---|
| **Puffin** | Forth Islands | | 107 ad | | |
| **Guillemot** | Forth Islands | | 15 ad + 21 | | |
| **Guillemot** | Fowlsheugh | | 30 ad + 41 | | |
| **Razorbill** | Forth Islands | | 8 ad + 17 | | |
| **Razorbill** | Fowlsheugh | | 11 ad + 22 | | |

904. Breeding season effects from Forth & Tay wind farms were summed with the non-breeding effects from Forth & Tay wind farms and relevant UK wind farms (Table 9-176). Displacement of kittiwake at English offshore wind farms has been considered as nil and has not been assessed. The effects of UK wind farms outside of the Forth and Tay wind farms were therefore limited to collisions during the non-breeding season.

Table 9-176: Effects applied to population models for NnG Worst-case design scenario (54 turbines) and population models for UK waters. Unless indicated as refering to adults (ad), effects are applied using the stable age structure.

| Species | Population | Collisions | Displacement | Collisions & Displacement (year round) | Collisions and displacement (breeding season) |
|---|---|---|---|---|---|
| **Gannet** | Forth Islands SPA | 668 | | | |
| **Kittiwake** | Forth Islands SPA | 11 ad + 41 | | | |
| **Kittiwake** | Fowlsheugh SPA | 22 ad + 94 | | | |

### *9.9.5.1.1 Gannet*

905. For gannet, only collision impacts were modelled in the cumulative PVA. For the Forth and Tay projects there were two scenarios modelled. As previously, Scenario One was for the NnG 2017 design scenario, and Inch Cape and Seagreen Phase 1 2017 design scenarios. Scenario Two considered the NnG 2017 design scenario with the 2014 consented designs for Inch Cape and Seagreen A and B.

**Scenario One: NnG 2017 design scenario and Inch Cape and Seagreen Phase 1 2017 (Phase 1) design scenarios**

906. Changes in the predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2017 F&T projects over 25 years are shown in Table 9-177.

Table 9-177: Change in predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2017 Forth and Tay projects over 25 years

| Species | SPA Population | Baseline change after 25 years (no wind farms) | Percentage point change with NnG & F&T projects after 25 years (collisions all year) | Percentage change in median annual growth rate compared to baseline | Counterfactual of the annual growth rate |
|---|---|---|---|---|---|
| **Gannet** | Forth Islands | 1.7171 | -0.294 | -17.10 | 82.90% |

907. The gannet population growth rate is predicted to increase over the 25 year period, although there is a decrease in this growth rate when the NnG and Forth and Tay projects are present. Overall, the change in the median annual growth rate when comparing the baseline (no wind farms) with the NnG and Forth and Tay projects is a decrease of 17.10% (Table 9-177). Alternatively, the counterfactual of the growth rate is 82.90% of that for the scenario with no wind farm constructed.

908. Changes in the predicted population size for gannets breeding at the Bass Rock with and without the NnG and 2017 Forth and Tay projects over 25 years are shown in Table 9-178.

Table 9-178: Change in predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2017 Forth and Tay projects over 25 years

| Species | SPA & start Population | Baseline population after 25 years (no wind farm) | Population after 25 years with NnG & F&T projects (collisions all year) | Percentage change in median final population size compared to baseline | Counterfactual of Population Size (CPS) |
|---|---|---|---|---|---|
| **Gannet** | Forth Islands 75,259 pairs | 132,394 pairs | 123,131 pairs | -7.00 | 93.00% |

909. After 25 years, the gannet breeding population at the Forth Islands SPA is predicted to have increased considerably with the NnG and 2017 Forth and Tay projects present, compared to the current population level (75,259 pairs), although the increase is not predicted to be as high as the scenario with no wind farms present (Table 9-178). Overall, the change in the median final population size when comparing the baseline (no wind farms) with the built scenario is a decrease of 7.00%. This equates to a CPS value of 93.00% of the scenario with no wind farm.

910. Changes in the predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2017 Forth and Tay projects over 50 years are shown in Table 9-179.

Table 9-179: Change in predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2017 Forth and Tay projects over 50 years

| Species | SPA Population | Baseline change after 50 years (no wind farm) | Percentage point change with NnG & F&T projects after 50 years (collisions all year) | Percentage change in median annual growth rate compared to baseline | Counterfactual of the annual growth rate |
|---|---|---|---|---|---|
| **Gannet** | Forth Islands | 1.7189 | -0.296 | -17.24 | 82.76% |

911. The gannet population growth rate at the Forth Islands SPA is predicted to increase over the 50 year period, although there is a decrease in this growth rate when the NnG and 2017 Forth and Tay projects are present. Overall, the change in the median annual growth rate when comparing the

baseline (no wind farms) with the built scenario after 50 years is a decrease of 17.24% (Table 9-179). Alternatively, the counterfactual of the growth rate is 82.76% of that for the scenario with no wind farm constructed. These values are similar to those predicted after 25 years (Table 9-177).

912. Changes in the predicted population size for gannets breeding at the Bass Rock with and without the NnG and 2017 Forth and Tay projects over 50 years are shown in Table 9-180.

Table 9-180: Change in predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario 1 Forth and Tay projects over 50 years

| Species | SPA & start Population | Baseline population after 50 years (no wind farm) | Population after 50 years with NnG & F&T projects (collisions all year) | Percentage change in median final population size compared to baseline | Counterfactual of Population Size (CPS) |
|---|---|---|---|---|---|
| **Gannet** | Forth Islands 75,259 pairs | 203,046 pairs | 175,208 pairs | -13.71 | 86.29% |

913. After 50 years, the gannet breeding population at the Forth Islands SPA is predicted to have increased considerably with the NnG and Forth and Tay projects present, compared to the current population level (75,259 pairs), although the increase is not predicted to be as high as the scenario with no wind farms present (Table 9-180). This was similar to but slightly lower than the prediction after 25 years (Table 9-178). Overall, the change in the median final population size when comparing the baseline (no wind farms) with the built scenario is a decrease of 13.71%. This equates to a CPS value of 86.29% of the scenario with no wind farm.

914. A comparison of the 50$^{th}$ centile values for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2017 Forth and Tay projects over 25 years and 50 years is shown in Table 9-181.

Table 9-181: Comparison of the 50$^{th}$ centile values for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2017 Forth and Tay projects over 25 years and 50 years

| Species | SPA Population | 50th centile for unimpacted population (Baseline) | Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG & F&T projects (collisions all year) | Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG & F&T projects (collisions all year) |
|---|---|---|---|---|
| **Gannet** | Forth Islands | 0.5 | 0.05 | 0.01 |

915. For an unimpacted population 50% of the model runs would not be lower than the median. When the impact is predicted to be larger, the distribution curves of unimpacted and impacted population sizes are further apart. This results in a lower likelihood of the unimpacted population being at or below the median of the impacted population. Comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted populations shows that over 25 years at least 5% and over 50 years at least 1% of the model runs end not lower than the median population size of the unimpacted population. This indicates that there is a low probability of the unimpacted population being at or below the median of the impacted population.

**Scenario 2: NnG 2017 design scenario and Inch Cape and Seagreen A and B 2014 design scenarios**

916. Changes in the predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2014 Forth and Tay projects over 25 years are shown in Table 9-182.

Table 9-182: Change in predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2014 Forth and Tay projects over 25 years

| Species | SPA Population | Baseline change after 25 years (no wind farms) | Percentage point change with NnG & F&T projects after 25 years (collisions all year) | Percentage change in median annual growth rate compared to baseline | Counterfactual of the annual growth rate |
|---|---|---|---|---|---|
| **Gannet** | Forth Islands | 1.7171 | -0.632 | -36.81 | 63.19% |

917. The gannet population growth rate is predicted to increase over the 25 year period, although the growth rate when the NnG and 2014 Forth and Tay projects are present is reduced. Overall, the change in the median annual growth rate when comparing the baseline (no wind farms) with the NnG and Forth and Tay projects is a decrease of 36.81% (Table 9-182), which is more than double the decrease in rate compared to Scenario One (Table 9-177). Alternatively, the counterfactual of the growth rate is 63.19% of that for the scenario with no wind farm constructed, which is also lower than was estimated for Scenario One after 25 years (Table 9-177).

918. Changes in the predicted population size for gannets breeding at the Bass Rock with and without the NnG and 2014 Forth and Tay projects over 25 years are shown in Table 9-183.

Table 9-183: Change in predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2014 Forth and Tay projects over 25 years

| Species | SPA & start Population | Baseline population after 25 years (no wind farm) | Population after 25 years with NnG & F&T projects (collisions all year) | Percentage change in median final population size compared to baseline | Counterfactual of Population Size (CPS) |
|---|---|---|---|---|---|
| **Gannet** | Forth Islands 75,259 pairs | 132,394 pairs | 112,892 pairs | -14.73 | 85.27% |

919. After 25 years, the gannet breeding population at the Forth Islands SPA is predicted to have increased with the NnG and 2014 Forth and Tay projects present, compared to the current population level (75,259 pairs), although the increase is not predicted to be as high as the scenario with no wind farms present (Table 9-183). Comparing the Scenario Two results with Scenario One (Table 9-178), the predicted percentage change in the median final population size is approximately double for Scenario Two, at -14.73%. The CPS value for Scenario Two after 25 years is also lower than for Scenario One, at 85.27% of the scenario with no wind farm.

920. Changes in the predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2014 Forth and Tay projects over 50 years are shown in Table 9-184.

Table 9-184: Change in predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2014 Forth and Tay projects over 50 years

| Species | SPA Population | Baseline change after 50 years (no wind farm) | Percentage point change with NnG & F&T projects after 50 years (collisions all year) | Percentage change in median annual growth rate compared to baseline | Counterfactual of the annual growth rate |
|---|---|---|---|---|---|
| **Gannet** | Forth Islands | 1.7189 | -0.632 | -36.79 | 63.21% |

921. The gannet population growth rate at the Forth Islands SPA is predicted to increase over the 50 year period, although there is a decrease in this growth rate when the NnG and 2014 Forth and Tay projects are present (Table 9-184). Overall, the change in the median annual growth rate when comparing the baseline (no wind farms) with Scenario Two after 50 years is a decrease of 36.79%, which is more than double the decrease in rate compared to Scenario One (Table 9-179). Alternatively, the counterfactual of the growth rate is 63.21% of that for the scenario with no wind farm constructed, which is also lower than was estimated for Scenario One after 50 years (Table 9-179).

922. Changes in the predicted population size for gannets breeding at the Bass Rock with and without the NnG and 2014 Forth and Tay projects over 50 years are shown in Table 9-185.

Table 9-185: Change in predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without NnG and the 2014 Forth and Tay projects over 50 years

| Species | SPA & start Population | Baseline population after 50 years (no wind farm) | Population after 50 years with NnG & F&T projects (collisions all year) | Percentage change in median final population size compared to baseline | Counterfactual of Population Size (CPS) |
|---|---|---|---|---|---|
| **Gannet** | Forth Islands 75,259 pairs | 203,046 pairs | 148,150 pairs | -27.04 | 72.96% |

923. After 50 years, the gannet breeding population at the Forth Islands SPA is predicted to have increased considerably with NnG and the 2014 Forth and Tay projects present, compared to the current population level (75,259 pairs), although the increase is not predicted to be as high with no wind farms present (Table 9-185). As expected, the predicted final population size after 50 years is also lower for Scenario Two than for Scenario One (Table 9-180). Overall, the change in the median final population size after 50 years when comparing the baseline (no wind farms) with Scenario Two present is a decrease of 27.04%. The CPS value for Scenario Two after 50 years is also lower than for Scenario One, at 72.96% of the scenario with no wind farm.

924. A comparison of the 50th centile values for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2014 Forth and Tay projects over 25 years and 50 years is shown in Table 9-186.

