BERWICK BANK WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT REPORT

Volume 2, Chapter 11: Offshore and Intertidal Ornithology

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EIA Report - Chapter 11
Final

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11. OFFSHORE AND INTERTIDAL ORNITHOLOGY

11.1. INTRODUCTION

1. This chapter of the Offshore Environmental Impact Assessment Report (EIA Report) presents the assessment of the likely significant effects (as per the "EIA Regulations") on the environment of the Berwick Bank Wind Farm offshore infrastructure which is the subject of this application (hereafter referred to as "the Proposed Development") on offshore and intertidal ornithology. Specifically, this chapter considers the potential impact of the Proposed Development seaward of Mean High Water Springs (MHWS) during the construction, operation and maintenance, and decommissioning phases.

2. "Likely Significant Effect (LSE)" is a term used in both the "EIA Regulations" and the Habitat Regulations. Reference to LSE in this offshore EIA report refers to "LSE" as used by the "EIA Regulations". This offshore EIA report is accompanied by a Report to Inform Appropriate Assessment (RIAA) which uses the term LSE as defined by the Habitat Regulations Assessment (HRA) Regulations.

3. The assessment presented is informed by the following technical chapters:

- volume 2, chapter 7: Physical Processes;
- volume 2, chapter 9: Fish and Shellfish Ecology;
- volume 3, appendix 11.1: Baseline Ornithology Technical Report;
- volume 3, appendix 11.2: Ornithology Inter-tidal Survey Report;
- volume 3, appendix 11.3: Ornithology Collision Risk Modelling Technical Report;
- volume 3, appendix 11.4: Ornithology Displacement Technical Report;
- volume 3, appendix 11.5: Ornithology Apportioning Technical Report;
- volume 3, appendix 11.6: Ornithology Population Viability Assessment Technical Report;
- volume 3, appendix 11.7: Boat-based Survey Report; and
- volume 3, appendix 11.8: Offshore Ornithology Road Map.

11.2. PURPOSE OF THIS CHAPTER

4. The primary purpose of the Offshore EIA Report is outlined in volume 1, chapter 1. It is intended that the Offshore EIA Report will provide the Scottish Ministers, statutory and non-statutory stakeholders with sufficient information to determine the likely significant effects of the Proposed Development on the receiving environment.

5. In particular, this offshore and intertidal ornithology EIA Report chapter:

- presents the existing environmental baseline established from desk studies, site-specific surveys and consultation with stakeholders;
- identifies any assumptions and limitations encountered in compiling the environmental information;
- presents the likely significant environmental effects on offshore and intertidal ornithology arising from the Proposed Development and reaches a conclusion on the likely significant effects on offshore and intertidal ornithology, based on the information gathered and the analysis and assessments undertaken; and
- highlights any necessary monitoring and/or mitigation measures which are recommended to prevent, minimise, reduce or offset the likely significant adverse environmental effects of the Proposed Development on offshore and intertidal ornithology.

11.3. STUDY AREA

6. Three study areas have been used to inform this chapter of the Offshore EIA Report. These are listed below, with further detail provided in the following sections:

- Offshore Ornithology regional study area;
- Offshore Ornithology study area; and
- Intertidal Ornithology study area.

11.3.1. OFFSHORE ORNITHOLOGY REGIONAL STUDY AREA

7. The Offshore Ornithology regional study area was determined by the area within which potential impacts to breeding seabirds could occur and was based on the foraging ranges of breeding seabirds. Many seabirds have large foraging ranges which in some cases extend several hundred kilometres from their breeding colonies. Birds may therefore overlap (i.e. have connectivity with) the Proposed Development, even when the colonies they originate from are a significant distance away. The Offshore Ornithology regional study area therefore also encompasses the Special Protection Area (SPA) breeding colonies with potential connectivity to the Proposed Development during the breeding season (Figure 11.1).

8. Published mean-maximum foraging ranges (plus one standard deviation (+1 S.D.)) in Woodward *et al*. (2019) were used to define the Offshore Ornithology regional study area. Gannet has the largest foraging range (315.2 km ± 194.2 km) of the key species considered in the ornithology assessment. The Offshore Ornithology regional study area therefore extends 509.4 km from the Proposed Development (Figure 11.1). Search areas for SPA breeding colonies and regional search areas for other key species in the assessment will fall within the mean-maximum foraging range of gannet. Therefore, this approach is appropriate to define the maximum extent of the Offshore Ornithological regional study area.

9. A seabird colony that is affected by the potential impacts of the Proposed Development could also be affected by the potential impacts at other developments within the foraging range of breeding seabirds from that colony. The cumulative study area for each species will therefore be defined by implementing a search area equivalent to the species-specific mean-maximum foraging range (+ 1 S.D.) along a marine pathway, from those potentially affected breeding colonies of that species.

10. In the non-breeding season, seabirds are not constrained by colony location and, depending on individual species, range widely within United Kingdom (UK) seas and beyond. The Zone of Influence (ZoI) for seabird species in the non-breeding season (where an assessment is deemed to be required) is based on Furness (2015) which presents Biologically Defined Minimum Population Scales (BDMPS).

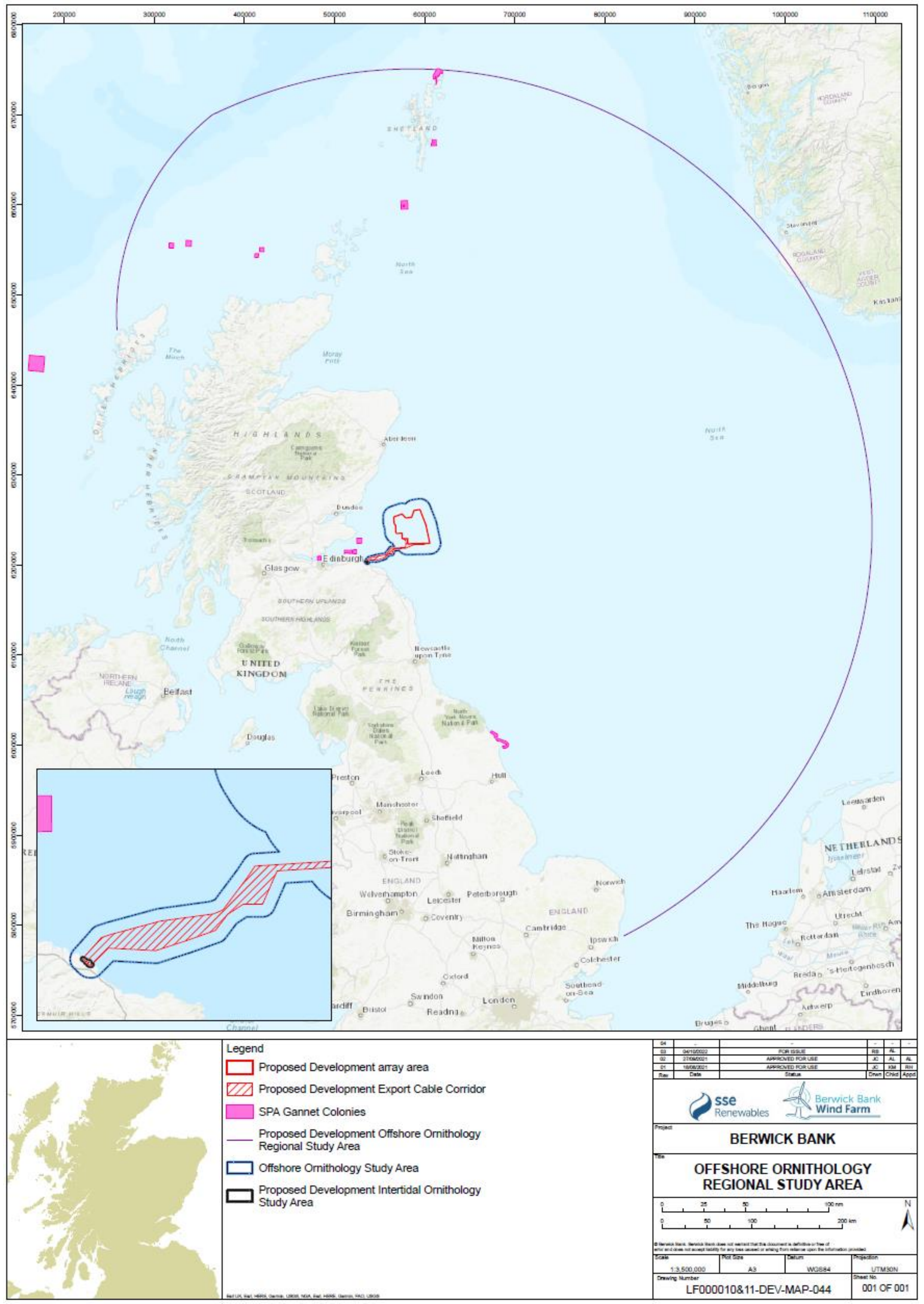

Figure 11.1: Offshore Ornithology Regional Study Area

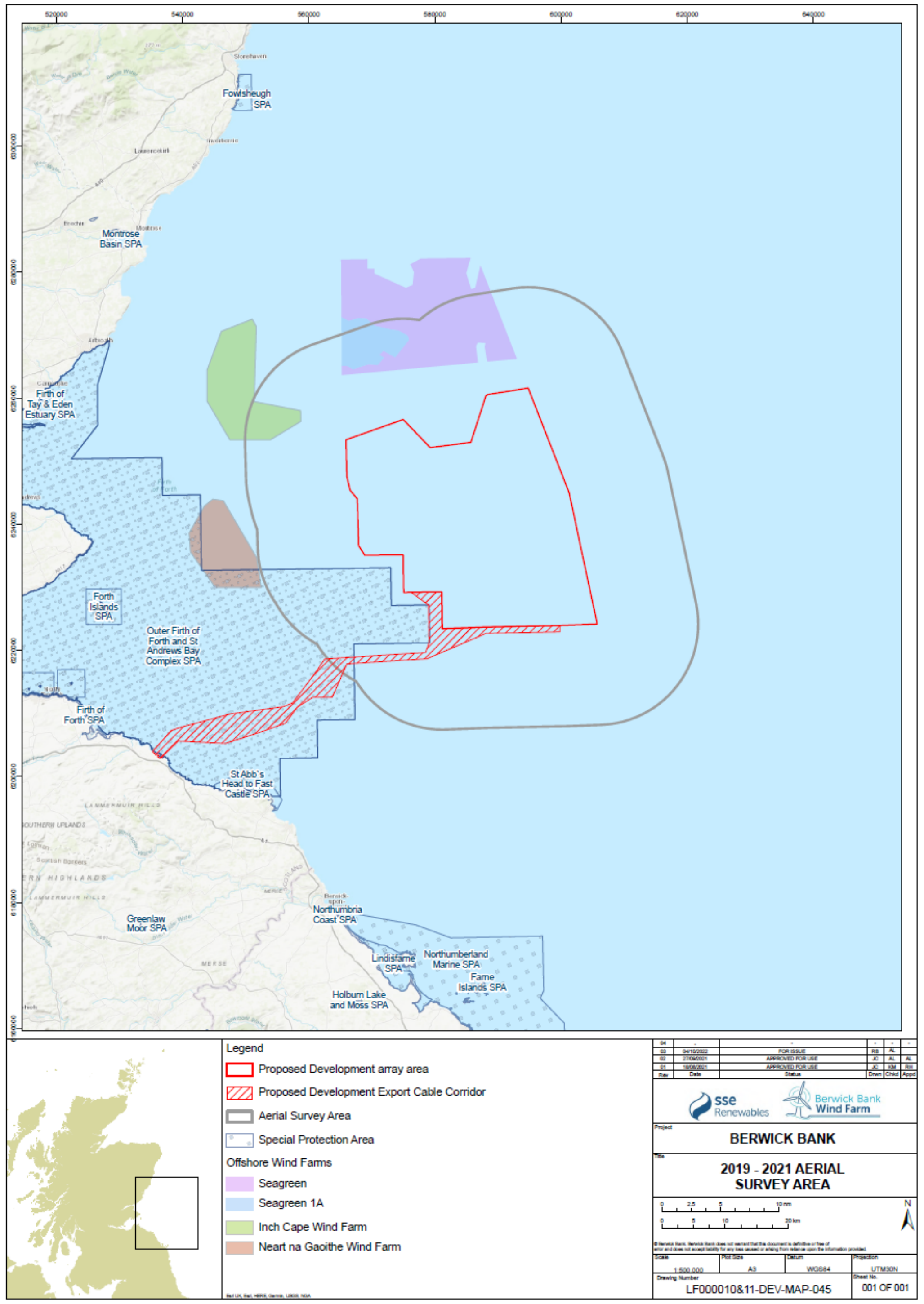

Figure 11.2: Offshore Ornithology Study Area

11.3.2. OFFSHORE ORNITHOLOGY STUDY AREA

11. The area covered by the baseline digital aerial surveys encompasses the Proposed Development array area, plus a 16 km buffer, which makes up the Offshore Ornithology study area (Figure 11.2). For the purposes of the assessment on bird impacts data obtained within the 16 km buffer area have been used to provide context in relation to the Proposed Development array area.

12. Using this extensive study area provides a wide ornithological context for the Proposed Development. It is also an appropriate size to provide a robust pre- and post-construction comparison of seabird abundance and distribution along a gradient outward from the Proposed Development and to allow this to be monitored.

13. The Proposed Development export cable corridor beyond the 16 km buffer area was not included in the digital aerial survey area. Based on the predicted level of impact arising from cable laying on seabirds the use of existing data sources is considered sufficient to characterise baseline characteristics of the Proposed Development export cable corridor for the purposes of the EIA Report. This approach was discussed at Ornithology Road Map Meeting 2 and further discussed and agreed at Ornithology Road Map 6 (see volume 3, appendix 11.8).

14. It should be noted that the digital aerial dataset collected within the Proposed Development offshore ornithology study area was re-analysed with reference to the Proposed Development boundary refinement process that was undertaken in June 2022, so that all figures presented in this chapter and the supporting documents regarding the Proposed Development reflect this boundary refinement.

11.3.3. INTERTIDAL ORNITHOLOGY STUDY AREA

15. The offshore topic of offshore and intertidal ornithology includes an area of intertidal habitat seaward of MHWS and landward of Mean Low Water Springs (MLWS). This intertidal area overlaps with the onshore topic of ecology and ornithology (landward of MHWS).

16. The Intertidal Ornithology study area for the assessment of effects on birds in the intertidal zone covers the coastal area between MHWS and MLWS at the landfall locations within which intertidal bird surveys have been carried out in the non-breeding season. The Intertidal Ornithology study area extends approximately 6 km along the coast to cover the two landfall locations that were covered during the surveys and extends up to 1.5 km seaward from MHWS (Figure 11.3). However, it should be noted that only the northern landfall location at Skateraw is now being considered. Survey data from the southern landfall location was included in the assessment process to provide greater context.