Table 9-186: Comparison of the 50th centile values for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2014 Forth and Tay projects over 25 years and 50 years

| Species | SPA Population | 50th centile for unimpacted population (Baseline) | Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG & F&T projects (collisions all year) | Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG & F&T projects (collisions all year) |
|---|---|---|---|---|
| **Gannet** | Forth Islands | 0.5 | 0 | 0 |

925. For an unimpacted population 50% of the model runs would not be lower than the median. When the impact is predicted to be larger, the distribution curves of unimpacted and impacted population sizes are further apart. This results in a lower likelihood of the unimpacted population being at or below the median of the impacted population. Comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted populations shows that over both 25 years and 50 years, 0% of the model runs end not lower than the median population size of the unimpacted population. This indicates that there is a very low probability of the unimpacted population being at or below the median of the impacted population.

**NnG, Inch Cape and Seagreen A and B, plus UK North Sea and English Channel OWF projects**

926. For gannet, the Scoping Opinion recommended that the PVA assessed cumulative collision impacts arising from NnG, Inch Cape and Seagreen in the breeding season, together with collision impacts in the non-breeding season from other projects in the UK North Sea and English Channel (Marine Scotland, 2017).

927. As previously, Scenario One was for the NnG design scenario, and Inch Cape and Seagreen A and B 2017 design scenarios. Scenario Two considered the NnG 2017 design scenario with the 2014 consented designs for Inch Cape and Seagreen A and B.

928. For clarity, these are referred to as “Scenario One & UK” and “Scenario Two & UK” in the following text and tables.

**Scenario 1 and UK**

929. Changes in the predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario One & UK projects over 25 years are shown in Table 9-187.

Table 9-187: Change in predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario One & UK projects over 25 years

| Species | SPA Population | Baseline change after 25 years (no wind farms) | Percentage point change with NnG, F&T & UK projects after 25 years (collisions all year) | Percentage change in median annual growth rate compared to baseline | Counterfactual of the annual growth rate |
|---|---|---|---|---|---|
| **Gannet** | Forth Islands | 1.7171 | -0.319 | -18.57 | 81.43% |

930. The gannet population growth rate at the Forth Islands SPA is predicted to increase over the 25 year period, although there is a decrease in this growth rate when the Scenario One & UK projects are present. Overall, the change in the median annual growth rate when comparing the baseline (no wind farms) with the built projects is a decrease of 18.57% (Table 9-187). Alternatively, the counterfactual of the growth rate is 81.43% of that for the scenario with no wind farms constructed.

931. This change in median annual growth rate is lower for the Scenario One & UK projects, compared with Scenario Two and no UK projects (Table 9-182). This is as a result of including gannets from other colonies and countries present in the North Sea in the non-breeding season in the assessment, and of subsequent apportioning of impacts across these populations.

932. Changes in the predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario One & UK projects over 25 years are shown in Table 9-188.

Table 9-188: Change in predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario One & UK projects over 25 years

| Species | SPA & start Population | Baseline population after 25 years (no wind farm) | Population after 25 years with NnG, F&T & UK projects (collisions all year) | Percentage change in median final population size compared to baseline | Counterfactual of Population Size (CPS) |
|---|---|---|---|---|---|
| **Gannet** | Forth Islands 75,259 pairs | 132,394 pairs | 121,977 pairs | -7.87 | 92.13% |

933. The gannet breeding population at the Forth Islands SPA is predicted to increase over the 25 year period, although the predicted end population is lower when the Scenario One & UK projects are present (Table 9-188). Overall, the change in the median annual growth rate when comparing the baseline (no wind farms) with the built projects is a decrease of 7.87%. The predicted end population and the CPS value are both higher for the Scenario One & UK projects, compared with Scenario Two (NnG & 2014 F&T projects, no UK projects) (79,322 pairs) (Table 9-183). This is as a result of including gannets from other colonies and countries present in the North Sea in the non-breeding season in the assessment, and of subsequent apportioning of impacts during the non-breeding season across these populations.

934. Changes in the predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario One & UK projects over 50 years are shown in Table 9-189.

Table 9-189: Change in predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario One & UK projects over 50 years

| Species | SPA Population | Baseline change after 50 years (no wind farm) | Percentage point change with NnG, F&T & UK projects after 50 years (collisions all year) | Percentage change in median annual growth rate compared to baseline | Counterfactual of the annual growth rate |
|---|---|---|---|---|---|
| **Gannet** | Forth Islands | 1.7189 | -0.322 | -18.72 | 81.28% |

935. The gannet population growth rate at the Forth Islands SPA is predicted to increase over the 50 year period, although there is a decrease in this growth rate when the Scenario One & UK projects are present (Table 9-189). Overall, the change in the median annual growth rate when comparing the baseline (no wind farms) with the built projects is a decrease of 18.72%, which is similar to the 25 year assessment (Table 9-187). The corresponding counterfactual of the annual growth rate is 81.28%, which is also similar to the 25 year assessment value.

936. This change in median annual growth rate and the associated counterfactual is lower for the Scenario One & UK projects, compared with Scenario Two (NnG & 2014 F&T projects, no UK projects) (Table 9-182). This is as a result of including gannets from other colonies and countries present in the North Sea in the non-breeding season in the assessment, and of subsequent apportioning of impacts during the non-breeding season across these populations.

937. Changes in the predicted population size for gannets breeding at the Bass Rock with and without the Scenario One & UK projects over 50 years are shown in Table 9-190.

Table 9-190: Change in predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario One & UK projects over 50 years

| Species | SPA & start Population | Baseline population after 50 years (no wind farm) | Population after 50 years with NnG, F&T & UK projects (collisions all year) | Percentage change in median final population size compared to baseline | Counterfactual of Population Size (CPS) |
|---|---|---|---|---|---|
| **Gannet** | Forth Islands 75,259 pairs | 203,046 pairs | 172,618 pairs | -14.99% | 85.01% |

938. The gannet breeding population at the Forth Islands SPA is predicted to increase over the 50 year period, although the predicted end population is lower when the Scenario One & UK projects are present compared to the baseline (Table 9-190). Overall, the change in the median annual growth rate when comparing the baseline (no wind farms) with the built projects is a decrease of 14.99%. The predicted end population and the CPS value are both higher for the Scenario One & UK projects, compared with Scenario Two (NnG & 2014 F&T projects, no UK projects) after 50 years (148,150 pairs) (Table 9-185), but slightly lower than the predicted end population for Scenario One (No UK projects) (175,208 pairs) (Table 9-180). This is as a result of including gannets from other colonies and countries present in the North Sea in the non-breeding season in the assessment and of subsequent apportioning of impacts during the non-breeding season across these populations.

939. A comparison of the 50th centile values for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario One and UK projects over 25 years and 50 years is shown in Table 9-191.

Table 9-191: Comparison of the 50th centile values for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario One and UK projects over 25 years and 50 years

| Species | SPA Population | 50th centile for unimpacted population (Baseline) | Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG, F&T & UK projects (collisions all year) | Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG, F&T & UK projects (collisions all year) |
|---|---|---|---|---|
| **Gannet** | Forth Islands | 0.5 | 0.03 | 0.01 |

940. For an unimpacted population 50% of the model runs would not be lower than the median. When the impact is predicted to be larger, the distribution curves of unimpacted and impacted population sizes are further apart. This results in a lower likelihood of the unimpacted population being at or below the median of the impacted population. Comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted populations shows that over 25 years at least 3% and over 50 years at least 1% of the model runs end not lower than the median population size of the unimpacted population. This indicates that there is a low probability of the unimpacted population being at or below the median of the impacted population.

**Scenario 2 & UK**

941. Changes in the predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario Two and UK projects over 25 years are shown in Table 9-192.

Table 9-192: Change in predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario Two and UK projects over 25 years

| Species | SPA Population | Baseline change after 25 years (no wind farms) | Percentage point change with NnG, F&T & UK projects after 25 years (collisions all year) | Percentage change in median annual growth rate compared to baseline | Counterfactual of the annual growth rate |
|---|---|---|---|---|---|
| **Gannet** | Forth Islands | 1.7171 | -0.648 | -37.76 | 62.24% |

942. For both the baseline and built scenarios, the gannet population growth rate at the Forth Islands SPA is predicted to increase over the 25 year period, although there is a decrease in this growth rate when the Scenario Two and UK projects are present. Overall, the change in the median annual growth rate when comparing the baseline (no wind farms) with the built projects is a decrease of 37.36% (Table 9-192). Alternatively, the counterfactual of the growth rate is 62.24% of that for the scenario with no wind farms constructed.

943. The change in median annual growth rate for the Scenario Two and UK projects, was only slightly larger (-37.76%) than Scenario Two with no UK projects) (-36.81%) (Table 9-182). The value for the associated counterfactual (62.24%) followed a similar pattern (63.19%). This is as a result of including gannets from other colonies and countries present in the North Sea in the non-breeding season in the assessment, and of subsequent apportioning of impacts across these populations.

944. Changes in the predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario Two and UK projects over 25 years are shown in Table 9-193.

Table 9-193: Change in predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario Two and UK projects over 25 years

| Species | SPA & start Population | Baseline population after 25 years (no wind farm) | Population after 25 years with NnG, F&T & UK projects (collisions all year) | Percentage change in median final population size compared to baseline | Counterfactual of Population Size (CPS) |
|---|---|---|---|---|---|
| **Gannet** | Forth Islands 75,259 pairs | 132,394 pairs | 112,406 pairs | -15.10 | 84.90% |

945. For both the baseline and built scenarios, the gannet breeding population at the Forth Islands SPA is predicted to increase over the 25 year period, although the predicted end population is lower when the Scenario Two and UK projects are present (Table 9-193). Overall, the change in the median annual growth rate when comparing the baseline (no wind farms) with the built projects is a decrease of 15.10%. The predicted end population and the CPS value are both only slightly lower for the Scenario Two and UK projects, compared with Scenario Two (NnG & 2014 F&T projects, no UK projects) (112,892 pairs and CPS value of 85.27% (Table 9-183). This is as a result of including gannets from other colonies and countries present in the North Sea in the non-breeding season in the assessment, and of subsequent apportioning of impacts during the non-breeding season across these populations.

946. Changes in the predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario Two and UK projects over 50 years are shown in Table 9-194.

Table 9-194: Change in predicted population growth rate for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario Two and UK projects over 50 years

| Species | SPA Population | Baseline change after 50 years (no wind farms) | Percentage point change with NnG, F&T & UK projects after 50 years (collisions all year) | Percentage change in median annual growth rate compared to baseline | Counterfactual of the annual growth rate |
|---|---|---|---|---|---|
| **Gannet** | Forth Islands | 1.7189 | -0.650 | -37.81 | 62.19% |

947. For both the baseline and built scenarios, the gannet population growth rate at the Forth Islands SPA is predicted to increase over the 50 year period, although there is a decrease in this growth rate when the Scenario Two and UK projects are present (Table 9-194). Overall, the change in the median annual growth rate when comparing the baseline (no wind farms) with the built projects is a decrease of 37.81%, which is very slightly larger than for the 25 year assessment (-37.76%) (Table 9-192). The counterfactual of the growth rate (62.19%) is also correspondingly slightly lower than for the 25 year assessment (62.24%).

948. This change in median annual growth rate is only slightly larger for the Scenario Two and UK projects, compared with Scenario Two (NnG & 2014 F&T projects, no UK projects) (-36.79%), with a corresponding similarity between the values for the counterfactual of the growth rate (Table 9-184). This is a result of including gannets from other colonies and countries present in the North Sea in the non-breeding season in the assessment, and of subsequent apportioning of impacts during the non-breeding season across these populations.

949. Changes in the predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario Two and UK projects over 50 years are shown in Table 9-195.

Table 9-195: Change in predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario Two and UK projects over 50 years

| Species | SPA & start Population | Baseline population after 50 years (no wind farm) | Population after 50 years with NnG, F&T & UK projects (collisions all year) | Percentage change in median final population size compared to baseline | Counterfactual of Population Size (CPS) |
|---|---|---|---|---|---|
| **Gannet** | Forth Islands<br>75,259 pairs | 203,046 pairs | 146,818 pairs | -27.69 | 72.31% |

950. For both the baseline and built scenarios, the gannet breeding population at the Forth Islands SPA is predicted to increase over the 50 year period, although the predicted end population is lower when the Scenario Two and UK projects are present compared to the baseline (Table 9-195). Overall, the change in the median annual growth rate when comparing the baseline (no wind farms) with the built projects is a decrease of -27.69%, with a corresponding CPS value of 72.31%. The predicted end population and the CPS value are both only slightly lower for the Scenario Two and UK projects, compared with Scenario Two (NnG & 2014 F&T projects, no UK projects) after 50 years (148,150 pairs and CPS value of 72.96%) (Table 9-185). This is as a result of including gannets from other colonies and countries present in the North Sea in the non-breeding season in the assessment and of subsequent apportioning of impacts during the non-breeding season across these populations.

951. A comparison of the 50$^{th}$ centile values for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario Two and UK projects over 25 years and 50 years is shown in Table 9-196.

Table 9-196: Comparison of the 50th centile values for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Scenario Two and UK projects over 25 years and 50 years

| Species | SPA Population | 50th centile for unimpacted population (Baseline) | Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG, F&T & UK projects (collisions all year) | Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG, F&T & UK projects (collisions all year) |
|---|---|---|---|---|
| **Gannet** | Forth Islands | 0.5 | 0 | 0 |

952. For an unimpacted population 50% of the model runs would not be lower than the median. When the impact is predicted to be larger, the distribution curves of unimpacted and impacted population sizes are further apart. This results in a lower likelihood of the unimpacted population being at or below the median of the impacted population. Comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted populations shows that over both 25 years and 50 years 0% of the model runs end below the median population size of the unimpacted population. This indicates that there is a low probability of the unimpacted population being at or below the median of the impacted population.

### *9.9.5.1.2 Kittiwake*

953. As with gannet, the PVA modelled outputs from the 2017 and 2014 design scenarios for Inch Cape and Seagreen A and B, termed Scenario One and Scenario Two respectively. As recommended in the Scoping Opinion, the PVA modelled the effects of annual collisions on their own, and also with annual displacement (Marine Scotland, 2017).

**Scenario One: NnG 2017 design scenario and 2017 Inch Cape and Seagreen Phase 1 design scenarios**

954. Changes in the predicted population growth rate for kittiwakes breeding in the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2017 Forth and Tay projects over 25 years are shown in Table 9-197.

Table 9-197: Change in predicted population growth rate for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2017 Forth and Tay projects over 25 years

| Species | SPA Population | Baseline change after 25 years (no wind farm) | Percentage point change with NnG & F&T projects after 25 years | | Percentage change in median annual growth rate compared to baseline | | Counterfactual of the annual growth rate | |
|---|---|---|---|---|---|---|---|---|
| | | | Collision (y) | Collision (y) & Disp (br) | Collision (y) | Collision (y) & Disp (br) | Collision (y) | Collision (y) & Disp (br) |
| **Kittiwake** | Forth Islands | 0.9099 | -0.508 | -0.628 | -55.87 | -68.99 | 44.13% | 31.01% |
| | Fowlsheugh | -2.2647 | -0.384 | -0.475 | -16.93 | -20.96 | 116.93% | 120.96% |

955. For the Forth Islands SPA, for both the baseline and built scenarios, the population growth rate for kittiwake is predicted to increase slightly over the 25 year period, although there is a slightly lower rate of increase when NnG and the 2017 Forth and Tay projects are present (Table 9-197). When collision and displacement effects were considered together, the percentage point change in the predicted population growth rate was larger, compared to collision effects alone. The values for the percentage change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario, and the corresponding counterfactual of the growth rate are both

overestimated by the model, due to the fact that the Forth Islands SPA population of kittiwake is predicted to be fairly stable over 25 years, with a low population growth rate. This means that any change in median annual growth rate will be relatively large, relative to the small initial rate. Similarly, the counterfactual of the growth rate is highly influenced by the initial growth rate and bears little relevance to the change in growth rate on its own. Therefore, in this case, the percentage point change gives a better representation of the change in growth rate.

956. For Fowlsheugh SPA, for both the baseline and built scenarios, the population growth rate for kittiwake is predicted to decrease over the 25 year period, with a slightly higher rate of decrease when NnG and the 2017 Forth and Tay projects are present (Table 9-197). Collision and displacement effects combined resulted in a larger percentage change than collision alone. For the counterfactual of the annual growth rate, as the baseline population for kittiwake at Fowlsheugh SPA has a negative growth rate, a counterfactual growth rate of >100% indicates a further decline in growth rate for these impacted scenarios.

957. Changes in the predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2017 Forth and Tay projects over 25 years are shown in Table 9-198.

Table 9-198: Change in predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2017 Forth and Tay projects over 25 years

| Species | SPA & start Population | Baseline population after 25 years (no wind farm) | Population after 25 years with NnG & F&T projects | | Percentage change in median final population size compared to baseline | | Counterfactual of Population Size (CPS | |
|---|---|---|---|---|---|---|---|---|
| | | | Coll (y) | Coll (y) & Disp (br) | Coll (y) | Coll (y) & Disp (br) | Coll (y) | Coll (y) & Disp (br) |
| **Kittiwake** | Forth Islands 4,663 pairs | 6,118 pairs | 5,380 pairs | 5,202 pairs | -12.07 | -14.97 | 87.93% | 85.03% |
| | Fowlsheugh 9,665 pairs | 4,629 pairs | 4,166 pairs | 4,084 pairs | -9.99 | -11.77 | 90.01% | 88.23% |

958. For the Forth Islands SPA, the kittiwake breeding population is predicted to be higher than the start population at the end of the 25 year period, although the end population is predicted to be lowerwhen NnG and the 2017 Forth and Tay projects are present (Table 9-198). The largest difference was predicted to occur for combined collisions throughout the year and displacement in the breeding season. Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG and the 2017 Forth and Tay projects is a maximum decrease of 14.97% for the Forth Islands SPA, for collisions throughout the year and displacement in the breeding season. This gives a CPS value of 85.03% of the scenario with no wind farm.

959. For the Fowlsheugh SPA, the kittiwake breeding population is predicted to be lower than the start population at the end of the 25 year period, with a lower predicted end population when NnG and the 2017 Forth and Tay projects are present (Table 9-198). There was a slightly lower end population predicted for combined collisions throughout the year and displacement in the breeding season, compared to collisions alone. Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG and the 2017 Forth and Tay projects is a maximum decrease of 11.77% for Fowlsheugh SPA, for combined collisions throughout the year and displacement in the breeding season. This gives a CPS value of 88.23% of the scenario with no wind farm.

960. Changes in the predicted population growth rate for kittiwakes breeding in the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2017 Forth and Tay projects over 50 years are shown in Table 9-199.

Table 9-199: Change in predicted population growth rate for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2017 Forth and Tay projects over 50 years

| Species | SPA Population | Baseline change after 50 years (no wind farm) | Percentage point change with NnG & F&T projects after 50 years | | Percentage change in median annual growth rate compared to baseline | | Counterfactual of the annual growth rate | |
|---|---|---|---|---|---|---|---|---|
| | | | Collision (y) | Collision (y) & Disp (br) | Collision (y) | Collision (y) & Disp (br) | Collision (y) | Collision (y) & Disp (br) |
| **Kittiwake** | Forth Islands | 0.9068 | -0.511 | -0.625 | -56.36 | -68.88 | 43.64% | 31.12% |
| | Fowlsheugh | -2.2758 | -0.385 | -0.466 | -16.90 | -20.49 | 116.90% | 120.49% |

961. For the Forth Islands SPA, for both the baseline and built scenarios, the population growth rate for kittiwake is predicted to increase slightly over the 50 year period, although there is a slightly lower rate of increase when NnG and the 2017 Forth and Tay projects are present (Table 9-199). When collision and displacement effects were considered together, the percentage point change in the predicted population growth rate was slightly larger, compared to collision effects alone. The values for the percentage change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario, and the corresponding counterfactual of the growth rate are both overestimated by the model, due to the fact that the Forth Islands SPA population of kittiwake is predicted to be fairly stable over 50 years, with a low population growth rate. This means that any change in median annual growth rate will be relatively large, relative to the small initial rate. Similarly, the counterfactual of the growth rate is highly influenced by the initial growth rate and bears little relevance to the change in growth rate on its own. Therefore, in this case, the percentage point change gives a better representation of the change in growth rate.For Fowlsheugh SPA, for both the baseline and built scenarios, the population growth rate for kittiwake is predicted to decrease over the 50 year period, with a slightly higher rate of decrease when NnG and the 2017 Forth and Tay projects are present (Table 9-199). Collision and displacement effects combined resulted in a larger percentage change than collision alone. For the counterfactual of the annual growth rate, as the baseline population for kittiwake at Fowlsheugh SPA has a negative growth rate, a counterfactual growth rate of >100% indicates a further decline in growth rate for these impacted scenarios. Percentage change and associated CPS values were similar to those estimated after 25 years (Table 9-197).

962. Changes in the predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2017 Forth and Tay projects over 50 years are shown in Table 9-200.

Table 9-200: Change in predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2017 Forth and Tay projects over 50 years

| Species | SPA & start Population | Baseline population after 50 years (no wind farm) | Population after 50 years with NnG & F&T projects | | Percentage change in median final population size compared to baseline | | Counterfactual of Population Size (CPS | |
|---|---|---|---|---|---|---|---|---|
| | | | Coll (y) | Coll (y) & Disp (br) | Coll (y) | Coll (y) & Disp (br) | Coll (y) | Coll (y) & Disp (br) |
| **Kittiwake** | Forth Islands 4,663 pairs | 7,665 pairs | 5,920 pairs | 5,593 pairs | -22.77 | -27.03 | 77.23% | 72.97% |
| | Fowlsheugh 9,665 pairs | 2,593 pairs | 2,125 pairs | 2,036 pairs | -18.03 | -21.50 | 81.97% | 78.50% |

963. Overall, with no wind farms present, the Forth Islands SPA population was predicted to be higher after 50 years than the current population level. When NnG and the 2017 Forth and Tay projects are present, the end population is predicted to be lower than the baseline end population, with a slightly lower end population predicted for combined collisions throughout the year and displacement in the breeding season, compared to collisions alone (Table 9-200). This gives a CPS value of 72.97% of the scenario with no wind farm.

964. For the Fowlsheugh SPA population, for both the baseline and built scenarios, the kittiwake breeding population is predicted to be lower than the start population after 50 years, with a lower predicted end population when NnG and the 2017 Forth and Tay projects are present (Table 9-200). There was a slightly lower end population predicted for combined collisions throughout the year and displacement in the breeding season, compared to collisions alone. Similarly, CPS values were slightly lower for collisions and displacement throughout the year, compared to collisions alone.

965. A comparison of the 50$^{th}$ centile values for kittiwakes breeding at the Forth Islands and Fowlsheugh SPAs with and without NnG and the 2017 Forth and Tay projects over 25 years and 50 years is shown in Table 9-201.

Table 9-201: Comparison of the 50$^{th}$ centile values for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2017 Forth and Tay projects over 25 years and 50 years

| Species | SPA Population | 50th centile for unimpacted population (Baseline) | Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG & F&T projects | | Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG & F&T projects | |
|---|---|---|---|---|---|---|
| | | | Coll (y) | Coll (y) & Disp (br) | Coll (y) | Coll (y) & Disp (br) |
| **Kittiwake** | Forth Islands | 0.50 | 0.03 | 0.01 | 0.01 | 0 |
| | Fowlsheugh | 0.50 | 0.06 | 0.03 | 0.03 | 0.01 |

966. For an unimpacted population 50% of the model runs would not be lower than the median. When the impact is predicted to be larger, the distribution curves of unimpacted and impacted population sizes are further apart. This results in a lower likelihood of the unimpacted population being at or below

the median of the impacted population. Comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted Forth Islands SPA populations shows that over 25 years, between 1% and 3%, and over 50 years between 0% and 1% of the model runs end not lower than the median population size of the unimpacted population. For Fowlsheugh SPA, over 25 years, between 3% and 6%, and over 50 years between 1% and 3% of the model runs end not lower than the median population size of the unimpacted population. This indicates that there is a low probability of the unimpacted population being at or below the median of the impacted population.