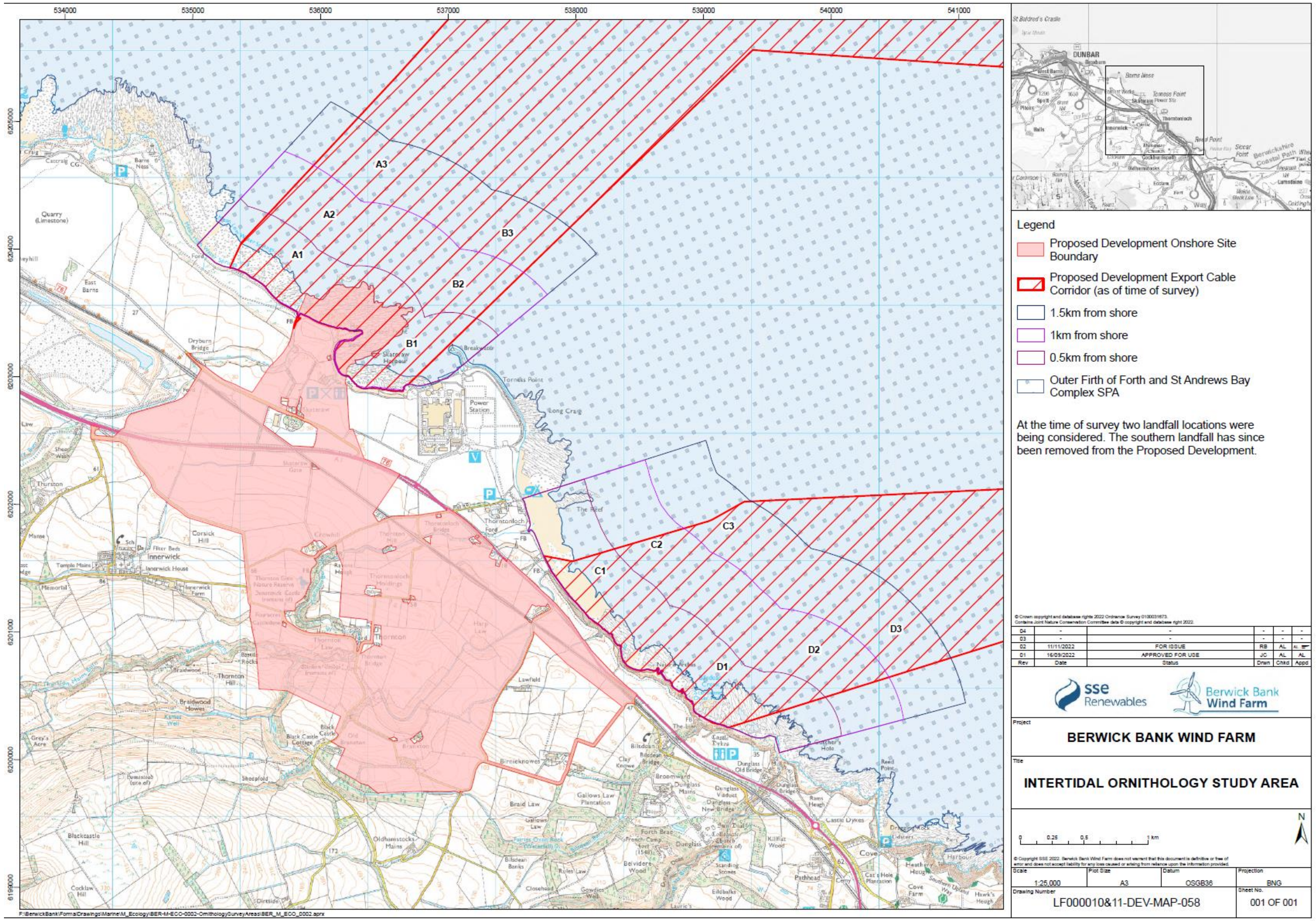

Figure 11.3: Intertidal Ornithology Study Area

11.4. POLICY AND LEGISLATIVE CONTEXT

17. Policy and legislation on renewable energy infrastructure is presented in volume 1, chapter 2 of the Offshore EIA Report. Policy specifically in relation to offshore and intertidal ornithology, is contained in the Scottish National Marine Plan (NMP) (Scottish Government, 2015). A summary of the legislative provisions relevant to offshore and intertidal ornithology are provided in Table 11.1, with other relevant policy provisions set out in Table 11.2. Further detail is presented in volume 1, chapter 2.

Table 11.1: Summary of Legislation Relevant to Offshore and Intertidal Ornithology

Summary of Relevant Legislation	How and Where Considered in the Offshore EIA Report
Ornithology	
The Habitats Regulations: The Conservation (Natural Habitats and c.) Regulations 1994 (as amended). The Conservation of Offshore Marine Habitats and Species Regulations 2017 The Conservation of Habitats and Species Regulations 2017 The Conservation of Habitats and Species (Amendment) (European Union (EU) Exit) Regulations 2019	The Habitats Regulations require that where a plan or project that is not directly connected with, or necessary to the management of a European site, but likely to have a significant effect, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives. Likely significant effects on ornithology features of European sites are considered from an EIA perspective within this report. Assessment of the likely significant effects on the qualifying interest features of Special Protection Areas (SPAs), together with assessment on other Natura sites and qualifying interest features (e.g. Special Areas of Conservation (SAC)) from a habitats perspective are provided in a Habitats Regulations Appraisal.
The Nature Conservation (Scotland) Act 2004 (as amended)	The Act sets out a series of measures which are designed to conserve biodiversity and to protect and enhance the biological and geological natural heritage of Scotland.
The Wildlife and Countryside Act 1981 (as amended)	The primary legislation protecting animals, plants and certain habitats in the UK, including all wild birds and their nests, eggs and chicks.
EIA Regulations: The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 The Marine Works (Environmental Impact Assessment) Regulations 2007	The EIA report must fulfil the requirements of the EIA regulations.

Table 11.2: Summary of NMP Policies Relevant to Offshore and Intertidal Ornithology

Summary of NMP Provision	How and Where Considered in the Offshore EIA Report
Scottish National Marine Plan	
Part 1: Objectives and marine planning policies Sustainable development of offshore wind, wave and tidal renewable energy in the most suitable locations.	Refer to volume 1, chapter 4.
Policy GEN 9 Natural heritage Development and use of the marine environment must: (a) Comply with legal requirements for protected areas and protected species. (b) Not result in significant impact on the national status of Priority Marine Features. (c) Protect and, where appropriate, enhance the health of the marine area.	Legislative requirements for offshore wind farms are considered within volume 1, chapter 2.
Living within Environmental Limits A strategic approach to mitigating potential impacts and cumulative impacts on the marine environment forms an integral part of marine planning and decision making, whilst issues arising in the coastal interface should align between marine and terrestrial processes.	A Cumulative Effect Assessment (CEA) has been undertaken and is outlined in section 11.12.

11.5. CONSULTATION

18. The offshore and intertidal ornithology Road Map is a 'live' document which has been used as a tool to facilitate early engagement with stakeholders and subsequent engagement throughout the pre-application phase of the Proposed Development including on agreeing to scoping impacts out of the assessment, and/or agreeing the level of assessment which will be presented for impacts, so that the focus in the EIA submission documents is on likely significant environmental effects as required by the EIA Regulations.

19. A summary of the key issues raised during consultation activities undertaken to date specific to offshore and intertidal ornithology is presented in Table 11.3 below, together with how these issues have been considered in the production of this offshore and intertidal ornithology EIA Report chapter and associated appendices. Further detail is presented within volume1, chapter 5. Additional information on the Road Map process relevant to offshore and intertidal ornithology is presented in Appendix 11.8.

Table 11.3: Summary of Key Consultation Issues Raised During Consultation Activities Undertaken for the Proposed Development Relevant to Offshore and Intertidal Ornithology

Date	Meeting Agenda	Response to Issue Raised and/or Where Considered in this Chapter and associated appendices
22/7/2021	• Berwick Bank Wind Farm project design • Project programme and key dates • Engagement and consultation including road map process • Discussion on technical ornithology elements including baseline characterisation, collision risk and displacement	Baseline characterisation presented in Appendix 11.1 Approach to Collision Risk Modelling (CRM) and CRM results are presented in Appendix 11.3 Approach to displacement assessment and results are presented in Appendix 11.5

Date	Meeting Agenda	Response to Issue Raised and/or Where Considered in this Chapter and associated appendices
		Road Map meeting 1 minutes including actions are presented in volume 3, appendix 11.8, annex A
9/8/2021	• Road Map Meeting 1 – review of note and actions • Update on engagement / road map process • Berwick Bank Scoping Comments • Approach to technical reporting methodology including responses to HiDef Questions	Approach to technical reporting methodology presented in Appendix 11.1, 11.3, and 11.4 Road Map meeting 2 minutes including actions are presented in volume 3, appendix 11.8, annex A
28/9/2021	• Review of actions from RM1 and RM2 • MRSea - discussion of issues and approach to baseline • Present initial outputs of baseline characterisation work • Discussion on PVA methodology • Overview of updated LSE Screening Report • Discussion on additional questions / clarifications on approach to technical work	MRSea outputs are presented in Appendix 11.1, Annex L Baseline characterisation is presented in Appendix 11.1 PVA Methodology is presented in Appendix 11.6 Road Map meeting 3 minutes including actions are presented in volume 3, appendix 11.8, annex A
8/12/2021	• Review of actions from RM1 to RM3 • Overview of Baseline Report • Presentation of CRM results • Base case (Deterministic Band CRM, Generic Flight Height, SNCB avoidance rates) • Contextual results (sCRM, Bowgen and Cook avoidance rates, site-specific flight heights) • SeabORD • Apportioning Tool comparison • In-Combination Assessment	Baseline characterisation is presented in Appendix 11.1 CRM results including from both deterministic and stochastic modelling are presented in Appendix 11.3 SeabORD outputs are presented in Appendix 11.4, annex D SeabORD review is presented in Appendix 11.4. annex H Methodology for undertaking Ornithological Apportioning is presented in Appendix 11.5 Road Map meeting 4 minutes including actions are presented in volume 3, appendix 11.8, annex A
31/1/2022	• Review of actions from RM1 to RM4 • Refined CRM results • Ecosystem Approach • Outstanding issues • Baseline definition for in-combination assessment	CRM results are presented in Appendix 11.3 The Ecosystem Approach for ornithology is presented in Appendix 20 Road Map meeting 5 minutes including actions are presented in volume 3, appendix 11.8, annex A
10/5/2022	• Developer Update • Review of actions from RM1 to RM5 • Scoping Opinion – areas highlighted for further discussion • In-combination totals methodology	Road Map meeting 6 minutes including actions are presented in volume 3, appendix 11.8, annex A

11.6. METHODOLOGY TO INFORM BASELINE

11.6.1. DESKTOP STUDY

20. Information on offshore and intertidal ornithology within the Offshore Ornithology regional study area was collected through a detailed desktop review of existing studies and datasets. These are summarised in Table 11.4 below.

Table 11.4: Summary of Key Desktop Reports and Datasets

Title	Source	Year	Author
Special Protection Areas, proposed Special Protection Areas, Sites of Special Scientific Interest, Ramsar sites.	NatureScot website	2021	NatureScot
Seabirds Count national colony census data	Seabird Monitoring Programme website	2015 - 2021	BTO
Desk-based revision of seabird foraging ranges used for HRA screening.	Published paper	2019	Woodward *et al.*
Seagreen 1 (Alpha and Bravo) Environmental Statement, Addendum and associated technical reports.	Seagreen online library	2018 - 2020	SSE
Wetlands Bird Survey (WeBS) data	National WeBS database	2015-2020	BTO

21. Additional datasets used for the desktop review are presented in Table 2.1.1 of volume 3, appendix 11.1.

11.6.2. IDENTIFICATION OF DESIGNATED SITES

22. All designated sites within the Offshore Ornithology regional study area and qualifying interest features that could be affected by the construction, operation and maintenance, and decommissioning phases of the Proposed Development were identified using the three-step process described below:

- Step 1: All designated sites of international, national and local importance within the Offshore Ornithology regional study area were identified using a number of sources. These sources included published information on Special Protection Areas (SPAs) for birds such as the NatureScot website.
- Step 2: Information was compiled on the relevant qualifying interest features for each of these sites. Key information included most recently available population count or estimate from the Seabird Monitoring Programme (SMP) online database, as well as published information on the mean maximum foraging range (plus 1 S.D.). This information was taken from the most recent available source (Woodward *et al*. 2019).
- Step 3: Using the above information and expert judgement, sites were included for further consideration if:
  - A designated site directly overlaps with the Proposed Development, including the Proposed Development export cable corridor;
  - The Proposed Development is located within mean maximum foraging range (+1SD) of any species of qualifying interest from designated sites; or
  - Designated sites are within the potential ZoI for impacts associated with the Proposed Development.

23. This information was used within the EIA Report assessment to determine the conservation importance of features present in the Offshore Ornithology regional study area.

11.6.3. SITE-SPECIFIC SURVEYS

24. To inform the offshore and intertidal ornithology EIA Report chapter, site-specific surveys were undertaken, as agreed with Marine Scotland Licencing Operations Team (MS-LOT), Marine Scotland Science (MSS), NatureScot and Royal Society for the Protection of Birds (RSPB). A summary of the surveys undertaken to inform the offshore and intertidal ornithology impact assessment are outlined in Table 11.5 below.

Table 11.5: Summary of Site-Specific Survey Data

Title	Extent of Survey	Overview of Survey	Survey Contractor	Date	Reference to Further Information
Digital aerial surveys	Offshore Ornithology study area	25 monthly digital aerial transect surveys to characterise the Proposed Development array area and 16 km buffer	HiDef Ltd	March 2019 to April 2021	Volume 3, appendix 11.1
Intertidal ornithology surveys	Intertidal and nearshore area of offshore cable corridor	Intertidal and nearshore surveys to characterise the ornithology in the vicinity of the proposed landfalls	RPS Ltd.	July 2020 to June 2021	Volume 3, appendix 11.2

25. The following secondary data sources have also been used to provide relevant supplementary contextual information on the Proposed Development array area and surrounding buffer area:

- Boat-based transect survey data from July and August 2020 and between April and May 2021 within the Proposed Development targeted at recording seabird flight height and behaviour and collecting associated environmental variable data (volume 3, appendix 11.7);
- Boat-based transect survey data of the Firth of Forth Round 3 Zone from December 2009 to November 2011; and
- Seabird colony data and seabird tracking data from Forth Islands, Fowlsheugh and St Abb's Head collected between 2010 and 2019.

26. Methods used and results from the site-specific digital aerial surveys are presented in section 4 of volume 3, appendix 11.1.

11.7. BASELINE ENVIRONMENT

11.7.1. OVERVIEW OF BASELINE ENVIRONMENT

27. A summary of the baseline environment for offshore and intertidal ornithology is provided in the following sections. Full details of the analysis undertaken to develop the offshore and intertidal ornithology baseline is provided in volume 3, appendix 11.1, which includes information on survey design and methods, as well as the analysis techniques implemented to characterise the baseline.

Offshore Ornithology

28. Seabird abundance estimates from the site-specific digital aerial surveys and how they were derived are presented in detail in volume 3, appendix 11.1. Detail from the baseline report has not been repeated within this chapter in order to present a clear and concise impact assessment.

29. Species assessed for impacts are those which were recorded during digital aerial surveys and which are considered to be at potential risk either due to their abundance, potential sensitivity to wind farm impacts or due to biological characteristics (e.g., commonly fly at rotor heights) which make them potentially susceptible. The conservation status of these species is provided in Table 11.6. Abundances and distributions of all species observed are presented in volume 3, appendix 11.1.