**Scenario Two: NnG 2017 design scenario and 2014 Inch Cape and Seagreen A and B design scenarios**

967. Changes in the predicted population growth rate for kittiwakes breeding in the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2014 Forth and Tay projects over 25 years are shown in Table 9-202.

Table 9-202: Change in predicted population growth rate for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2014 Forth and Tay projects over 25 years

| Species | SPA Population | Baseline change after 25 years (no wind farm) | Percentage point change with NnG & F&T projects after 25 years | | Percentage change in median annual growth rate compared to baseline | | Counterfactual of the annual growth rate | |
|---|---|---|---|---|---|---|---|---|
| | | | Collision (y) | Collision (y) & Disp (br) | Collision (y) | Collision (y) & Disp (br) | Collision (y) | Collision (y) & Disp (br) |
| **Kittiwake** | Forth Islands | 0.9099 | -1.464 | -1.583 | -160.92 | -174.00 | -60.92% | -74.00% |
| | Fowlsheugh | -2.2647 | -1.104 | -1.193 | -48.73 | -52.69 | 148.73% | 152.69% |

968. For the Forth Islands SPA, for the baseline scenario, the population growth rate for kittiwake is predicted to increase slightly over the 25 year period. With NnG and the 2014 Forth and Tay projects present, the population is predicted to decline, with a percentage point change of -1.464 from the baseline, for collision alone (Table 9-202). When collision and displacement effects were considered together, the percentage point change in the predicted population growth rate was slightly larger (-1.583), compared to collision effects alone. The values for the percentage change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario, and the corresponding counterfactual of the growth rate are both overestimated by the model, due to the fact that the Forth Islands SPA population of kittiwake is predicted to be fairly stable over 25 years, with a low population growth rate. This means that any change in median annual growth rate will be relatively large, relative to the small initial rate. Similarly, the counterfactual of the growth rate is highly influenced by the initial growth rate and bears little relevance to the change in growth rate on its own. Therefore, in this case, the percentage point change gives a better representation of the change in growth rate.

969. For Fowlsheugh SPA, for both baseline and built scenarios, the population growth rate for kittiwake is predicted to decrease slightly over the 25 year period, with a higher rate of decrease for combined annual collision and breeding season displacement effects, compared to collision alone. The difference between the associated counterfactual of the growth rate values was also slightly greater for collision and displacement than for collision alone. For the counterfactual of the annual growth rate, as the baseline population for kittiwake has a negative growth rate, a counterfactual growth rate of >100% indicates a further decline in growth rate for these impacted scenarios.

970. Changes in the predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2014 Forth and Tay projects over 25 years are shown in Table 9-203.

Table 9-203: Change in predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2014 Forth and Tay projects over 25 years

| Species | SPA & start Population | Baseline population after 25 years (no wind farm) | Population after 25 years with NnG & F&T projects | | Percentage change in median final population size compared to baseline | | Counterfactual of Population Size (CPS | |
|---|---|---|---|---|---|---|---|---|
| | | | Coll (y) | Coll (y) & Disp (br) | Coll (y) | Coll (y) & Disp (br) | Coll (y) | Coll (y) & Disp (br) |
| **Kittiwake** | Forth Islands 4,663 pairs | 6,118 pairs | 4,199 pairs | 4,059 pairs | -31.36 | -33.66 | 68.64% | 66.34% |
| | Fowlsheugh 9,665 pairs | 4,629 pairs | 3,454 pairs | 3,367 pairs | -25.39 | -27.27 | 74.61% | 72.74% |

971. For the Forth Islands SPA, for the baseline scenario, the kittiwake end population is predicted to be higher after 25 years than the start population. With NnG and the 2014 Forth and Tay projects present, the kittiwake end population is predicted to be lower after 25 years than the start population (Table 9-203). The largest difference is predicted to occur for annual collisions and displacement in the breeding season. Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG and the 2014 Forth and Tay projects is a maximum decrease of 33.66% for the Forth Islands SPA, for annual collisions and breeding season displacement. This gives a CPS value of 66.34% of the scenario with no wind farm.

972. For the Fowlsheugh SPA, for both the baseline and built scenarios, the kittiwake breeding end population is predicted to be lower than the start population, after 25 years, with a lower end population predicted when NnG and the 2014 Forth and Tay projects are present (Table 9-203). There was a lower end population predicted for annual collisions and breeding season displacement combined, compared to collisions only and this was also the same for the CPS values.

973. Changes in the predicted population growth rate for kittiwakes breeding in the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2014 Forth and Tay projects over 50 years are shown in Table 9-204.

Table 9-204: Change in predicted population growth rate for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2014 Forth and Tay projects over 50 years

| Species | SPA Population | Baseline change after 50 years (no wind farm) | Percentage point change with NnG & F&T projects after 50 years | | Percentage change in median annual growth rate compared to baseline | | Counterfactual of the annual growth rate | |
|---|---|---|---|---|---|---|---|---|
| | | | Collision (y) | Collision (y) & Disp (br) | Collision (y) | Collision (y) & Disp (br) | Collision (y) | Collision (y) & Disp (br) |
| **Kittiwake** | Forth Islands | 0.9068 | -1.460 | -1.561 | -160.97 | -172.12 | -60.97% | -72.12% |
| | Fowlsheugh | -2.2758 | -1.103 | -1.194 | -48.47 | -52.46 | 148.47% | 152.46% |

974. For the Forth Islands SPA, for the baseline scenario, the population growth rate for kittiwake is predicted to increase slightly over the 50 year period. With NnG and the 2014 Forth and Tay projects present, the population is predicted to decline, with a percentage point change of -1.460 from the baseline, for collision alone (Table 9-204). When collision and displacement effects were considered

together, the percentage point change in the predicted population growth rate was slightly larger (-1.561), compared to collision effects alone. These values were very similar to those predicted for the 25 year scenario (Table 9-202). The values for the percentage change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario, and the corresponding counterfactual of the growth rate are both overestimated by the model, due to the fact that the Forth Islands SPA population of kittiwake is predicted to be fairly stable over 25 years, with a low population growth rate. This means that any change in median annual growth rate will be relatively large, relative to the small initial rate. Similarly, the counterfactual of the growth rate is highly influenced by the initial growth rate and bears little relevance to the change in growth rate on its own. Therefore, in this case, the percentage point change gives a better representation of the change in growth rate.

975. For Fowlsheugh SPA, for both the baseline and built scenarios, the population growth rate for kittiwake is predicted to decrease slightly over the 50 year period, with the rate of population decrease higher when NnG and the 2014 Forth and Tay projects are present (Table 9-204). When collision and displacement effects were considered together, the change in the predicted population growth rate was slightly larger, compared to collision effects alone. The difference between the associated counterfactual of the growth rate values was also slightly greater for collision and displacement than for collision alone. For the counterfactual of the annual growth rate, as the baseline population for kittiwake has a negative growth rate, a counterfactual growth rate of >100% indicates a further decline in growth rate for these impacted scenarios.

976. Changes in the predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2014 Forth and Tay projects over 50 years are shown in Table 9-205.

Table 9-205: Change in predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2014 Forth and Tay projects over 50 years

| Species | SPA & start Population | Baseline population after 50 years (no wind farm) | Population after 50 years with NnG & F&T projects | | Percentage change in median final population size compared to baseline | | Counterfactual of Population Size (CPS | |
|---|---|---|---|---|---|---|---|---|
| | | | Coll (y) | Coll (y) & Disp (br) | Coll (y) | Coll (y) & Disp (br) | Coll (y) | Coll (y) & Disp (br) |
| **Kittiwake** | Forth Islands 4,663 pairs | 7,665 pairs | 3,644 pairs | 3,458 pairs | -52.46 | -54.88 | 47.54% | 45.12% |
| | Fowlsheugh 9,665 pairs | 2,593 pairs | 1,462 pairs | 1,399 pairs | -43.61 | -46.07 | 56.39% | 53.93% |

977. For the Forth Islands SPA, for the baseline scenario, the kittiwake end population is predicted to be higher after 50 years than the start population. With NnG and the 2014 Forth and Tay projects present, the kittiwake end population is predicted to be lower than the start population after 50 years (Table 9-203). The largest difference is predicted to occur for annual collisions and displacement in the breeding season. Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG and the 2014 Forth and Tay projects is a maximum decrease of 54.88% for the Forth Islands SPA, for annual collisions and breeding season displacement. This gives a CPS value of 45.12% of the scenario with no wind farm. These values are lower than predicted after 25 years (Table 9-203).

978. For Fowlsheugh SPA, for both baseline and built scenarios, the end population was predicted to be lower than the start level after 50 years, with a lower end population predicted when NnG and the 2014 Forth and Tay projects are present (Table 9-205). A slightly lower end population was predicted for annual collisions and breeding season displacement combined, compared to collisions alone. Similarly, CPS values were slightly lower for annual collisions and breeding season displacement, compared to collisions alone. Predicted values are lower than predicted for Fowlsheugh SPA after 25 years (Table 9-203).

979. As expected, the 2014 Forth & Tay design scenarios gave lower predicted end populations than the 2017 Forth & Tay design scenarios, largely due to the greater number of turbines (Table 9-200).

980. A comparison of the 50th centile values for kittiwakes breeding at the Forth Islands and Fowlsheugh SPAs with and without NnG and the 2014 Forth and Tay projects over 25 years and 50 years is shown in Table 9-206.

Table 9-206: Comparison of the 50th centile values for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the 2014 Forth and Tay projects over 25 years and 50 years

| Species | SPA Population | 50th centile for unimpacted population (Baseline) | Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG & F&T projects | | Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG & F&T projects | |
|---|---|---|---|---|---|---|
| | | | Coll (y) | Coll (y) & Disp (br) | Coll (y) | Coll (y) & Disp (br) |
| **Kittiwake** | Forth Islands | 0.50 | 0 | 0 | 0 | 0 |
| | Fowlsheugh | 0.50 | 0 | 0 | 0 | 0 |

981. For an unimpacted population 50% of the model runs would not be lower than the median. When the impact is predicted to be larger, the distribution curves of unimpacted and impacted population sizes are further apart. This results in a lower likelihood of the unimpacted population being at or below the median of the impacted population. Comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted populations shows that over both 25 years and 50 years, 0% of the model runs end not lower than the median population size of the unimpacted population. This indicates that there is a very low probability of the unimpacted population being at or below the median of the impacted population.

**NnG, Inch Cape and Seagreen, plus UK North Sea OWF projects**

982. For kittiwake, the Scoping Opinion recommended that the PVA assessed cumulative collision impacts arising from NnG, Inch Cape and Seagreen in the breeding season, together with collision impacts in the non-breeding season from other projects in the UK North Sea (Marine Scotland, 2017).

983. As previously, Scenario One was for the NnG 2017 design scenario, and Inch Cape and Seagreen Phase 1 design scenarios. Scenario Two considered the NnG 2017 design scenario with the 2014 consented designs for Inch Cape and Seagreen A and B.

984. For clarity, these are referred to as “Scenario One & UK” and “Scenario Two & UK” in the following text and tables.

**Scenario 1 and UK**

985. For kittiwake, the Scoping Opinion recommended that the PVA assessed cumulative collision impacts arising from NnG, Inch Cape and Seagreen Phase 1 in the breeding season, together with collision impacts in the non-breeding season from other projects in the UK North Sea (Marine Scotland, 2017).