Table 11.6: Summary of Nature Conservation Status of Seabird Species Considered at Risk of Potential Impacts

Species	Scientific Name	Conservation Status
Common scoter	*Melanitta nigra*	Birds of Conservation Concern (BoCC)[1] Red listed, Birds Directive Migratory Species
Red-throated diver	*Gavia stellata*	BoCC Green listed, Birds Directive Migratory Species, Birds Directive Annex 1
Great northern diver	*Gavia immer*	BoCC Amber listed, Birds Directive Migratory Species, Birds Directive Annex 1
Fulmar	*Fulmarus glacialis*	BoCC Amber listed, Birds Directive Migratory Species
Storm petrel	*Hydrobates pelagicus*	BoCC Amber listed, Birds Directive Migratory Species, Birds Directive Annex 1
Manx shearwater	*Puffinus puffinus*	BoCC Amber listed, Birds Directive Migratory Species
Sooty shearwater	*Ardenna grisea*	BoCC Green listed, Birds Directive Migratory Species
Gannet	*Morus bassanus*	BoCC Amber listed, Birds Directive Migratory Species
Shag	*Gulosus aristotelis*	BoCC Red listed
Arctic skua	*Stercorarius parasiticus*	BoCC Red listed, Birds Directive Migratory Species
Pomarine skua	*Stercorarius pomarinus*	BoCC Green listed, Birds Directive Migratory Species
Great skua	*Stercorarius skua*	BoCC Amber listed, Birds Directive Migratory Species
Little auk	*Alle*	BoCC Green listed, Birds Directive Migratory Species
Puffin	*Fratercula arctica*	BoCC Red listed, Birds Directive Migratory Species
Razorbill	*Alca torda*	BoCC Amber listed, Birds Directive Migratory Species
Guillemot	*Uria aalge*	BoCC Amber listed, Birds Directive Migratory Species
Sandwich tern	*Thalasseus sandvicensis*	BoCC Amber listed, Birds Directive Migratory Species, Birds Directive Annex 1
Little tern	*Sternula albifrons*	BoCC Amber listed, Birds Directive Migratory Species, Birds Directive Annex 1
Common tern	*Sterna hirundo*	BoCC Amber listed, Birds Directive Migratory Species, Birds Directive Annex 1
Arctic tern	*Sterna paradisaea*	BoCC Amber listed, Birds Directive Migratory Species, Birds Directive Annex 1
Kittiwake	*Rissa tridactyla*	BoCC Red listed, Birds Directive Migratory Species
Little gull	*Hydrocoloeus minutus*	BoCC Green listed, Birds Directive Migratory Species
Black-headed gull	*Chroicocephalus ridibundus*	BoCC Amber listed, Birds Directive Migratory Species
Common gull	*Larus canus*	BoCC Amber listed, Birds Directive Migratory Species
Lesser black-backed gull	*Larus fuscus*	BoCC Amber listed, Birds Directive Migratory Species
Herring gull	*Larus argentatus*	BoCC Red listed, Birds Directive Migratory Species
Great black-backed gull	*Larus marinus*	BoCC Amber listed, Birds Directive Migratory Species

1 Stanbury et al., 2021

30. Impacts have been assessed in relation to relevant biological seasons, as defined by NatureScot (2020), and a summary of these seasons for seabird species is presented in Table 11.7. Seasons for three species (sooty shearwater, pomarine skua and little auk) are not defined by NatureScot, so these species are not listed.

Table 11.7: **Seasonal Definitions for Seabird Species (based on NatureScot, 2020)**

Species	Breeding Season	Non-breeding Season
Common scoter	-	July to April
Red-throated diver	May to mid-September	Mid-September to April
Great northern diver	-	October to mid-May
Fulmar	April to mid-September	Mid-September to March
Storm petrel	Mid-May to October	-
Manx shearwater	April to mid-October	-
Gannet	Mid-March to September	October to mid-March
Shag	March to September	October to February
Arctic skua	May to August	-
Great skua	Mid-April to mid-September	-
Puffin	April to mid-August	Mid-August to March
Razorbill	April to mid-August	Mid-August to March
Guillemot	April to mid-August	Mid-August to March
Sandwich tern	Mid-April to mid-September	-
Little tern	Mid-May to August	-
Common tern	May to mid-September	-
Arctic tern	May to August	-
Kittiwake	Mid-April to August	September to mid-April
Little gull	-	August to mid-April
Black-headed gull	April to August	September to March
Common gull	April to August	September to March
Lesser black-backed gull	Mid-March to August	-
Herring gull	April to August	September to February
Great black-backed gull	April to August	September to March

31. For the breeding season, the regional reference population for seabird species in the breeding season was calculated by summing the most recent colony counts from the SMP online database within mean-maximum foraging range (+1 S.D.) where available, as defined in Woodward *et al.* (2019). For the non-breeding period, the relevant BDMPS and associated population estimates were taken from Furness (2015) (Table 11.8 and Table 11.9).

Table 11.8: **Mean-maximum foraging distance + 1S.D. used for Seabird Species**

Species	Mean max Foraging Range +1 S.D.
Fulmar	542.3 ± 657.9 km
Storm petrel	336.0 km
Manx shearwater	1,346.8 ± 1,018.7 km
Gannet	315.2 ± 194.2 km
Shag	13.2 ± 10.5 km
Arctic skua	2.5 km
Great skua	443.3 ± 487.9 km
Puffin	137.1 ± 128.3 km
Razorbill	88.7 ± 75.9 km
Guillemot	73.2 ± 80.5 km
Sandwich tern	34.3 ± 23.2 km
Common tern	18.0 ± 8.9 km
Arctic tern	25.7 ± 14.8 km
Kittiwake	156.1 ± 144.5 km
Black-headed gull	18.5 km
Common gull	50 km
Lesser black-backed gull	127 ± 109 km
Herring gull	58.8 ± 26.8 km
Great black-backed gull	73 km

Table 11.9: **Breeding and non-breeding reference populations for seabird species**

Species	Breeding Season Reference Population (breeding adults)[1]	Non-breeding Season Reference Population (adult and immature) (Furness 2015)		
Manx shearwater	-	8,507 (migration seasons)		
Gannet	323,836	456,298 (autumn)		248,385 (spring)
Shag	-	45,503 (non-breeding season)		
Great skua	-	19,556 (autumn),	143 (winter)	8,485 (spring)
Puffin	233,550	231,957 (non-breeding season)		
Razorbill	124,717	591,874 (autumn and spring migration)		218,622 (winter period)
Guillemot	353,971	353,971[2] (non-breeding period)		
Common tern	-	144,911 (migration seasons)		
Arctic tern	-	163,930 (migration seasons)		
Kittiwake	319,126	829,937 (autumn migration)		627,816 (spring)
Lesser black-backed gull	13,994	209,007 (autumn),	39,314 (winter)	197,483 (spring)
Herring gull	29,600	49,432[2] (non-breeding)		
Great black-backed gull	188	91,399 (non-breeding)		

1 – Regional breeding populations within mean maximum foraging range only (volume 3, appendix 11.1). Manx shearwater is not included as there are no east coast breeding colonies (NatureScot, 2016)

2 – As advised in Scoping Opinion

Intertidal Ornithology

32. The Intertidal Ornithology study area comprised two separate landfall locations and their associated sections of export cable corridor (Figure 11.3). The length of shoreline surveyed covered approximately 6 km to ensure contemporary data were collected for all potential export cable landfall locations under investigation. Since the completion of the intertidal survey work, further analysis has been undertaken and the most southerly landfall site has been removed from the Proposed Development. The northern landfall location at Skateraw is therefore the remaining landfall option.

33. The programme of monthly intertidal and nearshore coastal bird surveys was conducted over 12 months between July 2020 and June 2021 inclusive. The survey programme included all key periods relating to bird interests and designated sites, specifically breeding and non-breeding seasons, plus spring and autumn passage. For comparison, WeBS count data were obtained from the BTO for the most recent high tide datasets gathered from the survey area which most closely corresponded to the intertidal ornithology study area.

34. The intertidal and nearshore bird survey data demonstrate that the Intertidal Ornithology study area supports a diversity of bird species typical of coastal areas off the east coast of Scotland, predominantly seaducks, wading birds, divers, grebes and other seabirds, primarily in the non-breeding season.

35. A total of 55 species were recorded within the intertidal and nearshore survey area during the survey programme. A total of 14 species of wildfowl were recorded, along with 15 species of waders, two diver species, two grebe species, ten species of gulls and terns and 12 species of seabirds.

36. The available WeBS data corresponded relatively closely with the intertidal and nearshore bird survey data. This demonstrated that the survey data were a robust representation of the diversity and abundance of the birds which typically occurs within the Intertidal Ornithology study area.

37. The intertidal shore and nearshore waters of the Iintertidal ornithology study area are typically of local importance for the majority of qualifying species for SPAs, Ramsar sites and Site of Special Scientific Interest (SSSIs) associated with the Firth of Forth.

38. Further information of the methods used and results from the intertidal bird surveys are presented in volume 3, appendix 11.2.

11.7.2. DESIGNATED SITES

39. Key designated sites identified for the offshore and intertidal ornithology chapter are described in Table 11.10. Typically, these are the closest designated sites to the Proposed Development that support important populations of breeding seabirds. Additional, more distant conservation sites considered for ornithological connectivity with the Proposed Development are detailed in volume 3, appendix 11.5.

Table 11.10: Key Designated Sites and Relevant Qualifying Interest Features for the Offshore and Intertidal Ornithology Chapter

Designated Site	Relevant Qualifying Interest Feature(s)
Outer Firth of Forth and St Andrew's Bay Complex SPA	Arctic tern, common tern, little gull, red-throated diver, Slavonian grebe, gannet, shag, eider, common scoter, velvet scoter, goldeneye, red-breasted merganser, black-headed gull, kittiwake, Manx shearwater, guillemot, razorbill, herring gull, common gull.
St Abb's Head to Fast Castle SPA and SSSI	Guillemot, razorbill, herring gull, kittiwake, shag.
Forth Islands SPA	Arctic tern, common tern, roseate tern, Sandwich tern, gannet, shag, lesser black-backed gull, puffin, guillemot, razorbill, kittiwake, herring gull, cormorant.
Fowlsheugh SPA	Fulmar, kittiwake, herring gull, guillemot, razorbill.
Farne Islands SPA	Arctic tern, common tern, roseate tern, kittiwake, guillemot, puffin, shag, cormorant.
Coquet Island SPA	Arctic tern, common tern, roseate tern, Sandwich tern, black-headed gull, lesser black-backed gull, herring gull, kittiwake, fulmar, puffin.
Buchan Ness to Collieston Coast SPA	Kittiwake, herring gull, guillemot, shag, fulmar.
Troup, Pennan and Lion's Heads SPA	Kittiwake, herring gull, guillemot, razorbill, fulmar.
East Caithness Cliffs	Kittiwake, herring gull, great black-backed gull, guillemot, razorbill, shag, cormorant, fulmar
Flamborough and Filey Coast SPA	Gannet, kittiwake, herring gull, guillemot, razorbill, puffin, shag, cormorant.
North Caithness Cliffs SPA	Kittiwake, guillemot, razorbill, puffin, fulmar.
Firth of Forth SPA, Ramsar site and SSSI	Site supports populations of European importance of species listed on Annex 1, and under Article 4.2 of the directive by regularly supporting winter populations of European and international importance of certain migratory species. Site also qualifies by supporting a winter waterfowl assemblage of European importance consisting of at least 95,000 individuals, including a further 17 species to those designated under Articles 4.1 and 4.2 alone. Listed as a Ramsar Site under the Conservation of Wetlands of International Importance especially as Waterfowl Habitat Nationally important site designated as a SSSI under the Wildlife and Countryside Act 1981 (as amended).

11.7.3. IMPORTANT ECOLOGICAL FEATURES

40. Important Ecological Features (IEFs) can be habitats, species, ecosystems and their functions/processes that are considered to be important and potentially impacted by the Proposed Development. As agreed by stakeholders, guidance from the Chartered Institute of Ecology and Environmental Management (CIEEM) (2019) was used to assess IEFs. In an ornithological context, IEFs can be attributed to individual key species (such as herring gull) or species groups (for example other gulls). Each IEF is assigned a value or importance rating which is based on ecological and conservation importance, for example a key species listed as a feature of an SPA. Table 11.11 details the criteria used for determining the importance of these key species and Table 11.12 presents the defining characteristics for classification of these key species, providing justifications for importance rankings for the key species likely to occur within the Offshore Ornithology study area, as well as a means to scope out species from further assessment on the basis of their importance. Specific reference is made to each species' conservation and ecological importance, where this is known. For the purposes of this assessment, the key species are those that are screened in for assessment in Table 11.12. These key species will be taken forward for assessment.

Table 11.11: Defining Criteria

Importance	Defining Criteria
International	Internationally designated sites within mean maximum foraging range +1 S.D. of the Proposed Development array area in the breeding season. Regularly occurring species protected under international law (i.e., Annex I species listed as qualifying interests of SPAs within mean maximum foraging range +1 S.D. of the Proposed Development array area for breeding species, or nearby non-breeding season SPA).
National	Nationally designated sites within mean maximum foraging range +1 S.D. of the Proposed Development array area. Species protected under national law. Regularly occurring Annex I or Birds Directive Migratory species which are not listed as qualifying interests of SPAs within mean maximum foraging range +1 S.D. of the Proposed Development array area. BoCC 'Red' list (Stanbury et al., 2021) and/or Scottish Biodiversity List species that have nationally important populations within the Offshore Ornithology study area.
Regional	BoCC 'Red' list (Stanbury et al., 2021) and/or UK Biodiversity Action Plan species that have regionally important populations within the Offshore Ornithology study area (i.e., are locally widespread and/or abundant).
Local	The species is common throughout Scottish waters but forms a key component of the bird assemblages in the Offshore Ornithology study area.

Table 11.12: Initial Scoping of Key Species within the Offshore Ornithology study area

Species	Importance	Justification
Common scoter	International	Scoped IN. Although listed on BoCC 'Red' list (Stanbury et al., 2021) and a UK Biodiversity Action Plan species, there are no breeding areas within mean maximum foraging distance. The species does not regularly occur in regionally or locally important populations within the Offshore Ornithology study area, based on baseline aerial survey data. However, common scoter is listed as a qualifying interest of Outer Firth of Forth and St Andrews Bay Complex marine SPA, and therefore has been scoped in on the basis of potential disturbance impacts arising from Export Cable installation within this SPA.
Red-throated diver	International	Scoped IN. Annex I species which is listed as a qualifying interest of Outer Firth of Forth and St Andrews Bay Complex marine SPA
Great northern diver	International	Scoped OUT. Although Annex I listed, the species does not breed in the UK. The species does not regularly occur in regionally or locally important populations within the Offshore Ornithology study area, based on baseline aerial survey data.
Fulmar	International	Scoped OUT. Internationally designated sites within mean maximum foraging range +1 S.D. of the Proposed Development array area. However, the species has a Very Low sensitivity and is not known to avoid vessels. In addition, the species has a maximum habitat flexibility score of 1 in Furness and Wade (2012), and a very large foraging range, suggesting the species utilises a wide range of habitats over a large area. Fulmar population vulnerability to collision mortality from offshore wind farms has been ranked as 'Very Low' (Bradbury et al., 2014).