For clarity, these are referred to as NnG, F & T and UK projects in the following text and tables. As previously stated, the PVA only considered collision impacts for kittiwake for the UK North Sea OWF projects.

986. Changes in the predicted population growth rate for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario One and UK projects over 25 years are shown in Table 9-207.

Table 9-207: Change in predicted population growth rate for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario One and UK projects over 25 years

| Species | SPA Population | Baseline change after 25 years (no wind farms) | Percentage point change with NnG, F&T & UK projects after 25 years (collisions all year) | Percentage change in median annual growth rate compared to baseline | Counterfactual of the annual growth rate |
|---|---|---|---|---|---|
| **Kittiwake** | Forth Islands | 0.9099 | -0.353 | -38.74 | 61.26% |
| | Fowlsheugh | -2.2647 | -0.303 | -13.38 | 113.38% |

987. For the Forth Islands SPA, for both the baseline and built scenarios, the population growth rate for kittiwake is predicted to increase slightly over 25 years, although there is a lower rate of increase when the Scenario One and UK projects are present. With Scenario One and the UK projects present, there is a predicted percentage point change of -0.353 from the baseline (Table 9-207). The values for the percentage change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario, and the corresponding counterfactual of the growth rate are both overestimated by the model, due to the fact that the Forth Islands SPA population of kittiwake is predicted to be fairly stable over 25 years, with a low population growth rate. This means that any change in median annual growth rate will be relatively large, relative to the small initial rate. Similarly, the counterfactual of the growth rate is highly influenced by the initial growth rate and bears little relevance to the change in growth rate on its own. Therefore, in this case, the percentage point change gives a better representation of the change in growth rate.

988. For Fowlsheugh SPA, for both the baseline and built scenarios, the population growth rate for kittiwake is predicted to decrease over 25 years, with a slightly higher rate of decrease when the Scenario One and UK projects are present. For the counterfactual of the annual growth rate, as the baseline population for kittiwake has a negative growth rate, a counterfactual growth rate of >100% indicates a further decline in growth rate for these impacted scenarios.

989. Changes in the predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario One and UK projects over 25 years are shown in Table 9-208.

Table 9-208: Change in predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario One and UK projects over 25 years

| Species | SPA & start Population | Baseline population after 25 years (no wind farm) | Population after 25 years with NnG, F&T & UK projects (collisions all year) | Percentage change in median final population size compared to baseline | Counterfactual of Population Size (CPS) |
|---|---|---|---|---|---|
| **Kittiwake** | Forth Islands 4,663 pairs | 6,118 pairs | 5,603 pairs | -8.42 | 91.58% |
| | Fowlsheugh 9,665 pairs | 4,629 pairs | 4,285 pairs | -7.43 | 92.57% |

990. For the Forth Islands SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to be higher than the start population after 25 years, although the end population is predicted to be lower when the Scenario One and UK projects are present, compared to the baseline end population (Table 9-208). For the Fowlsheugh SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to be lower than the start population after 25 years, with the end population when the Scenario One and UK projects are present predicted to be lower than the baseline end population.

991. Overall, for both SPA populations, the change in the median final population size when comparing the baseline (no wind farm) with the Scenario One and UK projects was lower (and CPS values higher) than predicted for Scenario One (no UK projects) (Table 9-198) and Scenario Two (no UK projects) (Table 9-203). This is a result of including kittiwakes from other colonies and countries present in the North Sea in the non-breeding season in the assessment, and the subsequent apportioning of impacts during the non-breeding season across these populations.

992. Changes in the predicted population growth rate for kittiwakes breeding in the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario One and UK projects over 50 years are shown in Table 9-209.

Table 9-209: Change in predicted population growth rate for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario One and UK projects over 50 years

| Species | SPA Population | Baseline change after 50 years (no wind farms) | Percentage point change with NnG, F&T & UK projects after 50 years (collisions all year) | Percentage change in median annual growth rate compared to baseline | Counterfactual of the annual growth rate |
|---|---|---|---|---|---|
| **Kittiwake** | Forth Islands | 0.9068 | -0.343 | -37.84 | 62.16% |
| | Fowlsheugh | -2.2758 | -0.299 | -13.13 | 113.13% |

993. For the Forth Islands SPA, for both the baseline and built scenarios, the population growth rate for kittiwake is predicted to increase slightly over 50 years, although there is a lower rate of increase when the Scenario One and UK projects are present. With Scenario One and the UK projects present, there is a predicted percentage point change of -0.343 from the baseline (Table 9-209). This is similar to the corresponding value predicted after 25 years (Table 9-207). The values for the percentage change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario, and the corresponding counterfactual of the growth rate are both overestimated by the model, due to the fact that the Forth Islands SPA population of kittiwake is predicted to be fairly stable over 25 years, with a low population growth rate. This means that any change in median

annual growth rate will be relatively large, relative to the small initial rate. Similarly, the counterfactual of the growth rate is highly influenced by the initial growth rate and bears little relevance to the change in growth rate on its own. Therefore, in this case, the percentage point change gives a better representation of the change in growth rate.

994. For Fowlsheugh SPA, for both the baseline and built scenarios, the population growth rate for kittiwake is predicted to decrease over 25 years, with a slightly higher rate of decrease when the Scenario One and UK projects are present. The predicted percentage point decline of -0.299 after 50 years was very similar to the value predicted after 25 years (Table 9-207). For the counterfactual of the annual growth rate, as the baseline population for kittiwake has a negative growth rate, a counterfactual growth rate of >100% indicates a further decline in growth rate for these impacted scenarios.

995. Changes in the predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario One and UK projects over 50 years are shown in Table 9-210.

Table 9-210: Change in predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario One and UK projects over 50 years

| Species | SPA & start Population | Baseline population after 50 years (no wind farm) | Population after 50 years with NnG, F&T & UK projects (collisions all year) | Percentage change in median final population size compared to baseline | Counterfactual of Population Size (CPS) |
|---|---|---|---|---|---|
| **Kittiwake** | Forth Islands 4,663 pairs | 7,665 pairs | 6,451 pairs | -15.84 | 84.16% |
| | Fowlsheugh 9,665 pairs | 2,593 pairs | 2,229 pairs | -14.03 | % |

996. For the Forth Islands SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to be higher than the start population after 50 years, although the end population is predicted to be lower when the Scenario One and UK projects are present, compared to the baseline end population (Table 9-210). For the Fowlsheugh SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to be lower than the start population after 25 years, with the end population when the Scenario One and UK projects are present predicted to be lower than the baseline end population.

997. Overall, for both SPA populations, the change in the median final population size when comparing the baseline (no wind farm) with the Scenario One and UK projects was lower (and CPS values higher) than predicted for Scenario One (no UK projects) (Table 9-200) and Scenario Two (no UK projects) (Table 9-205).

998. This is a result of including kittiwakes from other colonies and countries present in the North Sea in the non-breeding season in the assessment, and the subsequent apportioning of impacts during the non-breeding season across these populations.

999. A comparison of the 50th centile values for kittiwakes breeding at the Forth Islands and Fowlsheugh SPAs with and without Scenario One and the UK projects over 25 years and 50 years is shown in Table 9-211.

Table 9-211: Comparison of the 50th centile values for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without Scenario One and the UK projects over 25 years and 50 years

| Species | SPA Population | 50th centile for unimpacted population (Baseline) | Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG, F&T & UK projects (collisions all year) | Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG, F&T & UK projects (collisions all year) |
|---|---|---|---|---|
| **Kittiwake** | Forth Islands | 0.5 | 0.10 | 0.04 |
| | Fowlsheugh | 0.5 | 0.13 | 0.07 |

1000.For an unimpacted population 50% of the model runs would not be lower than the median. When the impact is predicted to be larger, the distribution curves of unimpacted and impacted population sizes are further apart. This results in a lower likelihood of the unimpacted population being at or below the median of the impacted population. Comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted populations shows that for the Forth Islands SPA over 25 years at least 10%, and 50 years at least 4% of the model runs end not lower than the median population size of the unimpacted population. Similarly, for Fowlsheugh SPA, over both 25 years and 50 years, between 13% and 7% of the model runs end not lower than the median population size of the unimpacted population. This indicates that there is a low probability of the unimpacted population being at or below the median of the impacted population.

**Scenario 2 and UK**

1001.For kittiwake, the Scoping Opinion recommended that the PVA assessed cumulative collision impacts arising from NnG, Inch Cape and Seagreen A and B in the breeding season, together with collision impacts in the non-breeding season from other projects in the UK North Sea (Marine Scotland, 2017). For clarity, these are referred to as the Scenario Two and UK projects in the following text and tables. As previously stated, the PVA only considered collision impacts for kittiwake for the UK North Sea OWF projects.

1002.Changes in the predicted population growth rate for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario Two and UK projects over 25 years are shown in Table 9-212.

Table 9-212: Change in predicted population growth rate for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario Two and UK projects over 25 years

| Species | SPA Population | Baseline change after 25 years (no wind farms) | Percentage point change with NnG, F&T & UK projects after 25 years (collisions all year) | Percentage change in median annual growth rate compared to baseline | Counterfactual of the annual growth rate |
|---|---|---|---|---|---|
| **Kittiwake** | Forth Islands | 0.9099 | -0.778 | -85.50 | 14.50% |
| | Fowlsheugh | -2.2647 | -0.660 | -29.14 | 129.14% |

1003.For the Forth Islands SPA, for both the baseline and built scenarios, the population growth rate for kittiwake is predicted to increase slightly over the 25 year period, although there is a lower rate of increase when the Scenario Two and UK projects are present (Table 9-212). With Scenario Two and the UK projects present, there is a predicted percentage point change of -0.778 from the baseline (Table 9-212). The values for the percentage change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario, and the corresponding counterfactual of the growth rate are both overestimated by the model, due to the fact that the Forth Islands SPA population of kittiwake is predicted to be fairly stable over 25 years, with a low population growth rate. This means that any change in median annual growth rate will be relatively large, relative to the small initial rate. Similarly, the counterfactual of the growth rate is highly influenced by the initial growth rate and bears little relevance to the change in growth rate on its own. Therefore, in this case, the percentage point change gives a better representation of the change in growth rate.

1004. For Fowlsheugh SPA, for both the baseline and built scenarios, the population growth rate for kittiwake is predicted to decrease over 25 years, with a slightly higher rate of decrease when the Scenario Two and UK projects are present (Table 9-212). For the counterfactual of the annual growth rate, as the baseline population for kittiwake has a negative growth rate, a counterfactual growth rate of >100% indicates a further decline in growth rate for these impacted scenarios.

1005. Changes in the predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario Two and UK projects over 25 years are shown in Table 9-213.

Table 9-213: Change in predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario Two and UK projects over 25 years

| Species | SPA & start Population | Baseline population after 25 years (no wind farm) | Population after 25 years with NnG, F&T & UK projects (collisions all year) | Percentage change in median final population size compared to baseline | Counterfactual of Population Size (CPS) |
|---|---|---|---|---|---|
| **Kittiwake** | Forth Islands 4,663 pairs | 6,118 pairs | 4,990 pairs | -18.44 | 81.56% |
| | Fowlsheugh 9,665 pairs | 4,629 pairs | 3,893 pairs | -15.89 | 84.11% |

1006. For the Forth Islands SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to be higher than the start population after 25 years, although the end population is predicted to be lower when the Scenario Two and UK projects are present, compared to the baseline end population (Table 9-213). For Fowlsheugh SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to be lower than the start population after 25 years, with the end population when the Scenario Two and UK projects are present predicted to be lower than the baseline end population.

1007. Overall, for both SPA populations, the percentage change in the median final population size when comparing the baseline (no wind farm) with the Scenario Two and UK projects was lower than Scenario Two (no UK projects) for both SPAs, for the collisions only scenario (Table 9-203). The CPS values for the Scenario Two and UK projects were also higher than for Scenario Two (no UK projects). This is a result of including kittiwakes from other colonies and countries present in the North Sea in the non-breeding season in the assessment, and the subsequent apportioning of impacts during the non-breeding season across these populations.