Species	Importance	Justification
Storm petrel	National	Scoped OUT. Regularly occurring Annex I species which is not listed as qualifying interests of SPAs within mean maximum foraging range +1 S.D. of the Proposed Development array area. The species does not regularly occur in regionally or locally important populations within the Offshore Ornithology study area, based on baseline aerial survey data.
Manx shearwater	International	Scoped OUT. Internationally designated sites within mean maximum foraging range +1 S.D. of the Proposed Development array area. However, the species has a Very Low sensitivity and is not known to avoid vessels. In addition, the species has a maximum habitat flexibility score of 1 in Furness and Wade (2012), and a very large foraging range, suggesting the species utilises a wide range of habitats over a large area. Manx shearwater population vulnerability to collision mortality from offshore wind farms has been ranked as 'Very Low' (Bradbury et al., 2014).
Sooty shearwater	National	Scoped OUT. The species does not breed in the UK. The species does not regularly occur in regionally or locally important populations within the Offshore Ornithology study area, based on baseline aerial survey data.
Gannet	International	Scoped IN. Internationally designated sites within mean maximum foraging range +1 S.D. of the Proposed Development array area.
Shag	International	Scoped IN. The species does not breed at internationally designated sites within mean maximum foraging range +1 S.D. of the Proposed Development array area (Table 11.8). The species does not regularly occur in regionally or locally important populations within the Offshore Ornithology study area, based on baseline aerial survey data. However, shag is listed as a qualifying interest of Outer Firth of Forth and St Andrews Bay Complex marine SPA, and therefore has been scoped in on the basis of potential disturbance impacts arising from Export Cable installation within this SPA.
Arctic skua	National	Scoped OUT. The species does not breed at internationally designated sites within mean maximum foraging range +1 S.D. of the Proposed Development array area. The species does not regularly occur in regionally or locally important populations within the Offshore Ornithology study area, based on baseline aerial survey data.
Pomarine skua	National	Scoped OUT. The species does not breed in the UK. The species does not regularly occur in regionally or locally important populations within the Offshore Ornithology study area, based on baseline aerial survey data.
Great skua	National	Scoped IN. Regularly occurring Birds Directive Migratory species which is not listed as qualifying interest of SPAs within mean maximum foraging range +1 S.D. of the Proposed Development array area.
Little auk	National	Scoped OUT. The species does not breed in the UK. The species does not regularly occur in regionally or locally important populations within the Offshore Ornithology study area, based on baseline aerial survey data.
Puffin	International	Scoped IN. Internationally designated sites within mean maximum foraging range +1 S.D. of the Proposed Development array area.
Razorbill	International	Scoped IN. Internationally designated sites within mean maximum foraging range +1 S.D. of the Proposed Development array area.
Guillemot	International	Scoped IN. Internationally designated sites within mean maximum foraging range +1 S.D. of the Proposed Development array area.
Sandwich tern	International	Scoped OUT. Although Annex I listed. the species does not breed at internationally designated sites within mean maximum foraging range +1 S.D. of the Proposed Development array area. The species does not regularly occur in regionally or locally important populations within the Offshore Ornithology study area, based on baseline aerial survey data.
Little tern	International	Scoped OUT. Although Annex I listed, the species does not breed at Internationally designated sites within mean maximum foraging range +1 S.D. of the Proposed Development array area. The species does not regularly occur in regionally or locally important populations within the Offshore Ornithology study area, based on baseline aerial survey data.
Common tern	National	Scoped IN. Regularly occurring Annex I species which is not listed as qualifying interests of SPAs within mean maximum foraging range +1 S.D. of the Proposed Development array area. Annex I species which is listed as a qualifying interest of Outer Firth of Forth and St Andrews Bay Complex marine SPA.
Arctic tern	International	Scoped IN. Internationally designated sites within mean maximum foraging range +1 S.D. of the Export Cable corridor. Annex I species which is listed as a qualifying interest of Outer Firth of Forth and St Andrews Bay Complex marine SPA.
Kittiwake	International	Scoped IN. Internationally designated sites within mean maximum foraging range +1 S.D. of the Proposed Development array area.
Little gull	International	Scoped IN. Annex I species which is listed as a qualifying interest of Outer Firth of Forth and St Andrews Bay Complex marine SPA
Black-headed gull	National	Scoped OUT. Regularly occurring Birds Directive Migratory species which is not listed as qualifying interests of SPAs within mean maximum foraging range +1 S.D. of the Proposed Development array area. The species does not regularly occur in regionally or locally important populations within the Offshore Ornithology study area, based on baseline aerial survey data.
Common gull	National	Scoped OUT. Regularly occurring Annex I or Birds Directive Migratory species which are not listed as qualifying interests of SPAs within mean maximum foraging range +1 S.D. of the Proposed Development array area. The species does not regularly occur in regionally or locally important populations within the Offshore Ornithology study area, based on baseline aerial survey data.
Lesser black-backed gull	International	Scoped IN. Internationally designated sites within mean maximum foraging range +1 S.D. of the Proposed Development array area.
Herring gull	International	Scoped IN. Internationally designated sites within mean maximum foraging range +1 S.D. of the Proposed Development array area.
Great black-backed gull	National	Scoped OUT. Regularly occurring Birds Directive Migratory species which is not listed as qualifying interests of SPAs within mean maximum foraging range +1 S.D. of the Proposed Development array area. The species does not regularly occur in regionally or locally important populations within the Offshore Ornithology study area, based on baseline aerial survey data.

11.7.4. FUTURE BASELINE SCENARIO

41. The EIA Regulations ((The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017, The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 and The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017)), require that "a description of the relevant aspects of the current state of the environment (baseline scenario) and an outline of the likely evolution thereof without development as far as natural changes from the baseline scenario can be assessed with reasonable effort ,on the basis of the availability of environmental information and scientific knowledge" is included within the Offshore EIA Report.

42. In the event that the Proposed Development does not come forward, an assessment of the future baseline conditions has been carried out and is described within this section.

43. The baseline environment is not static and will exhibit some degree of natural change over time, even if the Proposed Development does not come forward, due to naturally occurring cycles and processes. In this context, the future baseline scenario at this particular location would involve environmental changes such as climate change and established activities such as commercial fishing activity in the area, as well as the construction and operation of up to three other offshore wind farms to the north and west.

44. Scottish and UK waters are facing an increase in sea surface temperature. The rate of increases is varied geographically, but between 1985 and 2009, the average rate of increase in Scottish waters has been greater than 0.2 °C per decade, with the south-east of Scotland having a higher rate of 0.5°C per decade (Marine Scotland, 2011). A study completed over a longer period of time showed Scottish waters (coastal and oceanic) have warmed by between 0.05 and 0.07 °C per decade, calculated across the period 1870 – 2016 (Hughes *et al*., 2018). As highlighted in volume 2, chapter 9 and volume 3, appendix 20, changes in

sea temperature will have an effect on fish at all biological levels (cellular, individual, population, species, community and ecosystem) both directly and indirectly. As sea temperatures rise, species adapted to cold water (e.g. cod and herring) will begin to disappear while warm water adapted species will become more established. These changes will lead to changes in prey distribution and availability, which in turn will affect the seabird species that prey on these fish species, ultimately resulting in ecosystem and population level effects.

45. Any changes that may occur during the design life span of the Proposed Development should be considered in the context of both greater variability and sustained trends occurring on national and international scales in the marine environment.

11.7.5. DATA LIMITATIONS AND ASSUMPTIONS

46. The data sources used in this chapter are detailed in Table 11.4 and Table 11.5, with additional relevant information from volume 3, appendix 11.1. The desktop data used are the most up to date publicly available information which can be obtained from the applicable data sources as cited.

47. There is a high degree of variability in the marine environment, both spatially and temporally. However, as the baseline site characterisation for this Offshore EIA Report has been based on two years of digital aerial survey data, it is considered to be representative of the Proposed Development array area and surrounding buffer area for the purpose of impact assessment.

48. It was not always possible to complete digital aerial surveys every month, due to poor weather conditions in April 2019 and January 2020, and due to Covid-19 restrictions in April 2020. To make up for the missed January 2020 survey, two surveys were undertaken in February 2020, with results from the first of these (5/2/20) being used as a proxy for the January 2020 survey. As a result of Covid-19 disruption in April 2020, an additional survey was flown on 5th May 2020. In addition, two surveys were flown in April 2021, with the first of these being used as a proxy for the missed March 2021 survey, and the second April 2021 survey being used as a proxy for the missed survey in April 2019. Further details of survey coverage are presented in volume 3, appendix 11.1.

49. Surveys of the intertidal and near-shore area in the vicinity of the export cable landfall options were carried out to provide data in relation to potential impacts on estuarine birds in the vicinity. A programme of 'through the tide' surveys was designed to capture the numbers and distribution of birds in the intertidal and near-shore area throughout the year and over the full tidal cycle. Surveys were carried out in suitable weather conditions (avoiding times of low visibility and heavy precipitation) and there were no data gaps due to prolonged adverse weather. The intertidal surveys are considered to fulfil the industry standard requirements with no limitations or data gaps in this respect.

50. Given the limited scale of works required for the export cable corridor (i.e. a relatively small number of vessel movements over a relatively small area for a short period of time), no specific surveys were commissioned for the area between the Offshore Ornithology study area and the Intertidal Ornithology study area (i.e. within 1.5 km from MHWS, covered by shore-based surveys). Instead, the assessment for this section of the export cable corridor makes use of published data on the presence of birds from the desk study (volume 2, appendix 11.2). This approach was agreed at Road Map Meeting 6 on 10 May 2022, (see volume 3, appendix 11.8).

51. As there is a potential lack of data pertaining to pulses of passage movements by migratory waterbirds over or through the Proposed Development, Scoping Opinion advice was to assess these species with reference to site-specific survey results and the Marine Scotland commissioned update to the 2014 report on 'strategic assessment of collision risk of Scottish offshore wind farms to migrating birds' (WWT, 2014).

52. As of August 2022, this updated report was not publicly available therefore this assessment relies upon the Scoping Opinion advice which was to assess any SPA migratory waterbird species relevant to the Proposed Development which are not considered in the 2014 Report on a qualitative basis. Therefore, the collision assessment for migratory species was conducted based on the WWT (2014) report, with any SPA migratory waterbird species relevant to the Proposed Development which are not considered in the 2014 Report being assessed on a qualitative basis.

11.8. KEY PARAMETERS FOR ASSESSMENT

11.8.1. MAXIMUM DESIGN SCENARIO

53. The maximum design scenarios identified in Table 11.13 have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. These scenarios have been selected from the details provided in volume 1, chapter 3 of the Offshore EIA Report. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the Project Design Envelope (PDE) (e.g. different infrastructure layout), to that assessed here, be taken forward in the final design scheme.

Table 11.13: Maximum Design Scenario Considered for the Assessment of Potential Impacts on Offshore and Intertidal Ornithology

<table>
<tr><th rowspan="2">Potential Impact</th><th colspan="3">Phase[1]</th><th rowspan="2">Maximum Design Scenario</th><th rowspan="2">Justification</th></tr>
<tr><th>C</th><th>O</th><th>D</th></tr>
<tr><td>Disturbance and displacement from increased vessel activity (including helicopters) and other construction activity within the Proposed Development array area</td><td>✓</td><td>✓</td><td>✓</td><td>Construction Phase

Vessels associated with site preparation, foundation installation, OSPs/ Offshore convertor station platforms installation, inter-array cables, offshore export cables, and landfall works, with up to 11,484 vessel round trips over the construction phase; maximum vessels on site at any one time including:
• up to 9 main installation vessels making up to 297 return trips;
• up to 14 cargo barges making up to 194 return trips;
• up to 9 support vessels making up to 714 return trips;
• up to 22 tug/anchor handlers making up to 794 return trips;
• up to 6 cable installation vessels making up to 36 return trips;
• up to 22 guard vessels making up to 1,488 return trips;
• up to 8 survey vessels making up to 464 return trips;
• up to 14 crew transfer vessels (CTVs) making up to 3,342 return trips;
• up to 10 scour/cable protection installation vessels making up to 3,390 return trips; and
• up to 20 resupply vessels making up to 245 return trips.

Other activities:
• up to 10% of piles are anticipated to require drilling at wind turbine foundations (144 piles) with a maximum drilling duration of 96 days;
• up to 32 piles will require drilling at OSPs/ Offshore convertor station platforms foundations with a maximum drilling duration of up to 39 days; and
• burial of 1,225 km of inter-array cables and 828 km of offshore export cable via jet trenching; along with cable laying and jack up rigs

Operation and Maintenance Phase

Vessels used during routine inspections, repairs and replacement of equipment, major component replacement, painting or other coatings, removal of marine growth, replacement of access ladders, and geophysical surveys; maximum vessels on site at any one time including:
• up to 4 CTVs making up to 832 return trips per year;
• up to 1 jack up vessel making up to 2 return trips per year;
• up to 2 support vessels making up to 26 return trips per year;
• up to 1 cable repair vessel making up to 5 return trips per operational lifetime;
• up to 2 service operations vessels (SOV, daughter craft) making up to 4 movements within Proposed Development array area per day;
• up to 1 cable survey vessel making one return trip per year; and
• up to 1 excavator/backhoe dredger making up to 5 return trips over operational lifetime.

Decommissioning Phase

Vessels used for a range of decommissioning activities such as removal of foundations, cables and cable protection. Vessels assumed to be similar to vessel activity described for construction phase above</td><td>Maximum numbers of vessels on site at any one and largest numbers of round trips during each phase of the Proposed Development and broad range of vessel types representative of vessels to be used during construction, operation and maintenance and decommissioning will result in the greatest potential impact.

Range of other activities including maximum timescales (where available) during which activities are conducted</td></tr>
</table>

[1] C = Construction, O = Operation and maintenance, D = Decommissioning

Potential Impact	Phase[1] C	O	D	Maximum Design Scenario	Justification
Disturbance from aviation and navigation lighting		✓		**Operation and Maintenance Phase** Red, medium intensity aviation warning lights (2000 candela (cd)), with the 2000 cd light conforming to ICAO specification. Aviation lighting will be subject to reduction in lighting intensity, to a minimum of 200 cd, when the visibility in all directions from every wind turbine is more than 5 km. Aviation lighting to be located on either side of the nacelle for 360 degree visibility on all peripheral wind turbines. Aviation warning lights would flash simultaneously synchronised morse 'W' and be able to be switched on and off by means of twilight switches. Search and rescue (SAR) lighting of each of the non-periphery wind turbines will be combi infra-red (IR)/200 cd steady red aviation hazard lights, individually switchable.	Refer to volume 4, appendix 27, Lighting and Marking Plan
Indirect effects as a result of habitat loss/displacement of prey species due to increased noise and disturbance to seabed	✓	✓	✓	**Construction Phase** Up to 113,974,700 m^2 of temporary subtidal habitat loss/disturbance due to: • use of jack-up vessels during foundation installation, with up to 4 jack-up events per wind turbine and 4 jack-up events per OSPs/ Offshore convertor station platforms; • installation of up to 1,225 km of inter-array cables, up to 94 km of interconnector cable, up to 872 km offshore export cables with seabed disturbance width of: up to 25 m for sandwave clearance, up to 25 m for boulder clearance and up to 15 m for cable burial; • sandwave clearance for up to 20% of the Proposed Development export cable corridor length, up to 30% of inter-array cables and OSPs/ Offshore convertor station platforms interconnector cables; • Boulder clearance for up to 20% of offshore export cable length, inter-array cables and OSPs/ Offshore convertor station platforms interconnector cables; • anchor placement; • offshore export cables installation at the landfall via trenchless burial techniques; • up to 8 exit punches out, each 20 m x 5 m, for removal of up to 8 cables from the landfall; and • clearance of up to 14 UXO. Other impacts on fish and shellfish communities include: • increased SSC and associated deposition from construction activities, such as drilling of 179 foundations, installation of up to 1,225 km of inter-array and up to 872 km of offshore export cables; • injury and/or disturbance to fish and shellfish from underwater noise and vibration as a result of the clearance of up to 14 UXOs and installation of 179 offshore wind turbines and up to 10 OSPs/ Offshore convertor station platforms; and • up to 7,798,856 m^2 of long term habitat loss due to presence of wind turbine and OSPs/ Offshore convertor station platforms foundations as well as cable protection for cable crossing. Maximum duration of the offshore construction phase includes up to 373 days piling activity. **Operation and Maintenance Phase** • up to 989,000 m^2 temporary subtidal habitat loss/disturbance due to: major component replacements for wind turbines and OSPs/ Offshore convertor station platforms; inter-array, interconnector and offshore export cable repair/reburial events; • increased SSCs and associated sediment deposition from cable repair/reburial events; • up to 7,798,856 m^2 of long term subtidal habitat loss due to presence of: wind turbines on suction caisson foundations and 10 OSPs/ Offshore convertor station platforms on jacket foundations with	See volume 2, chapter 7, chapter 8 and chapter 9

Potential Impact	Phase[1] C	O	D	Maximum Design Scenario	Justification
				associated scour protection; cable protection associated with inter-array, interconnector and offshore export cables; cable protection for cable crossings; • EMF from subsea electrical cabling due to presence of inter-array and offshore export cables; • colonisation of foundations, scour protection and cable protection leading to long term habitat creation of up to 10,198,971 m^2; and • EMF from presence of up to 1,225 km of 66 kV inter-array cables and up to 872 km of 275 kV High Voltage Alternating Current (HVAC) offshore export cables. **Decommissioning Phase** • up to 34,571,200 m^2 temporary subtidal habitat loss/disturbance due to: use of jack up vessels during decommissioning of wind turbine and OSPs/ Offshore convertor station platform foundations; complete removal of inter-array, interconnector and offshore export cables; anchor placement during cable decommissioning; • increased SSCs and associated sediment deposition from: cutting and removal of piled jacket foundations and decommissioning of inter-array, interconnector and offshore export cables; and • up to 7,562,609 m^2 permanent subtidal habitat loss due to complete removal of cable protection and scour protection for inter-array, OSPs/ Offshore convertor station platform interconnector and offshore export cables.	
Disturbance and loss of seabed habitat arising from cable installation/removal (including section within the Outer Firth of Forth and St Andrews Bay Complex SPA)	✓	✓	✓	**Construction Phase** Temporary subtidal habitat loss/disturbance due to: • up to 872 km offshore export cables with seabed disturbance width of: up to 25 m for sandwave clearance, up to 25 m for boulder clearance and up to 15 m for cable burial; • sandwave clearance for up to 20% of the Proposed Development export cable corridor length; • Boulder clearance for up to 20% of offshore export cable length; • offshore export cables installation at the landfall via trenchless burial techniques; and • up to 8 exit punches out, each 20 m x 5 m, for removal of up to 8 cables from the landfall. Other impacts on fish and shellfish communities include: • increased SSC and associated deposition from construction activities, such as up to 872 km of offshore export cables; and • injury and/or disturbance to fish and shellfish from underwater noise and vibration as a result of the clearance of UXOs. **Operation and Maintenance Phase** • routine annual cable inspections; • predicted worst case is four export cable reburial events and four export cable repair events of up to 1,000m each over project lifetime; • temporary subtidal habitat loss/disturbance due to export cable repair/reburial events; • increased SSCs and associated sediment deposition from cable repair/reburial events; and • habitat loss due to cable protection for cable crossing. **Decommissioning Phase** As described for construction disturbance above.	

Potential Impact	Phase[1] C	O	D	Maximum Design Scenario	Justification
Displacement and barrier effects from offshore infrastructure		✓		**Operation and Maintenance Phase** Based on Proposed Development area of 1,010 km^2 and with displacement occurring out to 2 km a combined Proposed Development area plus 2 km buffer of 1,308 km^2.	Evidence from existing offshore wind farms indicates that if there is displacement that it will be limited to within 2 km of the wind farm boundary for all the species of concern for the development (see volume 3, appendix 11.4).
Collision		✓		**Operation and Maintenance Phase** • minimum wind turbine capacity of 14 MW; • between 179 and 307 wind turbines; and • minimum air gap of 37 m LAT. Worst-case scenario of 307 x 14 MW wind turbines.	CRM shows that 307 x 14 MW wind turbines have largest theoretical collision impact risk for all species considered (see volume 3, appendix 11.3).

11.8.2. IMPACTS SCOPED OUT OF THE ASSESSMENT

54. The offshore and intertidal ornithology Road Map process (volume 3, appendix 11.8) has been used to facilitate stakeholder engagement on topics to be scoped out of the assessment.

55. On the basis of the baseline environment and the project description outlined in volume 1, chapter 3 of the Offshore EIA Report, one impact is proposed to be scoped out of the assessment for offshore and intertidal ornithology. This was agreed with key stakeholders through consultation (Table 11.14).

Table 11.14: Impacts Scoped Out of the Assessment for Offshore and Intertidal Ornithology Chapter

Potential Impact	Phase[2]			Justification
	C	O	D	
Impacts arising from accidental pollution events	x	x	x	Embedded and applied mitigation implemented during construction, operation and decommissioning will avoid the risk of significant pollution incidence and as a result seabirds and shorebirds are extremely unlikely to be adversely affected by any such incident. Agreed in Scoping Opinion.

11.9. IMPACT ASSESSMENT METHODOLOGY

11.9.1. OVERVIEW

56. The offshore and intertidal ornithology impact assessment has followed the methodology set out in volume 1, chapter 6 of the Offshore EIA Report, with some adaptations to make it applicable to ornithology receptors. Specific to the offshore and intertidal ornithology chapter, the following guidance documents have also been considered:

- 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;
- Butler et al., 2020. Attributing seabirds at sea to appropriate breeding colonies and populations (CR/2015/18). Scottish Marine and Freshwater Science Vol 11 No 8, 140pp. DOI: 10.7489/2006-1;
- CIEEM, 2022. Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine version 1.2.
- King et al., 2009. Guidance on ornithological cumulative impact assessment for offshore wind developers;
- Maclean et al., 2009. Assessment methodologies for offshore wind farms;
- Natural England nepva tools (Searle et al., 2019, Mobbs et al., 2020)
- NatureScot. 2020. Seasonal Periods for Birds in the Scottish Marine Environment;
- NatureScot. 2018. Interim Guidance on Apportioning Impacts from Marine Renewable Developments to Breeding Seabird Populations in Special Protection Areas; and
- 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 developments.

[2] C = Construction, O = Operation and maintenance, D = Decommissioning

57. In addition, the offshore and intertidal ornithology impact assessment has considered the legislative framework as defined in Table 11.1.

11.9.2. IMPACT ASSESSMENT CRITERIA

58. The process for determining the significance of effects is a two-stage process that involves defining the magnitude of the potential impacts and the sensitivity of the receptors. This section describes the criteria applied in this chapter to assign values to the magnitude of potential impacts and the sensitivity of the receptors. The terms used to define magnitude and sensitivity are based on those which are described in further detail in volume 1, chapter 6 of the Offshore EIA Report.

59. The criteria for defining magnitude levels for ornithology receptors in this chapter are outlined in Table 11.15 below. This set of criteria has been determined on the basis of changes to bird populations. As a guide, it has been based on summing predicted adult mortality in the breeding season and mortality of all age classes in the non-breeding season and presenting this figure as an overall percentage increase in the baseline mortality in terms of the regional population. A guide percentage has been included for each of the categories of impact magnitude in Table 11.15. Where possible, the predicted magnitude has also been sense-checked against relevant PVA outputs for the species under consideration, which may revise the magnitude rating, depending on the PVA predictions.

Table 11.15: Definition of Terms Relating to the Magnitude of an Impact

Magnitude of Impact	Definition
High	A change in the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site that is predicted to irreversibly alter the population in the short-to-long term and to alter the long-term viability of the population and/or the integrity of the protected site. Recovery from that change predicted to be achieved in the long-term or irreversible following cessation of the project activity. Guide: Predicted increase to baseline mortality rate is above 10%.
Medium	A change in the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site that occurs in the short and long-term, but which is not predicted to alter the long-term viability of the population and/or the integrity of the protected site. Recovery from that change predicted to be achieved in the medium-term (i.e. no more than five years) following cessation of the project activity. Guide: Predicted increase to baseline mortality rate is above 5%.
Low	A change in the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site that is sufficiently small-scale or of short duration to cause no long-term harm to the feature/population. Recovery from that change predicted to be achieved in the short-term (i.e. no more than one year) following cessation of the project activity. Guide: Predicted increase to baseline mortality rate is between 1% and 5%.
Negligible	Very slight change from the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site. Recovery from that change predicted to be rapid (i.e. no more than circa six months) following cessation of the project related activity. Guide: Predicted increase to baseline mortality rate is less than 1%.

60. For ornithology, the sensitivity of a species is one of the core components of the assessment of potential impacts and their effects on birds. There is also a need to consider the conservation importance of each

species when making a decision on the definition of the overall sensitivity of any particular species to any potential impact or effect. As part of making that decision, account has to be taken on a species by species basis, bearing in mind that a species with a high conservation importance may not be sensitive to a specific effect, while a species with a low conservation importance might be very sensitive to the effect. For example, herring gull is a species listed as a qualifying feature for some SPAs and has a conservation concern listing of 'Red' because of recent population declines (Stanbury et al, 2021), but cannot be judged to be sensitive to disturbance as many individuals regularly exploit human sources of food and nest on buildings in busy cities. Red-throated diver however, is also a species listed as a qualifying feature for some SPAs, but is 'Green-listed' in the most recent Birds of Conservation Concern rankings (Stanbury et al, 2021), but is considerably more sensitive to human-related disturbance than herring gull.

61. Taking account of such differences between species is an important part of the overall process of determining the potential significance of an impact and this should be applied where needed as a method to modify the sensitivity of an effect assigned to a specific receptor.

62. Previous reviews have ranked individual seabird species for their sensitivity to potential impacts such as collision, disturbance and displacement (e.g. Furness and Wade, 2012, Furness *et al*., 2013, Bradbury *et al.,* 2014, Dierschke *et al*., 2016). Conclusions from these reviews have been used to inform definitions of sensitivity for bird species (Table 11.16).

Table 11.16: Definition of Terms Relating to the Sensitivity of the Receptor

Value (Sensitivity of the Receptor)	Description
Very High	Bird species has very limited tolerance of sources of disturbance such as noise, light, vessel movements, offshore structures and human activity or very high vulnerability to collision impacts.
High	Bird species has low tolerance of sources of disturbance such as noise, light, vessel movements, offshore structures and human activity or high vulnerability to collision impacts.
Medium	Bird species has moderate tolerance of sources of disturbance such as noise, light, vessel movements, offshore structures and human activity or moderate vulnerability to collision impacts.
Low	Bird species has high tolerance of sources of disturbance such as noise, light, vessel movements, offshore structures and human activity or low vulnerability to collision impacts.
Negligible	Bird species has very high tolerance of sources of disturbance such as noise, light, vessel movements, offshore structures and human activity or low vulnerability to collision impacts.

63. The conservation importance of receptor species is based on the status of the population from which individuals are predicted to originate from. For this assessment, conservation importance is primarily related to the degree of connectivity of receptor species to SPAs in the region. Example criteria for defining conservation importance in this chapter are outlined in Table 11.11. Additional consideration has also been given to the current BoCC5 national conservation status for particular species, where appropriate (Stanbury *et al,* 2021).

64. The significance of the effect upon offshore and intertidal ornithology is determined by correlating the magnitude of the impact and the sensitivity of the receptor (Table 11.17). In addition, the conservation importance of the receptor is also considered using expert judgement to sense-check the matrix outcome.

[3] Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora) and Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds.

65. In cases where a range is suggested for the significance of effect, there remains the possibility that this may span the significance threshold (i.e. the range is given as minor to moderate). In such cases the final significance is based upon the expert's professional judgement as to which outcome delineates the most likely effect, with an explanation as to why this is the case.

66. For the purposes of this assessment:

- a level of effect of moderate or more will be considered a 'significant' effect in terms of the EIA Regulations; and
- a level of effect of minor or less will be considered 'not significant' in terms of the EIA Regulations.

67. Effects of moderate significance or above are therefore considered important in the decision-making process, whilst effects of minor significance or less warrant little, if any, weight in the decision-making process. However, it should be noted that while minor impacts are not significant in their own right, it is important to distinguish these from other non-significant impacts as they may contribute to significant impacts cumulatively or through interactions.

Table 11.17: Matrix Used for the Assessment of the Significance of the Effect

Sensitivity of Receptor	Magnitude of Impact: Negligible	Low	Medium	High
Negligible	Negligible	Negligible to Minor	Negligible to Minor	Minor
Low	Negligible to Minor	Negligible to Minor	Minor	Minor to Moderate
Medium	Negligible to Minor	Minor	Moderate	Moderate to Major
High	Minor	Minor to Moderate	Moderate to Major	Major
Very High	Minor	Moderate to Major	Major	Major

11.9.3. DESIGNATED SITES

68. Where Natura 2000 sites (i.e., nature conservation sites in Europe designated under the Habitats or Birds Directives[3]) or sites in the UK that comprise the National Site Network (collectively termed 'European sites') are considered, this chapter makes an assessment of the likely significant effects in EIA terms on the qualifying interest feature(s) of the key sites as described within section 11.7.2 of this chapter, and more distant conservation sites detailed in volume 3, appendix 11.5.The assessment of the potential impacts on the site itself are deferred to the RIAA for the Proposed Development. A summary of the outcomes reported in the RIAA is provided in section 11.15 of this chapter.

69. With respect to locally designated sites and national designations (other than European sites), where these sites fall within the boundaries of a European site and where qualifying interest features are the same, only the European site has been taken forward for assessment. This is because potential impacts on the integrity and conservation status of the locally or nationally designated site are assumed to be inherent within the assessment of the European site (i.e., a separate assessment for the local or national site is not undertaken). However, where a local or nationally designated site falls outside the boundaries of a

European site, but within the Offshore Ornithology regional study area, an assessment of the LSEs on the overall site is made in this chapter using the EIA methodology.

11.10. MEASURES ADOPTED AS PART OF THE PROPOSED DEVELOPMENT

70. As part of the project design process, a number of measures have been proposed to reduce the potential for impacts on offshore and intertidal ornithology (see Table 11.18). As there is a commitment to implementing these measures, they are considered inherently part of the design of the Proposed Development and have therefore been considered in the assessment presented in section 11.11 below (i.e. the determination of magnitude and therefore significance assumes implementation of these measures). These measures are considered standard industry practice for this type of development.

Table 11.18: Designed In Measures Adopted as Part of the Proposed Development

Designed In Measures Adopted as Part of the Proposed Development	Justification
Increased air gap between the lower tip height and sea surface	By raising the air gap to a minimum of 37 m above Lowest Astronomical Tide (LAT) as a designed in measure the risk of collision impacts is significantly reduced as an increasing proportion of birds fly below the rotor height.
Avoidance of relatively high densities of seabirds	Based on existing baseline data the Project selected a site boundary that avoided areas recognised to have relatively high densities of seabirds. Subsequently, the boundary has been further refined to reduce the potential impacts on birds.
Site boundary moved 2 km away from boundary of Outer Firth of Forth and St Andrews Bay Complex SPA	During the refinement of the site boundary in June 2022, a decision was made to move it 2 km from the boundary of this SPA in order to reduce the possibility of any displacement effects on birds within the SPA.

11.11. ASSESSMENT OF SIGNIFICANCE

71. The potential impacts arising from the construction, operation and maintenance and decommissioning phases of the Proposed Development are listed in Table 11.13, along with the maximum design scenario against which each impact has been assessed.

72. An assessment of the likely significance of the effects of the Proposed Development on offshore and intertidal ornithology receptors caused by each identified impact is given below.