1008. Changes in the predicted population growth rate for kittiwakes breeding in the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario Two and UK projects over 50 years are shown in Table 9-214.

Table 9-214: Change in predicted population growth rate for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario Two and UK projects over 50 years

| Species | SPA Population | Baseline change after 50 years (no wind farms) | Percentage point change with NnG, F&T & UK projects after 50 years (collisions all year) | Percentage change in median annual growth rate compared to baseline | Counterfactual of the annual growth rate |
|---|---|---|---|---|---|
| **Kittiwake** | Forth Islands | 0.9068 | -0.784 | -86.49 | 13.51% |
| | Fowlsheugh | -2.2758 | -0.642 | -28.19 | 128.19% |

1009.For the Forth Islands SPA, for both the baseline and built scenarios, the population growth rate for kittiwake is predicted to increase slightly over the 50 year period, although there is a lower rate of increase when the Scenario Two and UK projects are present (Table 9-214). With Scenario Two and the UK projects present, there is a predicted percentage point change of -0.774 from the baseline. This is similar to the value predicted after 25 years (Table 9-212). The values for the percentage change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario, and the corresponding counterfactual of the growth rate are both overestimated by the model, due to the fact that the Forth Islands SPA population of kittiwake is predicted to be fairly stable over 25 years, with a low population growth rate. This means that any change in median annual growth rate will be relatively large, relative to the small initial rate. Similarly, the counterfactual of the growth rate is highly influenced by the initial growth rate and bears little relevance to the change in growth rate on its own. Therefore, in this case, the percentage point change gives a better representation of the change in growth rate.

1010.For Fowlsheugh SPA, for both the baseline and built scenarios, the population growth rate for kittiwake is predicted to decrease over 50 years, with a slightly higher rate of decrease when the Scenario Two and UK projects are present (Table 9-214). For the counterfactual of the annual growth rate, as the baseline population for kittiwake has a negative growth rate, a counterfactual growth rate of >100% indicates a further decline in growth rate for these impacted scenarios.

1011.Changes in the predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario Two and UK projects over 50 years are shown in Table 9-215.

Table 9-215: Change in predicted population size for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without the Scenario Two and UK projects over 50 years

| Species | SPA & start Population | Baseline population after 50 years (no wind farm) | Population after 50 years with NnG, F&T & UK projects (collisions all year) | Percentage change in median final population size compared to baseline | Counterfactual of Population Size (CPS) |
|---|---|---|---|---|---|
| **Kittiwake** | Forth Islands 4,663 pairs | 7,665 pairs | 5,164 pairs | -32.63 | 67.37% |
| | Fowlsheugh 9,665 pairs | 2,593 pairs | 1,867 pairs | -27.99 | 72.01% |

1012.For the Forth Islands SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to be higher than the start population after 50 years, although the end population is predicted to be lower when the Scenario Two and UK projects are present, compared to the baseline end population (Table 9-215). For Fowlsheugh SPA, for both the baseline and built scenarios, the kittiwake breeding population is predicted to be lower than the start population after 50 years, with the end population when the Scenario Two and UK projects are present predicted to be lower than the baseline end population.

1013.Overall, for both SPA populations, the percentage changes in the median final population size when comparing the baseline (no wind farm) with the Scenario Two and UK projects for collision only, were lower than predicted for Scenario Two (no UK projects) (Table 9-205). The respective CPS values were also higher for the Scenario Two and UK projects. This is a result of including kittiwakes from other colonies and countries present in the North Sea in the non-breeding season in the assessment, and the subsequent apportioning of impacts during the non-breeding season across these populations.

1014.A comparison of the 50th centile values for kittiwakes breeding at the Forth Islands and Fowlsheugh SPAs with and without Scenario Two and the UK projects over 25 years and 50 years is shown in Table 9-216.

Table 9-216: Comparison of the 50th centile values for kittiwakes breeding at the Forth Islands SPA and Fowlsheugh SPA with and without Scenario Two and the UK projects over 25 years and 50 years

| Species | SPA Population | 50th centile for unimpacted population (Baseline) | Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG, F&T & UK projects (collisions all year) | Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG, F&T & UK projects (collisions all year) |
|---|---|---|---|---|
| **Kittiwake** | Forth Islands | 0.5 | 0 | 0 |
| | Fowlsheugh | 0.5 | 0 | 0 |

1015.For an unimpacted population 50% of the model runs would not be lower than the median. When the impact is predicted to be larger, the distribution curves of unimpacted and impacted population sizes are further apart. This results in a lower likelihood of the unimpacted population being at or below the median of the impacted population.  Comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted populations shows that for both the Forth Islands SPA and Fowlsheugh SPA over both 25 years and 50 years, 0% of the model runs end not lower than the median population size of the unimpacted population.  This indicates that there is a low probability of the unimpacted population being at or below the median of the impacted population.

### *9.9.5.1.3 Guillemot*

1016.For guillemot, only annual displacement impacts were modelled in the cumulative PVA, covering cumulative displacement effects for NnG, Inch Cape and Seagreen A and B, as recommended in the Scoping Opinion (Marine Scotland, 2017). Only one scenario was modelled, as the displacement effects and site boundaries are the same for both the 2014 and 2017 Inch Cape and Seagreen projects.

1017.Changes in the predicted population growth rate for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 25 years are shown in Table 9-217.

Table 9-217: Change in predicted population growth rate for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth and Tay projects over 25 years

| Species | SPA Population | Baseline change after 25 years (no wind farm) | Percentage point change with NnG & F&T projects after 25 years (displacement all year) | Percentage change in median annual growth rate compared to baseline | Counterfactual of the annual growth rate |
|---|---|---|---|---|---|
| **Guillemot** | Forth Islands | 1.8949 | -0.063 | -3.32 | 96.68% |
| | Fowlsheugh | 2.3258 | -0.024 | -1.01 | 98.99% |

1018.For both the baseline and built scenarios, the guillemot population growth rate at both the Forth Islands SPA and Fowlsheugh SPA is predicted to increase over 25 years, although there is a slight decrease in these growth rates when NnG and the Forth & Tay projects are present. Overall, the change in the median annual growth rates when comparing the baseline (no wind farm) with the built scenario was similar for the two SPAs, with a slightly higher rate of decrease for the Forth Islands SPA (Table 9-217). The counterfactual of the growth rate also followed this pattern. These results indicate that displacement arising from NnG and the Forth and Tay projects will not have a significant negative effect on breeding guillemots at these two SPAs.

1019.Changes in the predicted population size for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 25 years are shown in Table 9-218.

Table 9-218: Change in predicted population size for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 25 years

| Species | SPA & start Population | Baseline population after 25 years (no wind farm) | Population after 25 years with NnG & F&T projects (displacement all year) | Percentage change in median final population size compared to baseline | Counterfactual of Population Size (CPS) |
|---|---|---|---|---|---|
| **Guillemot** | Forth Islands 38,573 pairs | 67,234 pairs | 66,454 pairs | -1.16 | 98.84% |
| | Fowlsheugh 74,379 pairs | 150,711 pairs | 149,071 pairs | -1.09 | 98.91% |

1020.For the Forth Islands SPA, for both the baseline and built scenarios, the guillemot breeding population is predicted to increase over 25 years, although the end population is predicted to be slightly lower when NnG and the Forth & Tay projects are present (Table 9-218). Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is a decrease of 1.16%. This gives a CPS value of 98.84% of the scenario with no wind farm.

1021.For the Fowlsheugh SPA, for both the baseline and built scenarios, the guillemot breeding population is also predicted to increase over 25 years, although the end population is predicted to be slightly lower when NnG and the Forth & Tay projects are present. Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is decrease of 1.09%, while the CPS value is 98.91% of the scenario with no wind farm. This indicates that there is predicted to be very little impact from displacement from NnG and the Forth and Tay projects on the guillemot breeding populations at Forth Islands SPA and Fowlsheugh SPA over 25 years.

1022.Changes in the predicted population growth rate for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 50 years are shown in Table 9-219.

Table 9-219: Change in predicted population growth rate for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 50 years

| Species | SPA Population | Baseline change after 50 years (no wind farm) | Percentage point change with NnG & F&T projects after 50 years (displacement all year) | Percentage change in median annual growth rate compared to baseline | Counterfactual of the annual growth rate |
|---|---|---|---|---|---|
| Guillemot | Forth Islands | 1.8916 | -0.045 | -2.39 | 97.61% |
| | Fowlsheugh | 2.3278 | -0.045 | -1.94 | 98.06% |

1023.The population growth rate for guillemots at both the Forth Islands SPA and Fowlsheugh SPA is predicted to increase over the 50 year period, although there is a slight decrease in this growth rate when NnG and the Forth & Tay projects are present. Overall, the change in the median annual growth rates when comparing the baseline (no wind farm) with NnG and the Forth & Tay projects is a decrease of 2.39% for the Forth Islands SPA and a slightly lower decrease (-1.94%) for Fowlsheugh SPA (Table 9-219). The counterfactuals of the growth rate also followed this pattern. These results were similar to the predicted growth rates for the first 25 year period (Table 9-217), and indicate that displacement arising from NnG and the Forth and Tay projects will not have a significant negative effect on breeding guillemots at these two SPAs.

1024.Changes in the predicted population size for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 50 years are shown in Table 9-220.

Table 9-220: Change in predicted population size for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 50 years

| Species | SPA & start Population | Baseline population after 50 years (no wind farm) | Population after 50 years with NnG & F&T projects (displacement all year) | Percentage change in median final population size compared to baseline | Counterfactual of Population Size (CPS) |
|---|---|---|---|---|---|
| Guillemot | Forth Islands 38,573 pairs | 108,366 pairs | 105,244 pairs | -2.88 | 97.12% |
| | Fowlsheugh 74,379 pairs | 267,057 pairs | 261,912 pairs | -1.93 | 98.07% |

1025.For the Forth Islands SPA, for both the baseline and built scenarios, the guillemot breeding population is predicted to increase over 50 years, with a slightly lower end population predicted when NnG and the Forth & Tay projects are present (Table 9-220). Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is a decrease of 2.88%. This gives a counterfactual population size that is 97.12% of the scenario with no wind farm.

1026.For the Fowlsheugh SPA, for both the baseline and built scenarios, the guillemot breeding population is also predicted to increase over 50 years, with a slightly lower end population predicted when NnG and the Forth & Tay projects are present. Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is decrease of 1.93%, while the CPS value is 98.07% of the scenario with no wind farm. These results were similar to the predicted end populations for the first 25 year period (Table 9-218), and indicate that there is predicted to be very little impact from displacement from NnG and the Forth & Tay projects on the breeding populations at Forth Islands SPA and Fowlsheugh SPA over the 50 year lifetime of the Project.

1027.A comparison of the 50th centile values for guillemots breeding at the Forth Islands and Fowlsheugh SPAs with and without NnG and the Forth & Tay projects over 25 years and 50 years is shown in Table 9-221.

Table 9-221: Comparison of the 50th centile values for guillemots breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 25 years and 50 years

| Species | SPA Population | 50th centile for unimpacted population (Baseline) | Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG & F&T projects (displacement all year) | Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG & F&T projects (displacement all year) |
|---|---|---|---|---|
| **Guillemot** | Forth Islands | 0.50 | 0.47 | 0.43 |
| | Fowlsheugh | 0.50 | 0.45 | 0.45 |

1028.For an unimpacted population 50% of the model runs would not be lower than the median. When the impact is predicted to be larger, the distribution curves of unimpacted and impacted population sizes are further apart. This results in a lower likelihood of the unimpacted population being at or below the median of the impacted population. Comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted Forth Islands SPA populations shows that over 25 years and 50 years, between 47% and 43% of the model runs end not lower than the median population size of the unimpacted population. For the Fowlsheugh SPA, both 25 years and 50 years were similar, with a maximum of 45% of the model runs ending not lower than the median population size of the unimpacted population. This indicates that there is a high probability of the unimpacted population being at or below the median of the impacted population.