DISTURBANCE AND DISPLACEMENT FROM INCREASED VESSEL ACTIVITY AND OTHER CONSTRUCTION ACTIVITY WITHIN PROPOSED DEVELOPMENT ARRAY AREA

73. Direct temporary disturbance or displacement of birds within the Proposed Development array area during the construction, operation and maintenance, and decommissioning phases will occur as a result of a range of activities including use of jack-up vessels during foundation installation/maintenance, installation and maintenance of inter-array and offshore export cables (including seabed clearance operations prior to cable installation) and anchor placements associated with these activities. Disturbance arising from these operations has the potential to affect identified key species directly (e.g. disturbance of individuals) and indirectly (e.g. disturbance to prey distribution or availability). The maximum design scenario, outlined in Table 11.13, describes the elements of the Proposed Development considered within this assessment.

Construction Phase

Magnitude of Impact

74. Activities resulting in the disturbance or displacement of birds from increased vessel activity and construction activity will occur intermittently throughout the construction period. The offshore construction works which includes activities resulting in temporary disturbance or displacement of birds from increased vessel activity are assumed to be undertaken over a period of 4 years and 8 months between 2026 and 2032, which represents a reasonable worst case for the purposes of assessment.

75. The impact is predicted to be of local spatial extent, intermittent, medium-term duration (although only a small proportion of the total area will be affected at any one time, with individual elements of construction having much shorter durations) and will affect any birds in the vicinity of these activities directly. The magnitude is considered to be negligible.

Sensitivity of the Receptor

76. Some species are more susceptible to disturbance than others. There is evidence from studies that demonstrate that species such as divers and scoters may avoid shipping by several kilometres (e.g. Garthe and Hüppop, 2004; Schwemmer *et al.* 2011), while gulls are not considered susceptible to disturbance, as they are often associated with fishing boats (e.g. Camphuysen, 1995; Hüppop and Wurm, 2000).

77. In order to focus the assessment, a screening exercise was undertaken to identify those species likely to be susceptible to disturbance and displacement as a result of increased vessel activity associated with construction (Table 11.19). This was based on previous sensitivity reviews such as Garthe and Hüppop (2004), who developed a scoring system for such disturbance factors, which is used widely in offshore wind farm EIAs. Similarly, Furness and Wade (2012) developed disturbance ratings for particular species based on Garthe and Hüppop (2004), alongside scores for habitat flexibility and conservation importance in a Scottish context. These factors were used to define an index value that highlights the sensitivity of a species to disturbance and displacement. Any species with a low sensitivity to disturbance or displacement or that was recorded only in very small numbers within the Offshore Ornithology study area was screened out of further assessment.

Table 11.19: Sensitivity of Species to disturbance and displacement from increased vessel activity in Proposed Development Array Area during Construction Phase

Species	Sensitivity to Disturbance and Displacement	Screening Result (IN/OUT)
Common scoter	High	Screened OUT for Proposed Development as the species was recorded in very low numbers on baseline surveys and therefore additional disturbance/displacement would be negligible.
Red-throated diver	High	Screened OUT for Proposed Development as the species was recorded in low numbers on baseline surveys and therefore additional disturbance/displacement would be negligible.
Great northern diver	High	Screened OUT for Proposed Development as the species was recorded in very low numbers on baseline surveys and therefore additional disturbance/displacement would be negligible.
Fulmar	Very low	Screened OUT for Proposed Development as the species has a very low sensitivity to disturbance and is not known to avoid vessels.

Species	Sensitivity to Disturbance and Displacement	Screening Result (IN/OUT)
Storm petrel	Very low	Screened OUT for Proposed Development as the species was recorded in very low numbers on baseline surveys and therefore additional disturbance/displacement would be negligible. The species also has a very low sensitivity to disturbance and is not known to avoid vessels.
Manx shearwater	Very Low	Screened OUT for Proposed Development as the species has a very low sensitivity to disturbance and is not known to avoid vessels.
Sooty shearwater	Very Low	Screened OUT for Proposed Development as the species has a very low sensitivity to disturbance and is not known to avoid vessels.
Gannet	Low	Screened OUT for Proposed Development as the species has a low sensitivity to disturbance and displacement.
Shag	Medium	Screened OUT for Proposed Development as the species was recorded in very low numbers on baseline surveys and therefore additional disturbance/displacement would be negligible.
Arctic skua	Very Low	Screened OUT for Proposed Development as the species was recorded in very low numbers on baseline surveys and therefore additional disturbance/displacement would be negligible. The species also has a very low sensitivity to disturbance and is not known to avoid vessels.
Pomarine skua	Very Low[4]	Screened OUT for Proposed Development as the species was recorded in very low numbers on baseline surveys and therefore additional disturbance/displacement would be negligible.
Great Skua	Very Low	Screened OUT for Proposed Development as the species has a very low sensitivity to disturbance and is not known to avoid vessels.
Little auk	Low	Screened OUT for Proposed Development as the species has a low sensitivity to disturbance and displacement.
Puffin	Low	Screened OUT for Proposed Development as the species has a low sensitivity to disturbance and displacement.
Razorbill	Medium	Screened IN for Proposed Development due to numbers recorded and classified as medium sensitivity to disturbance and displacement.
Guillemot	Medium	Screened IN for Proposed Development due to numbers recorded and classified as medium sensitivity to disturbance and displacement.
Sandwich tern	Low	Screened OUT for Proposed Development as the species was recorded in very low numbers on baseline surveys and therefore additional disturbance/displacement would be negligible.
Little tern	Low	Screened OUT for Proposed Development as the species was recorded in very low numbers on baseline surveys and therefore additional disturbance/displacement would be negligible.
Common tern	Low	Screened OUT as the species has a low sensitivity to disturbance and displacement.
Arctic tern	Low	Screened OUT as the species has a low sensitivity to disturbance and displacement.
Kittiwake	Low	Screened OUT as the species has a low sensitivity to disturbance and displacement.
Little gull	Low	Screened OUT as the species has a low sensitivity to disturbance and displacement.
Black-headed gull	Low	Screened OUT as the species has a low sensitivity to disturbance and displacement.
Common gull	Low	Screened OUT as the species has a low sensitivity to disturbance and displacement.
Lesser black-backed gull	Low	Screened OUT as the species has a low sensitivity to disturbance and displacement.
Herring gull	Low	Screened OUT as the species has a low sensitivity to disturbance and displacement.
Great black-backed gull	Low	Screened OUT as the species has a low sensitivity to disturbance and displacement.

[4] Pomarine skua was not ranked in Furness and Wade (2012) but sensitivity to disturbance assumed to be similar to Arctic skua and great skua.

78. Two species (guillemot and razorbill) were identified as being potentially sensitive to disturbance and displacement from increased vessel activity within the Proposed Development array area during the construction phase.

79. Previous reviews concluded that guillemots and razorbills have a medium sensitivity to disturbance and displacement, based on their sensitivity to ship and helicopter traffic in Garthe and Hüppop (2004), Furness and Wade (2012), Furness et al. (2013) and Bradbury et al. (2014). Therefore, there is potential for disturbance and displacement of guillemots and razorbills due to construction activity, including wind turbine construction and associated vessel traffic. On this basis, guillemot and razorbill have been screened in for further assessment (Table 11.19). All other species have been screened out.

80. Construction will not occur across the whole of the Proposed Development array area at the same time, but will be completed via a series of construction campaigns,

81. Any impacts resulting from disturbance and displacement from construction activities are considered likely to be short-term, temporary and reversible in nature, lasting only for the duration of construction activity, with birds expected to return to the area once construction activities have ceased. Consequently, any disturbance effects will occur only in the areas where vessels are operating at any given point and not over the entire site. The magnitude of the impact is therefore deemed to be negligible.

Sensitivity of the Receptor

82. Based on previous reviews as detailed above, guillemot and razorbill sensitivity to displacement associated with vessel movements vessels during the construction phase is considered to be medium.

Significance of the Effect

83. For guillemot and razorbill, the magnitude of the impact is deemed to be negligible and the sensitivity of these two species is considered to be medium. The effect on these two species will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

84. No offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **negligible to minor** adverse significance, which is not significant in EIA terms.

Operation and Maintenance Phase

Magnitude of Impact

85. During the operation and maintenance phase, disturbance or displacement of birds from increased vessel activity will be at a lower, more localised scale, restricted to around individual wind turbines where maintenance is being conducted.

86. The impact is predicted to be of local spatial extent, intermittent, short-term duration (individual maintenance operations will occur over a period of days to weeks) and will affect any birds in the vicinity of these activities directly. The magnitude is considered to be negligible.

Sensitivity of the Receptor

87. The sensitivity of offshore and intertidal birds to disturbance and displacement arising from increased vessel activity during the operation and maintenance phase can be found in the construction phase assessment above (paragraph 82 *et seq*.).

Significance of the Effect

88. Overall, the magnitude of the impact is deemed to be negligible and the sensitivity of the majority of species is considered to be low (Table 11.20). The effect on these species will, therefore, be of negligible to minor significance, which is not significant in EIA terms.

89. For guillemot and razorbill, the magnitude of the impact is deemed to be negligible and the sensitivity of these two species is considered to be medium. The effect on these two species will, therefore, be of **negligible to minor** significance, which is not significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

90. No offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **negligible to minor** adverse significance, which is not significant in EIA terms.

Decommissioning Phase

Magnitude of Impact

91. Activities resulting in the disturbance or displacement of offshore and intertidal birds from increased vessel activity will occur intermittently throughout the decommissioning period. The offshore decommissioning phase which includes activities resulting in temporary disturbance or displacement of birds from increased vessel activity is predicted to not exceed the construction period. Overall, the magnitude of impacts arising during the decommissioning phase are predicted to be the same as for the construction period.

92. The impact is predicted to be of local spatial extent, intermittent, medium-term duration (although only a small proportion of the total area will be affected at any one time, with individual elements of decommissioning having much shorter durations) and will affect any birds in the vicinity of these activities directly. The magnitude is considered to be negligible.

Sensitivity of the Receptor

93. The sensitivity of offshore and intertidal birds to disturbance and displacement arising from increased vessel activity and other construction activity during the decommissioning phase can be found in the construction phase assessment above (paragraph 82 *et seq*.).

Significance of the Effect

94. Overall, the magnitude of the impact is deemed to be negligible and the sensitivity of the majority of species is considered to be low (Table 11.19). The effect on these species will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms.

95. For guillemot and razorbill, the magnitude of the impact is deemed to be negligible and the sensitivity of these two species is considered to be medium. The effect on these two species will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

96. No offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **negligible to minor** adverse significance, which is not significant in EIA terms.

DISTURBANCE FROM AVIATION AND NAVIGATION LIGHTING

97. There is the potential that aviation and navigation lighting on wind turbines could attract or repel birds moving through the Proposed Development at night. There is some evidence that nocturnal lighting may cause changes in bird behaviour and habitat selection (Drewitt and Langston, 2008). However much of this evidence is based on oil and gas platforms, and as offshore wind farms are typically less intensively lit than these installations, any impacts are likely to be less extreme. It is currently planned that only the peripheral wind turbines will be illuminated (with red aviation and yellow navigation lighting). All other wind turbines will be unlit apart from small white lamps above wind turbine access doors. Based on available evidence, it is considered that red lighting (i.e., aviation warning lights) may have minimal effects on seabirds, with yellow lighting (i.e., navigational lighting) also having low impacts (Syposz et al, 2021).

98. Any impacts are considered to be restricted to the operation and maintenance phase.

Operation and Maintenance Phase

Magnitude of Impact

99. A significant impact could potentially occur if large numbers of migrants fly through the Proposed Development in a single event, leading to mass disorientation or collisions. However, there is no evidence from any existing UK offshore wind farm to suggest mass collision events occur as a result of aviation and navigation lighting that is typically used for UK offshore wind farms. Evidence from Kerlinger et al., (2010) and Welcker et al., (2017) found that nocturnal migrants do not have a higher risk of collision with wind farms than species that migrate during daylight, while mortality rates are not higher at offshore wind farms with lighting compared to those without. Furthermore, studies have shown that nocturnal flight is altered to counteract the risk of collision at offshore wind farms (Dirksen et al., 1998 and Desholm and Kahlert, 2005). Based on these studies, it is considered that the potential magnitude of impacts would be no greater than negligible to birds with respect to lighting.

Sensitivity of the Receptor

100. The seabird species that are considered most at risk of collisions with wind turbines (gannet and kittiwake), are unlikely to be active at night, as they either return to their colonies or roost on the sea surface during darkness (Wade et al., 2016). A tracking study by Furness et al., (2018) reported that gannet flight and diving activity was minimal during the night. Kotzerka et al., (2010) reported that kittiwake foraging trips mainly occurred during daylight hours and that birds were largely inactive at night and therefore at lower risk of interactions with wind turbines.

101. Gulls are known to have low to moderate levels of nocturnal activity but are sometimes attracted to lit fishing vessels and well-lit oil and gas platforms that attract fish to the surface waters (Burke et al., 2012). However, it is considered that as offshore wind farms are typically considerably less intensively lit than these installations, the degree of nocturnal attraction for large gull species is likely to be lower.

102. Overall, it is considered likely that seabird species in the marine environment would exhibit no more than a medium sensitivity to lighting associated with the Proposed Development.

Significance of the Effect

103. Overall, the magnitude of the impact is deemed to be negligible, and the sensitivity of species is considered to be no more than medium (Table 11.20). The effect will therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

104. No offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **negligible to minor** adverse significance, which is not significant in EIA terms.

INDIRECT EFFECTS AS A RESULT OF HABITAT LOSS/DISPLACEMENT OF PREY SPECIES DUE TO INCREASED NOISE AND DISTURBANCE TO SEABED

105. Indirect disturbance and displacement of birds may occur during the construction phase if there are impacts on prey species and/or the habitats of prey species. These indirect effects include those resulting from the production of underwater noise (e.g. during piling) and the generation of suspended sediments (e.g. during preparation of the seabed for wind turbine foundations). Such activities may change the behaviour or availability of prey species for seabirds. Underwater noise may cause fish and mobile invertebrates to avoid the area of construction and may also affect their physiology and behaviour. Suspended sediments may cause fish and mobile invertebrates to avoid the construction area and may smother and hide immobile benthic prey. These outcomes may lead to a reduction in prey being available within the construction area for foraging seabirds. Such potential effects on benthic invertebrates and fish have been assessed in volume 2, chapter 7, chapter 8 and chapter 9. The conclusions of those assessments inform this assessment of indirect effects on ornithological receptors.

Construction Phase

Magnitude of Impact

106. For seabirds, the key prey species are likely to be herring, sprat and sandeel. Based on information presented in volume 2, chapter 9, adult fish species are more mobile than juveniles, and may show avoidance behaviour within areas affected by increased suspended sediments concentrations (SSC), making them less susceptible to physiological effects of this impact. Juvenile fish are therefore more likely to be affected by such habitat disturbances, as they are typically less mobile and so less able to avoid such impacts. However, natural temporary increases in SSC associated with winter storm events are also likely to occur in the area, therefore it is expected that most juvenile fish likely to occur in the vicinity of construction activities will be largely unaffected by the low level temporary increases in SSC, as the concentrations are likely to be within the range of natural variability for these species and will reduce to background concentrations within a very short period (approximately two tidal cycles).

107. Volume 2, chapter 7 outlines physical changes to the seabed and to suspended sediment levels, and discusses the nature of any change and impact. Such changes are considered to be temporary, small scale and highly localised, and therefore any associated effects are concluded to be of negligible to minor significance (see volume 2, chapter 7).

108. Temporary habitat loss/disturbance of benthic habitats within the Proposed Development will occur during the construction, operation and maintenance, and decommissioning phases. Temporary habitat loss/disturbance can result from activities including use of jack-up vessels during foundation installation, sandwave and boulder clearance, cable installation and repair as well as anchor placements associated with these activities. Installation of the Proposed Development infrastructure, resulting in the temporary subtidal habitat loss/disturbance will occur intermittently throughout the construction period.

109. For subtidal benthic habitats, the magnitude of the impact is deemed to be medium, and the sensitivity of the receptor is considered to be medium. Although this effect will, therefore, be of **moderate** adverse significance in the short term (i.e. within two years of completion of construction activities) (see volume 2, chapter 8), it is not predicted to have a significant impact on prey fish species in the vicinity (see volume 2, chapter 9), therefore there is not considered to be any corresponding indirect effect on seabirds foraging in the vicinity.

110. For most marine and diadromous fish species, the magnitude of the impact is low, and the sensitivity is considered to be low, therefore the effect will be of minor adverse significance, which is not significant in EIA terms. For sandeels, the magnitude of the impact is low and the sensitivity is considered to be medium. The effect will, therefore, be of **minor** significance which is not significant in EIA terms (see volume 2, chapter 9).

111. In addition to potential impacts on fish species distribution arising from increases in SSC affecting foraging seabirds, there is also the potential for increased SSC affecting the ability of foraging seabirds to detect prey. However, as for the fish species present in the area, natural temporary increases in SSC associated with winter storm events are also likely to occur, therefore it is expected that most foraging seabirds likely to occur in the vicinity of construction activities will be largely unaffected by the low level temporary increases in SSC, as the concentrations are likely to be within the range of natural variability for these species and will reduce to background concentrations within a very short period (approximately two tidal cycles). Known foraging ranges of seabirds are considerably larger than the temporary, localised effects from increases in SSC as a result of construction activities, therefore significant impacts on foraging seabirds in the vicinity of these construction activities are not considered likely to occur.

112. Overall, impacts from increased suspended sediments during the construction phase are considered to be of minor adverse significance for marine fish species and of **negligible to minor** adverse significance for diadromous fish species, which is not significant in EIA terms (see volume 2, chapter 7).

113. Noise impacts on marine and diadromous fish were predicted to arise from from activities such as pile driving for jacket foundations and UXO clearance. Underwater noise can potentially have an adverse impact on fish species ranging from physical injury/mortality to behavioural effects. Injury and/or mortality for all fish and shellfish species is to be expected for individuals within very close proximity to piling operations, however, "soft start" procedures will allow mobile individuals in close proximity to flee the area prior to maximum hammer energy levels. Overall, noise impacts were considered to be of **minor** adverse significance for marine and diadromous fish species, which is not significant in EIA terms (see volume 2, chapter 9).

114. Following a negligible or minor adverse impact on fish that are prey species for seabirds, the impact on seabirds is predicted to be of local spatial extent, medium term duration and intermittent, (although only a small proportion of the total area will be affected at any one time, with individual elements of construction having much shorter durations). It is predicted that the impact will affect seabirds indirectly. The magnitude is therefore considered to be negligible.

Sensitivity of the Receptor

115. As already outlined, construction activities may change the behaviour or availability of prey species for seabirds, resulting in the availability of such prey species being temporarily reduced. However, the majority of seabird species have a variety of target prey species and have large foraging ranges, meaning that they can forage for alternative prey species or move to other foraging areas if prey becomes temporarily unavailable due to construction activities.

116. The sensitivity of seabirds to indirect effects as a result of habitat loss or displacement of prey species due to increased noise and disturbance during construction is therefore considered to be low.

Significance of the Effect

117. Overall, the magnitude of the impact is deemed to be negligible and the sensitivity of seabirds to this impact is considered to be low. The effect on these species will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

118. No offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **negligible to minor** adverse significance, which is not significant in EIA terms.

Operation and Maintenance Phase

Magnitude of Impact

119. Long term subtidal habitat loss impacts will occur during the construction phase and will be continuous throughout the anticipated 35 year operation and maintenance phase. Long term habitat loss will occur directly under all wind turbine and OSP foundation structures (suction caisson and piled jacket foundations respectively), associated scour protection and cable protection (including at cable crossings) where this is required. The seabed habitats removed by the installation of infrastructure will reduce the amount of suitable habitat and available food resource for fish and shellfish species and communities associated with the baseline substrates/sediments, which could in turn, reduce the availability of these prey fish species for foraging seabirds in the vicinity.

120. However, the majority of fish species would be able to avoid habitat loss effects due to their greater mobility and would recover into the areas affected following cessation of construction. Sandeels (and other less mobile prey species) would be affected by long term subtidal habitat loss, although recovery of this species is expected to occur quickly as the sediments recover following installation of infrastructure and adults recolonise and also via larval recolonisation of the sandy sediments which dominate the Proposed Development fish and shellfish ecology study area.

121. Overall, the effect on fish species is considered to be of **minor** adverse significance, which is not significant in EIA terms (see volume 2, chapter 9).

122. Following a minor adverse impact on fish that are prey species for seabirds, the impact on seabirds is predicted to be of local spatial extent, indirect and of medium-term duration, as prey species distribution is considered likely to recover over time. The magnitude is therefore considered to be negligible.

Sensitivity of the Receptor

123. The sensitivity of the offshore and intertidal birds to indirect effects as a result of habitat loss or displacement of prey species due to increased noise and disturbance during construction during the decommissioning phase can be found in the construction phase assessment above (paragraph 115 *et seq*.).

Significance of the Effect

124. Overall, the magnitude of the impact is deemed to be negligible and the sensitivity of offshore and intertidal birds to this effect is considered to be low. The effect on these species will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

125. No offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **negligible to minor** adverse significance, which is not significant in EIA terms.

Decommissioning Phase

Magnitude of Impact

126. Activities resulting in indirect effects on offshore and intertidal birds as a result of habitat loss or displacement of prey species due to increased noise and disturbance during decommissioning will occur intermittently throughout the decommissioning period. The offshore decommissioning phase which includes activities resulting in temporary disturbance or displacement of birds from increased vessel activity is predicted to not exceed the construction period.

127. The impact is predicted to be of local spatial extent, intermittent, medium-term duration (although only a small proportion of the total area will be affected at any one time, with individual elements of decommissioning having much shorter durations) and will affect any birds in the vicinity of these activities directly. The magnitude is considered to be negligible.

Sensitivity of the Receptor

128. The sensitivity of the offshore and intertidal birds to indirect effects as a result of habitat loss or displacement of prey species due to increased noise and disturbance during construction during the decommissioning phase can be found in the construction phase assessment above (paragraph 115 *et seq*.).

<u>Significance of the effect</u>

129. Overall, the magnitude of the impact is deemed to be negligible and the sensitivity of offshore and intertidal birds to this effect is considered to be low. The effect on these species will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms.

<u>Secondary and Tertiary Mitigation and Residual Effect</u>

130. No offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **negligible to minor** adverse significance, which is not significant in EIA terms.

DISTURBANCE AND LOSS OF SEABED HABITAT ARISING FROM CABLE INSTALLATION/REMOVAL WITHIN THE OUTER FIRTH OF FORTH AND ST ANDREWS BAY COMPLEX SPA

131. Direct temporary disturbance or displacement of birds along the offshore export cable corridor within the Outer Firth of Forth and St Andrews Bay Complex SPA may occur during the construction, operation and decommissioning phases, as a result of installation, maintenance and removal of the offshore export cables (including seabed clearance operations prior to cable installation) and anchor placements associated with these activities. Disturbance arising from these activities has the potential to affect identified species directly (e.g. disturbance of individuals) and indirectly (e.g. disturbance to prey distribution or availability). The maximum design scenario, outlined in Table 11.13, describes the elements of the proposed project considered within this assessment.

Construction Phase

<u>Magnitude of Impact</u>

132. Activities resulting in the disturbance or displacement of birds within the Outer Firth of Forth and St Andrews Bay Complex SPA as a result of increased vessel activity along the Proposed Development export cable corridor may occur intermittently throughout the construction period. Installation and maintenance of offshore export cables (including seabed clearance operations prior to cable installation) will occur over a period of up to 24 months.

133. Up to eight export cables will be trenched and buried, each a maximum of 109 km long, however this includes lengths of export cable within the array area, outside of the SPA boundary. It is estimated that total impacts from trenching and burying the cable will impact a 15 m wide corridor of seabed and therefore a total of 12.43 km^2 of seabed could be disturbed during the trenching and burying of the export cables. It is estimated that approximately 15% of the cable route may need protection, which would be a permanent loss of seabed. If this is the case, then an estimated 2.616km^2 of seabed could be lost due to cable protection.

134. Cables will be trenched and buried using either mechanical ploughs or cutters or by high pressure jets depending on the ground conditions. If cable protection is not required, the trenches will backfill naturally over time. The length of time it takes for the trenches to backfill will be dependent on the local seabed conditions and currents.

135. In areas of soft mud or sand, natural infill is predicted to occur rapidly and studies have indicated that infill of trenches can occur at a rate of between 0.2 and 0.5 m every six months, with sediment communities returning to the area of disturbed sediment within 12 months of the cable laying having been undertaken (BERR, 2008). Consequently, the potential impacts from trenching cables within the SPA will be localised and temporary and will not have a long-term impact on the habitat.

136. It is concluded that the very small area of seabed habitat lost within the SPA as a result of cable protection will not cause a significant reduction in the extent, distribution or quality of habitats that support the qualifying species or their prey. The trenching of cables will cause a localised and temporary impact on the habitats within the SPA.

137. Direct disturbance impacts are predicted to be of local spatial extent, intermittent, medium-term duration (although only a small proportion of the total area will be affected at any one time, with individual elements of decommissioning having much shorter durations) and will only affect any birds in the vicinity of these activities directly. Overall, the magnitude of these impacts is considered to be negligible.

<u>Sensitivity of the Receptor</u>

138. Some seabird species are more susceptible to disturbance than others. There is evidence from studies that demonstrate that species such as divers and scoters may avoid shipping by several kilometres (e.g. Garthe and Hüppop, 2004; Schwemmer et al. 2011), while gulls are not considered susceptible to disturbance, as they are often associated with fishing boats (e.g. Camphuysen, 1995; Hüppop and Wurm, 2000).

139. In order to focus the assessment, a screening exercise was undertaken to identify those species of qualifying interest for the Outer Firth of Forth and St Andrews Bay Complex SPA that are likely to be susceptible to disturbance and displacement from installation of the offshore export cables (Table 11.20). This was based on previous sensitivity reviews such as Garthe and Hüppop (2004), who developed a scoring system for such disturbance factors, which is used widely in offshore wind farm EIAs. Similarly, Furness and Wade (2012) developed disturbance ratings for particular species based on Garthe and Hüppop (2004), alongside scores for habitat flexibility and conservation importance in a Scottish context. These factors were used to define an index value that highlights the sensitivity of a species to disturbance and displacement. In addition, rankings from two similar reviews (Furness et al., 2013 and Bradbury et al., 2014) were also compared and used to inform this screening exercise.

140. Any species with a moderate or high sensitivity to disturbance or displacement that is listed as a Qualifying Interest for the Outer Firth of Forth and St Andrews Bay Complex SPA was screened into the assessment.

Table 11.20: Sensitivity to Disturbance and Displacement from Increased Vessel Activity for Species Listed as Qualifying Interests for the Outer Firth of Forth and St Andrews Bay Complex SPA

Species	Sensitivity to Disturbance and Displacement	Qualifying Interest for the Outer Firth of Forth and St Andrews Bay Complex SPA	Screening Result (IN/OUT)
Eider	High	Breeding and non-breeding season	Screened IN
Common scoter	High	Non-breeding season	Screened IN
Velvet Scoter	Moderate	Non-breeding season	Screened IN as the species has a moderate sensitivity to disturbance and displacement
Red-breasted Merganser	Moderate	Non-breeding season	Screened IN as the species has a moderate sensitivity to disturbance and displacement
Goldeneye	High	Non-breeding season	Screened IN
Long-tailed Duck	Low	Non-breeding season	Screened OUT as the species has a low sensitivity to disturbance and displacement

Species	Sensitivity to Disturbance and Displacement	Qualifying Interest for the Outer Firth of Forth and St Andrews Bay Complex SPA	Screening Result (IN/OUT)
Red-throated diver	High	Non-breeding season	Screened IN
Slavonian Grebe	Moderate	Non-breeding season	Screened IN as the species has a moderate sensitivity to disturbance and displacement
Manx shearwater	Very Low	Breeding season	Screened OUT as the species has a very low sensitivity to disturbance and is not known to avoid vessels.
Gannet	Low	Breeding season	Screened OUT as the species has a low sensitivity to disturbance and displacement.
Shag	Moderate	Breeding and non-breeding season	Screened IN
Puffin	Low	Breeding season	Screened OUT as the species has a low sensitivity to disturbance and displacement.
Razorbill	Moderate	Non-breeding season	Screened IN due to numbers recorded and classified as medium sensitivity to disturbance and displacement.
Guillemot	Moderate	Breeding and non-breeding season	Screened IN due to numbers recorded and classified as medium sensitivity to disturbance and displacement.
Common tern	Low	Breeding season	Screened OUT as the species has a low sensitivity to disturbance and displacement.
Arctic tern	Low	Breeding season	Screened OUT as the species has a low sensitivity to disturbance and displacement.
Kittiwake	Low	Breeding and non-breeding season	Screened OUT as the species has a low sensitivity to disturbance and displacement.
Little gull	Low	Non-breeding season	Screened OUT as the species has a low sensitivity to disturbance and displacement.
Black-headed gull	Low	Non-breeding season	Screened OUT as the species has a low sensitivity to disturbance and displacement.
Common gull	Low	Non-breeding season	Screened OUT as the species has a low sensitivity to disturbance and displacement.
Herring gull	Low	Breeding and non-breeding season	Screened OUT as the species has a low sensitivity to disturbance and displacement.

141. A total of four species that are listed as Qualifying Interests for the Outer Firth of Forth and St Andrews Bay Complex SPA (eider, common scoter, goldeneye and red-throated diver), were screened in for further assessment, on the basis that they were of high sensitivity to disturbance and displacement from increased vessel activity associated with construction activities, based on sensitivity rankings in Garthe and Hüppop (2004), Furness and Wade (2012), Furness et al., (2013) and Bradbury et al., (2014) (Table 11.20).

142. In addition, six species (red-breasted merganser, shag, velvet scoter, Slavonian grebe, guillemot and razorbill) were screened in for further assessment on the basis that they were of moderate sensitivity to disturbance and displacement from increased vessel activity associated with construction activities, based on sensitivity rankings in Garthe and Hüppop (2004), Furness and Wade (2012), Furness et al., (2013) and Bradbury et al., (2014) (Table 11.20).

143. Of these six species, velvet scoter and Slavonian grebe were not recorded on digital aerial surveys within the Offshore Ornithology study area, or on surveys undertaken in the Intertidal Ornithology study area. The four remaining species (eider, common scoter, red-breasted merganser and goldeneye were recorded on nearshore surveys undertaken as part of baseline surveys for the intertidal export cable landfall sites. Eider was the most abundant and regularly present waterfowl species on these surveys, and birds were recorded on every month of the survey programme, with numbers typically ranging between one to 30 individuals. All birds were recorded within 1 km of the shore. Common scoters were recorded infrequently on nearshore surveys, with typically counts of fewer than 30 individuals recorded. All birds were recorded between 500 m and 1 km from shore. Red-breasted mergansers were recorded intermittently on nearshore surveys, predominantly during the winter and passage months in low numbers of no more than five birds. Almost all birds were recorded within 500 m of the shore. Goldeneye were recorded intermittently, predominantly during the winter and passage months in low numbers of no more than seven birds. Almost all birds were recorded within 500 m of the shore. All remaining wildfowl and wader species recorded during the inter-tidal surveys were not listed as qualifying species for the Outer Firth of Forth and St Andrews Bay Complex SPA, and numbers recorded on surveys did not exceed the 1% threshold of national importance (volume 3, appendix 11.2).