### *9.9.5.1.4 Razorbill*

1029.Changes in the predicted population growth rate for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 25 years are shown in Table 9-222.

Table 9-222: Change in predicted population size for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 25 years

| Species | SPA Population | Baseline change after 25 years (no wind farm) | Percentage point change with NnG & F&T projects after 25 years (displacement all year) | Percentage change in median annual growth rate compared to baseline | Counterfactual of the annual growth rate |
|---|---|---|---|---|---|
| **Razorbill** | Forth Islands | 0.0313 | -0.113 | -360.70 | -260.70% |
| | Fowlsheugh | 0.9516 | -0.181 | -19.00 | 81.00% |

1030.For the Forth Islands SPA, for the baseline scenario, the population growth rate for razorbill is predicted to increase slightly over the 25 year period. With NnG and the Forth and Tay projects present, the population is predicted to decline, with a percentage point change of -0.113 from the baseline (Table 9-222). The values for the percentage change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario, and the corresponding counterfactual of the growth rate are both overestimated by the model, due to the fact that the Forth Islands SPA razorbill population is predicted to be fairly stable over 25 years, with a low population growth rate. This means that any change in median annual growth rate will be relatively large, relative to the small initial rate. Similarly, the counterfactual of the growth rate is highly influenced by the initial growth rate and bears little relevance to the change in growth rate on its own. Therefore, in this case, the percentage point change gives a better representation of the change in growth rate.

1031.For Fowlsheugh SPA, for the baseline and built scenarios, the razorbill population growth rate is predicted to increase over 25 years, although there is a slight decrease in this growth rate when NnG and the Forth & Tay projects are present (Table 9-222). Overall, the change in the median annual growth rates when comparing the baseline (no wind farm) with the built scenario is a decrease of 19.00%, with a corresponding counterfactual of the growth rate of 81.00%.

1032.Changes in the predicted population size for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 25 years are shown in Table 9-223.

Table 9-223: Change in predicted population size for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 25 years

| Species | SPA & start Population | Baseline population after 25 years (no wind farm) | Population after 25 years with NnG & F&T projects (displacement all year) | Percentage change in median final population size compared to baseline | Counterfactual of Population Size (CPS) |
|---|---|---|---|---|---|
| **Razorbill** | Forth Islands 7,792 pairs | 7,862 pairs | 7,563 pairs | -3.80 | 96.20% |
| | Fowlsheugh 9,950 pairs | 13,491 pairs | 12,923 pairs | -4.21 | 95.79% |

1033.For the Forth Islands SPA, for the baseline scenario, the razorbill breeding population is predicted to be slightly higher than the start population after 25 years. With NnG and the Forth & Tay projects present, the end population after 25 years is predicted to be slightly lower than the start population (Table 9-223). Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is a decrease of 3.80%. This results in a CPS value of 96.20% of the scenario with no wind farm.

1034.For the Fowlsheugh SPA, for both the baseline and built scenarios, the razorbill breeding population is predicted to be higher than the start population after 25 years, although the end population is predicted to be slightly lower when NnG and the Forth & Tay projects are present (Table 9-223). Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is a decrease of 4.21%, and the CPS value is 95.79% of the scenario with no wind farm.

1035.Changes in the predicted population growth rate for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 50 years are shown in Table 9-224.

Table 9-224: Change in predicted population growth rate for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 50 years

| Species | SPA Population | Baseline change after 50 years (no wind farm) | Percentage point change with NnG & F&T projects after 50 years (displacement all year) | Percentage change in median annual growth rate compared to baseline | Counterfactual of the annual growth rate |
|---|---|---|---|---|---|
| **Razorbill** | Forth Islands | 0.0631 | -0.173 | -274.17 | -174.17% |
| | Fowlsheugh | 0.9416 | -0.133 | -14.14 | 85.86% |

1036.For the Forth Islands SPA, for the baseline scenario, the population growth rate for razorbill is predicted to increase slightly over the 25 year period. With NnG and the Forth and Tay projects present, the population is predicted to decline, with a percentage point change of -0.173 from the baseline (Table 9-224), which was slightly larger than predicted after 25 years (Table 9-222). The values for the percentage change in the median annual growth rate when comparing the baseline (no wind farm) with the built scenario, and the corresponding counterfactual of the growth rate are both overestimated by the model, due to the fact that the Forth Islands SPA razorbill population is predicted to be fairly stable over 50 years, with a low population growth rate. This means that any change in median annual growth rate will be relatively large, relative to the small initial rate. Similarly, the counterfactual of the growth rate is highly influenced by the initial growth rate and bears little relevance to the change in growth rate on its own. Therefore, in this case, the percentage point change gives a better representation of the change in growth rate.

1037.For Fowlsheugh SPA, for the baseline and built scenarios, the razorbill population growth rate is predicted to increase over 50 years, although there is a slight decrease in this growth rate when NnG and the Forth & Tay projects are present (Table 9-224). Overall, the change in the median annual growth rates when comparing the baseline (no wind farm) with the built scenario is a decrease of 14.14%, with a corresponding counterfactual of the growth rate of 85.86%.

1038.Changes in the predicted population size for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 50 years are shown in Table 9-225.

Table 9-225: Change in predicted population size for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 50 years

| Species | SPA & start Population | Baseline population after 50 years (no wind farm) | Population after 50 years with NnG & F&T projects (displacement all year) | Percentage change in median final population size compared to baseline | Counterfactual of Population Size (CPS) |
|---|---|---|---|---|---|
| **Razorbill** | Forth Islands 7,792 pairs | 8,063 pairs | 7,428 pairs | -7.88 | 92.12% |
| | Fowlsheugh 9,950 pairs | 16,932 pairs | 15,910 pairs | -6.04 | 93.96% |

1039.For the Forth Islands SPA, for the baseline scenario, the razorbill breeding population is predicted to be slightly higher than the start population after 50 years. With NnG and the Forth & Tay projects present, the end population after 50 years is predicted to be slightly lower than the start population (Table 9-225). Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG and the Forth & Tay projects is a decrease of 7.88%. This results in a CPS value of 92.12% of the scenario with no wind farm.

1040.For the Fowlsheugh SPA, for both the baseline and built scenarios, the razorbill breeding population is predicted to be higher than the start population after 25 years, although the end population is predicted to be slightly lower when NnG and the Forth & Tay projects are present. Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG and the Forth & Tay projects is a decrease of 6.04%, with a CPS value that is 93.96% of the scenario with no wind farm. The percentage change in population size and associated CPS values were slightly lower than predicted values after 25 years (Table 9-223), but indicate that there is predicted to be little impact from displacement from NnG and the Forth & Tay projects on the breeding populations at Forth Islands SPA and Fowlsheugh SPA over the 50 year lifetime of the Project.

1041.A comparison of the 50th centile values for razorbills breeding at the Forth Islands and Fowlsheugh SPAs with and without NnG and the Forth & Tay projects over 25 years and 50 years is shown in Table 9-226.

Table 9-226: Comparison of the 50th centile values for razorbills breeding at the Forth Islands SPA and Fowlsheugh SPA with and without NnG and the Forth & Tay projects over 25 years and 50 years

| Species | SPA Population | 50th centile for unimpacted population (Baseline) | Centile for impacted population that matches 50th centile for baseline population after 25 years with NnG & F&T projects (displacement all year) | Centile for impacted population that matches 50th centile for baseline population after 50 years with NnG & F&T projects (displacement all year) |
|---|---|---|---|---|
| **Razorbill** | Forth Islands | 0.50 | 0.42 | 0.39 |
| | Fowlsheugh | 0.50 | 0.42 | 0.41 |

1042.For an unimpacted population 50% of the model runs would not be lower than the median. When the impact is predicted to be larger, the distribution curves of unimpacted and impacted population sizes are further apart. This results in a lower likelihood of the unimpacted population being at or below the median of the impacted population. Comparing the distributions of population sizes after 25 years and 50 years for the unimpacted and impacted Forth Islands SPA populations shows that over 25 years and 50 years, between 42% and 39% of the model runs end not lower than the median population size of the unimpacted population. For the Fowlsheugh SPA, over 25 years and 50 years, between 42% and 41% of the model runs ended not lower than the median population size of the unimpacted population. This indicates that there is a high probability of the unimpacted population being at or below the median of the impacted population.

### *9.9.5.1.5 Puffin*

1043.Changes in the predicted population growth rate for puffins breeding at the Forth Islands SPA with and without NnG and the Forth & Tay projects over 25 years are shown in Table 9-227.

Table 9-227: Change in predicted population growth rate for puffins breeding at the Forth Islands SPA with and without NnG and the Forth & Tay projects over 25 years

| Species | SPA Population | Baseline change after 25 years (no wind farm) | Percentage point change with NnG & F&T projects after 25 years (displacement all year) | Percentage change in median annual growth rate compared to baseline | Counterfactual of the annual growth rate |
|---|---|---|---|---|---|
| **Puffin** | Forth Islands | 4.6103 | -0.088 | -1.92 | 98.08% |

1044.The puffin population growth rate at the Forth Islands SPA is predicted to increase over the 25 year period, although there is a slight decrease in this growth rate when NnG and the Forth & Tay projects are present. Overall, the change in the median annual growth rates when comparing the baseline (no wind farm) with the built scenario is a decrease of 1.92%, with a corresponding counterfactual of the growth rate of 98.08% (Table 9-227).

1045.Changes in the predicted population size for puffins breeding at the Forth Islands SPA with and without NnG and the Forth & Tay projects over 25 years are shown in Table 9-228.

Table 9-228: Change in predicted population size for puffins breeding at the Forth Islands SPA with and without NnG and the Forth & Tay projects over 25 years

| Species | SPA & start Population | Baseline population after 25 years (no wind farm) | Population after 25 years with NnG & F&T projects (displacement all year) | Percentage change in median final population size compared to baseline | Counterfactual of Population Size (CPS) |
|---|---|---|---|---|---|
| **Puffin** | Forth Islands 45,005 pairs | 174,231 pairs | 169,773 pairs | -2.56 | 97.44% |

1046.For the Forth Islands SPA, for both the baseline and built scenarios, the puffin breeding population is predicted to increase over 25 years compared to the start population, with a slightly lower end population when NnG and the Forth & Tay projects are present (Table 9-228). Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is a decrease of 2.56%. This results in a CPS value of 97.44% of the scenario with no wind farm, indicating that displacement will not have a negative effect on breeding puffins at the Forth Islands SPA over 25 years.

1047.Changes in the predicted population growth rate for puffins breeding at the Forth Islands SPA with and without NnG and the Forth & Tay projects over 50 years are shown in Table 9-229.

Table 9-229: Change in predicted population growth rate for puffins breeding at the Forth Islands SPA with and without NnG and the Forth & Tay projects over 50 years

| Species | SPA Population | Baseline change after 25 years (no wind farm) | Percentage point change with NnG & F&T projects after 25 years (displacement all year) | Percentage change in median annual growth rate compared to baseline | Counterfactual of the annual growth rate |
|---|---|---|---|---|---|
| **Puffin** | Forth Islands | 4.6011 | -0.084 | -1.82 | 98.18% |

1048.The puffin population growth rate at the Forth Islands SPA is predicted to increase over the 50 year period, although there is a slight decrease in this growth rate when NnG and the Forth & Tay projects are present. Overall, the change in the median annual growth rates when comparing the baseline (no wind farm) with NnG and the Forth & Tay projects is a decrease of 1.82% for the Forth Islands SPA (Table 9-229). This is a slightly lower decrease than was predicted over 25 years (-1.92%) (Table 9-227). The corresponding counterfactual value showed a similar pattern, compared to the 25 year period.

1049.Changes in the predicted population size for puffins breeding at the Forth Islands SPA with and without NnG and the Forth & Tay projects over 50 years are shown in Table 9-230.

Table 9-230: Change in predicted population size for puffins breeding at the Forth Islands SPA with and without NnG and the Forth & Tay projects over 50 years

| Species | SPA & start Population | Baseline population after 50 years (no wind farm) | Population after 50 years with NnG & F&T projects (displacement all year) | Percentage change in median final population size compared to baseline | Counterfactual of Population Size (CPS) |
|---|---|---|---|---|---|
| **Puffin** | Forth Islands 45,005 pairs | 531,902 pairs | 510,482 pairs | -4.03 | 95.97% |

1050.For the Forth Islands SPA, for both the baseline and built scenarios, the puffin breeding population is predicted to increase over 50 years compared to the start population, with a lower end population when NnG and the Forth & Tay projects are present (Table 9-230). Overall, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is a decrease of 4.03%. This is a slightly larger decrease than was predicted over 25 years (-2.56%) (Table 9-228). The CPS value for the 50 year assessment is also slightly lower than for the 25 year period.

*PVA conclusions*

1051.For gannet, the cumulative PVA only considered annual collision effects. For all cumulative wind farm scenarios tested, the predicted population growth rate increased, regardless of the modelled build scenario, although the predicted rate of population growth and resulting end population was lower than for the baseline scenario, with no wind farms built. As would be expected, the population growth rate and end population was lowest for NnG and the 2014 Forth and Tay projects, as this scenario involves the highest number of turbines, and consequently a higher predicted number of collisions, with all of these being assigned to the local breeding populations. Overall, results indicate that collision impacts from NnG and the Forth and Tay projects on the breeding gannet population at Forth Islands SPA over the lifetime of the Project are not likely to be significant.

1052.For kittiwake, the cumulative PVA considered collision effects in isolation and in combination with breeding season displacement effects for the Forth and Tay wind farms for both Scenarios One and Two, as well as collision effects for other UK North Sea wind farms in the non-breeding season. Of the two SPA populations modelled, Forth Islands SPA showed an increase in the baseline scenario, while Fowlsheugh SPA showed a decline in the baseline scenario. For the Forth Islands SPA, the increases remained evident for NnG and the 2017 Forth and Tay projects, even when other UK North Sea projects were included. When NnG and the 2014 Forth and Tay projects were included, the population growth rate and resulting end population decreased, as this scenario involves the highest number of turbines, and consequently a higher predicted number of collisions, with all of these being assigned to the local breeding populations.

1053.For Fowlsheugh SPA, for the modelled wind farm scenarios, the declines in the baseline scenario remained evident and were slightly enhanced, with lowest results for NnG and the 2014 Forth and Tay projects, as would be expected.

1054.Overall, results indicate that cumulative collision and displacement impacts from NnG, the Forth and Tay projects and other UK North Sea wind farms on the breeding kittiwake population at Forth Islands SPA and Fowlsheugh SPA over the lifetime of the Project are likely to be small and have relatively little influence on the resulting population size.For guillemot and razorbill, the cumulative PVA only considered displacement effects throughout the year for Forth Islands SPA and Fowlsheugh SPA. For guillemot, for all cumulative wind farm scenarios tested, the predicted population growth rate and end populations increased, regardless of the modelled build scenario. For both the 25 year and 50 year assessments, the difference between the population growth rate and end populations for the baseline and built scenarios was very small, indicating that displacement impacts from NnG and the

Forth and Tay projects on the breeding population of guillemots at Forth Islands SPA and Fowlsheugh SPA over the lifetime of the Project are not likely to be significant.

1055. For razorbill, of the two SPA populations modelled, both Forth Islands SPA and Fowlsheugh SPA showed an increase in the baseline scenario over 25 and 50 years, although the increase at Forth Islands SPA was very low. For the Forth Islands SPA, cumulative displacement effects were predicted to result in a decline in the population growth rate when NnG and the Forth and Tay projects were present, while the end populations after 25 and 50 years were slightly lower than the end populations for the baseline scenario. For Fowlsheugh SPA, for both the 25 year and 50 year assessments, the difference between the population growth rate and end populations for the baseline and built scenarios was small. Overall, results indicated that there is likely to be little impact from displacement from NnG and the Forth and Tay projects on the breeding populations of razorbills at Forth Islands SPA and Fowlsheugh SPA over the lifetime of the Project.

1056. For puffin, for the cumulative wind farm scenarios tested, the predicted population growth rate and end population increased, regardless of the modelled build scenario, although the predicted rate of population growth and resulting end population was lower than for the baseline scenario, with no wind farms built. This indicates that displacement impacts from NnG and the Forth and Tay projects on the breeding population of puffins at Forth Islands SPA over the lifetime of the Project are not likely to be significant.

1057. When interpreting the PVA results, it should be remembered that predicting longer term trends in seabird populations is difficult and that a number of assumptions have been made for this PVA assessment.

1058. Following the advice in the Scoping Opinion (Marine Scotland, 2017), the models used were density independent, which means that no account is taken of potentially limiting factors at a breeding colony such as lack of space for additional breeding birds. In other words, the model can predict increasing numbers of birds over time, and these increasing numbers of birds will have no effect on the model results. Although this makes the modelling process simpler, this may not be an accurate reflection of the situation at a breeding colony. However, Cook and Robinson (2015) concluded that density-independent models are likely to represent a more precautionary approach where there is uncertainty about the magnitude of a response, as they do not assume a compensatory increase in survival or productivity at low population sizes.

1059. As the models used are density independent, they are likely to over-estimate declines in small populations. Similarly, they may show population increases above those witnessed, due to modelled populations not being limited by density dependent effects. In addition, PVA modelling assumes that environmental conditions will remain the same over the runtime of the model (25 or 50 years in this case) as they were when the demographic data were collected, which is also unlikely.

1060. As highlighted in previous PVAs, a critical feature for interpreting population model outputs is to focus on the relative changes predicted, rather than viewing an absolute prediction as an indication of how the population is going to change. However, caution must be exercised before assuming that the absolute predictions can be relied upon. For this reason, the most robust interpretation of the results from a density independent model is in terms of the relative change in outputs between impacted and un-impacted scenarios (MacArthur Green 2015).

### 9.9.6 Transboundary Statement

1061. The Project Scoping Report concluded that given the location of the Project and the likely key receptors, potential transboundary effects are considered unlikely (NnGOWL, 2017).

1062. Based on the location of the Project and the likely key receptors, it was considered that there will be no significant transboundary effects on birds. In the breeding season, there are no non-UK seabird colonies within mean-maximum foraging range of the Project, therefore there will not be any transboundary impacts.

1063. In the non-breeding season, although it is possible that birds from non-UK seabird colonies may pass through the Wind Farm Area, there will be minimal impact from displacement or barrier effects, as foraging birds would be able to find food outside of the Wind Farm Area, and so would not be affected if they avoided the Wind Farm Area due to the presence of turbines. Although it is possible that birds from non-UK seabird colonies may collide with the turbines, it is considered very unlikely that significant numbers of a species from non-UK colonies would be affected, based on the number of birds predicted to be killed in the non-breeding season.

## 9.9.7 Mitigation and Monitoring

1064. The assessment of impacts on birds, both in isolation and cumulatively, as a result of the construction, operation and decommissioning of the Project are predicted to be of no significance. Based on the predicted effects it is concluded that no specific mitigation is required beyond the embedded mitigation set out in Section 9.8.1.

### 9.9.8 Monitoring

1065. Following consent, a Project Environmental Monitoring Plan (PEMP) will be developed and agreed with MS-LOT, in discussion with the Forth and Tay Regional Advisory Group (FTRAG). Monitoring will be required to validate the findings of the EIA.

1066. To date, there have been some high level discussions regarding future monitoring requirements for NnG. An ornithology sub-group for the FTRAG has been established, comprising representatives from NnG, Inch Cape, Seagreen, Marine Scotland, SNH, JNCC and RSPB. Initial discussions considered where monitoring should focus, in terms of research questions, key species, SPAs and effects to be addressed.

1067. The above discussions will continue and will inform the selection of the most appropriate monitoring methods. Methods selected will be subject to regular review, as technologies improve and as information from monitoring programmes at other offshore projects is published, together with results from industry-led research projects such as the Offshore Renewables Joint Industry Programme (ORJIP).

1068. At this stage it is considered likely that monitoring will focus on collision/avoidance, displacement/barrier, as well as population-level effects. Various methods and technologies are available to monitor displacement/barrier, including GPS tagging, radar, boat-based and digital aerial surveys. For monitoring collision/avoidance, there is the potential to use turbine mounted cameras, radar, human observers and laser range finders. In addition, if looking at population effects, it would be beneficial to have a better understanding of survival and productivity rates for breeding adults at these SPA colonies.

1069. The different potential methods are still being considered, and a future decision on a monitoring system will be determined depending on the most appropriate technology available at the time of selection. There is the potential for collaboration with other developers, government and NGOs, which could be progressed via the PEMP or separate studies.

## 9.10 Summary of Residual Effects

1070. This chapter has assessed the potential effects on birds of the construction, operation and decommissioning of the Project, both in isolation and cumulatively. Where significant effects were identified additional mitigation has been considered and incorporated into the assessment. Table 9-231 summarises the impact determinations discussed in this chapter and presents the post-mitigation residual significance.

Table 9-231: Summary of predicted impacts of the Project

| Potential Impact | Significance of Effect | Mitigation Measures | Residual Significance of Effect |
|---|---|---|---|
| **Construction** | | | |
| **Impacts of installation of Export cables** | Minor, adverse | Embedded mitigation | Minor, adverse |
| **Direct impacts of construction activites** | Negligible, adverse | Embedded mitigation | Negligible, adverse |
| **Indirect impacts of construction activities** | Minor, adverse | Embedded mitigation | Minor, adverse |
| **Operation** | | | |
| **Displacement & barrier impacts** | Puffine: Minor, adverse<br>All other species considered: Negligible, adverse | Embedded mitigation | Puffine: Minor, adverse<br>All other species considered: Negligible, adverse |
| **Collision impacts** | Gannet and Kittiwake: Minor, adverse<br>All other species considered: negligible, adverse | Embedded mitigation. Collision reduction technologies will be explored post-consent in consultation with FTRAG. | Gannet and Kittiwake: Minor, adverse<br>All other species considered: negligible, adverse |
| **Decommissioning** | | | |
| **As assessed for construction.** | | | |
| **Cumulative Effects** | | | |
| **Displacement & barrier impacts** | Puffine: Minor, adverse<br>All other species considered: Negligible, adverse | Embedded mitigation. | Puffine: Minor, adverse<br>All other species considered: Negligible, adverse |

| Potential Impact | Significance of Effect | Mitigation Measures | Residual Significance of Effect |
|---|---|---|---|
| **Collision impacts** | **Scenario 1** – <br>Gannet and Kittiwake: Minor, adverse<br>All other species considered: negligible, adverse<br>**Scenario 2** – <br>Kittiwake: Moderate effects predicted in the non-breeding season, and by association, throughout the year for NnG and 2014 Forth and Tay projects<br>Gannet: Minor, adverse<br>All other species considered: negligible, adverse | Embedded mitigation. Will explore collision reduction technologies post-consent in consultation with FTRAG.<br>It is considered highly unlikely that Inch Cape and Seagreen A & B will be built to the maximum extent of their consented envelopes, therefore the outcome of this assessment is considered to be highly precautionary and unrealistic.<br>Mitigation – reducing the number of turbines constructed and increasing average rotor height, both of which are anticipated. | **Scenario 1** – <br>Gannet and Kittiwake: Minor, adverse<br>All other species considered: negligible, adverse<br>**Scenario 2** – <br>Kittiwake: Moderate effects likely to be mitigated if projects are not built to their maximum consented 2014 design.<br>Gannet: Minor, adverse<br>All other species considered: negligible, adverse |

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