144. The Outer Firth of Forth and St Andrews Bay Complex SPA, supports the largest aggregations of eider in Scotland. Eider are resident throughout the year, with an inshore, coastal distribution. Common scoter occur in large numbers in the non-breeding season, with the majority of birds being found in inshore, coastal waters, particularly in St Andrews Bay and in the Firth of Forth. Goldeneye occur in peak numbers in the non-breeding season, primarily within the Firth of Forth, while peak numbers of red-breasted mergansers also occur in the non-breeding season, in the inshore, coastal waters of St Andrews Bay and the Firth of Forth (NatureScot, 2016).

145. Therefore, there is potential for disturbance and displacement of these ten species due to export cable construction activity within the Outer Firth of Forth and St Andrews Bay Complex SPA. However, construction will not occur within the whole of the Proposed Development export cable corridor at the same time, but will be carried out sequentially, as the cable-laying vessels move along the route. Consequently, any effects will only occur in the immediate vicinity where vessels are operating at any given point and not over the entire route. As a result, any effects will be very localised, temporary and short-term in duration, affecting only a very small extent of the areas used by these species. On this basis, any disturbance or displacement impact is considered to be negligible.

Significance of the Effect

146. Overall, for red-breasted merganser, shag, velvet scoter, Slavonian grebe, guillemot and razorbill, the magnitude of the impact is deemed to be negligible and the sensitivity is considered to be medium. The effect on these species will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms.

147. For eider, common scoter, goldeneye and red-throated diver, the magnitude of the impact is deemed to be negligible and the sensitivity of these species is considered to be high. The effect on these species will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

148. No offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **minor** adverse significance, which is not significant in EIA terms.

Operation and Maintenance Phase

Magnitude of Impact

149. Activities resulting in the disturbance or displacement of birds within the Outer Firth of Forth and St Andrews Bay Complex SPA as a result of increased vessel activity along the Proposed Development

export cable corridor may occur occasionally throughout the operation period. Maintenance and potentially replacement of offshore export cables may be required throughout the operation period.

150. Predicted worst case is four export cable reburial events and four export cable repair events of up to 1,000m each over project lifetime. Routine annual cable inspections will also be conducted.

151. It is concluded that the very small area of seabed habitat disturbance within the SPA as a result of cable reburial/replacement will not cause a significant reduction in the extent, distribution or quality of habitats that support the qualifying species or their prey. The re-burial of cables (if required) will cause a localised and temporary impact on the habitats within the SPA.

152. Direct disturbance impacts are predicted to be of local spatial extent, occasional, short-term duration (although only a small proportion of the total area will be affected at any one time), in the vicinity of the maintenance activities, which will only affect birds in the vicinity of these activities directly. Overall, the magnitude of these impacts is considered to be negligible.

Sensitivity of the Receptor

153. The sensitivity of the species that are listed as Qualifying Interests for the Outer Firth of Forth and St Andrews Bay Complex SPA to disturbance and displacement arising from increased vessel activity within the Proposed Development export cable corridor during the decommissioning phase can be found in the construction phase assessment above (paragraph 138 *et seq*.).

Significance of the Effect

154. Overall, for red-breasted merganser, shag, velvet scoter, Slavonian grebe, guillemot and razorbill, the magnitude of the impact is deemed to be negligible and the sensitivity is considered to be medium. The effect on these species will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms.

155. For eider, common scoter, goldeneye and red-throated diver, the magnitude of the impact is deemed to be negligible and the sensitivity of these species is considered to be high. The effect on these species will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

156. No offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **minor** adverse significance at worst, which is not significant in EIA terms.

Decommissioning Phase

Magnitude of Impact

157. Activities resulting in the disturbance or displacement of species that are listed as Qualifying Interests for the Outer Firth of Forth and St Andrews Bay Complex SPA from increased vessel activity within the Proposed Development export cable corridor will occur intermittently throughout the decommissioning period. The offshore decommissioning phase which includes activities resulting in temporary disturbance or displacement of birds from increased vessel activity is predicted to not exceed the construction period.

158. The impact is predicted to be of local spatial extent, intermittent, medium-term duration (although only a small proportion of the total area will be affected at any one time, with individual elements of decommissioning having much shorter durations) and will affect any birds in the vicinity of these activities directly. The magnitude is therefore considered to be negligible.

Sensitivity of the Receptor

159. The sensitivity of the species that are listed as Qualifying Interests for the Outer Firth of Forth and St Andrews Bay Complex SPA to disturbance and displacement arising from increased vessel activity within the Proposed Development export cable corridor during the decommissioning phase can be found in the construction phase assessment above (paragraph 138 *et seq*.).

Significance of the Effect

160. Overall, for red-breasted merganser, shag, guillemot and razorbill, the magnitude of the impact is deemed to be negligible and the sensitivity is considered to be medium. The effect on these species will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms.

161. For eider, common scoter, goldeneye and red-throated diver, the magnitude of the impact is deemed to be negligible and the sensitivity of these species is considered to be high. The effect on these species will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

162. No offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of no more than **minor** adverse significance, which is not significant in EIA terms.

DISPLACEMENT AND BARRIER EFFECTS FROM OFFSHORE INFRASTRUCTURE

163. Displacement and/or barrier effects on birds within the Proposed Development and immediate surrounding area during the operation phase may occur as a result of the presence of the operational wind turbines. Displacement and barrier effects have been considered together following the approach presented in SNCB guidance (2017).

164. Displacement and/or barrier effects resulting from the presence of offshore wind turbines has the potential to affect individuals of sensitive bird species directly. In effect, this represents indirect habitat loss, which would potentially reduce the area available to forage, rest and/or moult for sensitive seabirds that currently occur within and around the Proposed Development. Displacement may contribute to the overall fitness of individual birds, which could also affect individual breeding success or at an extreme level, could cause mortality of individuals.

165. The maximum design scenario, outlined in Table 11.13, describes the elements of the proposed project considered within this assessment.

Approach

166. SNCB guidance considers that displacement effects have to be assessed for the proposed development site as well as a surrounding 2 km buffer around the site (SCNBs, 2017). The method to calculate the mean seasonal peak (MSP) population estimates for relevant species for the Proposed Development array area and 2 km buffer was as follows:

- MSP population estimates were calculated for each species in each appropriate bio-season, taken as an average over the two years of surveying (March 2019 – March 2021). For example, the MSP population estimate for the breeding season was calculated as the average of the peak count in the breeding season in year one and the peak count in the breeding season in year two.

- For seasons starting or ending halfway through the month, the 15th/16th was used as a mid-month cut off. Surveys were assigned to a breeding season based on the date that the survey was flown, with some exceptions to ensure even coverage of months in both years.

167. Further details are presented in section 3.2 of volume 3, appendix 11.1. Seasonal mean peak abundances for the Proposed Development array area plus 2 km buffer are presented below for the relevant key species.

PVA Approach

168. Population Viability Analysis (PVA) of predicted displacement mortality was conducted for breeding colonies for the five key displacement species within multiple SPAs. The species/ SPA combinations modelled were chosen using a threshold approach advised in the Scoping Opinion (MS-LOT, 2022) and confirmed through the Ornithology Roadmap process (Meeting 6, 10th May 2022). Further details of the SPA combinations and impact scenarios used are presented in volume 3, appendix 11.6.

169. For each of these SPAs, the specific mortality scenarios used within each of the individual species PVAs were assumed. For this assessment, regional estimates are in essence a sum of projected population sizes, at each timepoint, for each of the constituent SPAs for the five key displacement species.

170. In detail 5,000 simulated population projections were run for each species, SPA and impact scenario. These were summed over SPAs for each projection year, within each species and impact scenario. This provided 5,000 regional population simulations for each species and impact scenario. The summary statistics and counterfactuals were calculated subsequently. Results for the 35-year period are presented and discussed for each of the key displacement species below. Results for the 50-year period are presented in volume3, appendix 11.6 for context.

171. It should be noted that for four of the key seabird species considered here, the regional populations as defined in the breeding and non-breeding seasons in this chapter are different (i.e., they derive from a very different composition of source populations/colonies). The PVAs are relevant to the regional population as defined for the breeding season but not to that defined for the non-breeding season (with the exception of guillemot). The PVAs also account for effects on this regional breeding population during both breeding and non-breeding periods. However, overall, the results of the regional PVAs are considered indicative for assessment purposes.

Reference Populations

172. For each of the five key species assessed for displacement impacts during the operation phase, reference populations were required for comparison with the number of birds considered likely to suffer mortality. For the breeding season assessment, the total number of breeding adults from all colonies within mean maximum foraging range + 1 S.D. were used, as estimated by Woodward et al., (2019), (Table 11.9) (volume 3, appendix 11.5).

173. Corresponding reference populations for the BDMPS bio-seasons that make up the non-breeding season were taken from Furness (2015) (Table 11.9).

174. The overall baseline mortality rates presented for each species were derived from the relevant annual mortality rate calculation for each age class (where available) from the PVA work, as presented in Table 11.21. Further details are provided in volume 3, appendix 11.6. The potential magnitude of impact was estimated by calculating the increase in either the adult baseline mortality (for the breeding season) or the average baseline mortality across all age classes for the other bio-seasons with respect to the regional populations.

Table 11.21: Average Mortality Rates Across All Age Classes of Key Species Considered for Displacement Assessment and Collision Assessment

Species	Parameter[1]	0-1	1-2	2-3	3-4	4-5	5-6	Adult	Productivity	Average mortality
Gannet	Demographic rate	0.542	0.779	0.859	0.863	0.954	-	0.954	0.698	0.151
	Population age ratio	0.184	0.096	0.074	0.061	0.049	-	0.536		
Herring Gull	Demographic rate	0.777	0.878	0.878	0.878	0.878	-	0.878	0.978	0.141
	Population age ratio	0.186	0.138	0.118	0.1	0.08	-	0.378		
Lesser black-backed Gull	Demographic rate	0.820	0.913	0.913	0.913	0.913	-	0.913	0.846	
	Population age ratio	0.199	0.1	0.089	0.079	0.067	-	0.466		
Kittiwake	Demographic rate	0.790	0.855	0.855	0.855	-	-	0.855	0.674	0.160
	Population age ratio	0.184	0.104	0.093	0.079	-	-	0.54		
Guillemot	Demographic rate	0.560	0.792	0.917	0.938	0.927	0.927	0.927	0.681	0.148
	Population age ratio	0.17	0.092	0.074	0.06	0.058	0.052	0.494	-	
Razorbill	Demographic rate	0.794	0.794	0.910	0.910	0.910	-	0.910	0.564	0.120
	Population age ratio	0.148	0.109	0.089	0.08	0.066	-	0.508	-	
Puffin	Demographic rate	0.892	0.892	0.892	0.760	0.805	-	0.901	0.648	0.122
	Population age ratio	0.145	0.128	0.115	0.099	0.072	-	0.442		

1 Demographic rate and population age ratio were based on data from Forth Islands SPA. See volume 3, appendix 11.6.

Operation and Maintenance Phase

175. Consultation representations and advice from MSS and NatureScot (4 February 2022) and discussions through the Ornithology Road Map process (volume 3, appendix 11.8), led to agreement that a displacement assessment was required for five species:

- gannet;
- kittiwake;
- guillemot;
- razorbill; and
- puffin.

176. These five species were selected based on their abundance in the Proposed Development, highlighted by the two years of baseline data (volume 3, appendix 11.1), and on evidence about their sensitivity to displacement and barrier effects (Furness et al., 2013; Bradbury et al., 2014; SNCBs, 2017).

177. For the displacement assessment for the operation phase, two approaches were undertaken – the Developer Approach and the Scoping Approach. While the Developer Approach is largely in accordance with the Scoping Opinion, there are differences between the two approaches, and justification for these differences are presented in volume 3, appendix 11.4.

178. The Scoping Opinion contained advice on the displacement and mortality rates to be used for the SNCB Matrix Approach. In addition, the Scoping Opinion (and subsequent advice received during the Ornithology Roadmap Process (volume 3, appendix 11.8) also recommended that estimates of displacement and barrier effects as generated by the publicly available individual-based modelling approach "SeabORD" (Searle et al. 2018), should be presented for kittiwake, guillemot, razorbill and puffin, if feasible.

179. In addition, since SeabORD does not include gannet, MSS, in their scoping representation of 16th December 2021, advised that an analysis of the extensive gannet GPS tracking data from the Bass Rock colony be undertaken to inform assessment of displacement and barrier effects for this species. Details of the analysis undertaken are given in volume 3, appendix 11.4, annex E, following the approach agreed through the Ornithology Roadmap Process (volume 3, appendix 11.8).

180. As part of the Developer Approach, a review of recent displacement rates applied by other assessments of displacement for offshore wind farms was undertaken for each of the five key species. A further review of the displacement values derived from multiple post-consent monitoring reports was undertaken to quantify a suitable evidence-led approach and to provide transparency on how the displacement rates used in the Developer Approach assessment were calculated (see volume 3, appendix 11.4).

181. The displacement assessments for the five key species are presented below. A summary of the displacement and mortality rates used in both the Scoping Approach and the Developer Approach is provided in Table 11.22.

Table 11.22: Displacement and Mortality Rates used for the Scoping Approach (Scoping Opinion 4 February 2022) and the Developer Approach

Species	Displacement Rate	Mortality Rate – Breeding Season	Mortality Rate – Non-breeding Seasons
Scoping Approach (February 2022)			
Guillemot, Razorbill & Puffin	60%	3% and 5%	1% and 3% (Puffin not assessed)
Gannet	70%	1% and 3%	1% and 3%
Kittiwake	30%	1% and 3%	1% and 3%
Developer Approach			
Guillemot and Razorbill	50% within WF area and 2km buffer [1]	1% [1]	1% [1]
Puffin	50% within WF area & 2km buffer [2]	1% [2]	Not assessed
Gannet	70%	1% [3]	1% [3]
Kittiwake	30% [4]	2% [4]	Not assessed

[1] Recommended maximum displacement rate from APEM (2022). Review of evidence to support auk displacement and mortality rates in relation to offshore wind farms. APEM Scientific Report P00007416. Ørsted, January 2022.

[2] Recommended displacement rates from MacArthur Green (2019a). Norfolk Vanguard Offshore Wind Farm. The Applicant Responses to First Written Questions. Appendix 3.3 – Operational Auk and Gannet Displacement: update and clarification.

[3] Natural England recommended displacement and mortality rates for Gannet for Norfolk Vanguard Offshore Wind Farm. MacArthur Green (2019b). Norfolk Vanguard Offshore Wind Farm Offshore Ornithology Assessment Update for Deadline 6.

[4] Based on MS Scoping Opinion for Forth & Tay projects (2017).

Gannet

182. For the Developer Approach displacement assessment, a displacement rate of 70% and a mortality rate of 1% was applied to each bio-season based on evaluation of the published literature and in line with values used by other offshore wind farm displacement assessments.

183. There were two parts to the Scoping Approach displacement assessment and these are outlined below. For Scoping Approach A, the parameters were the same as for the Developer Approach, (a displacement rate of 70% and a mortality rate of 1% were applied for the breeding and non-breeding seasons). For Scoping Approach B, a displacement rate of 70% and a mortality rate of 3% were applied for the breeding and non-breeding seasons. Scoping Approach A was therefore the same as the Developer Approach.

184. Further details of differences between the Developer Approach and the Scoping Approach for the displacement assessment are presented in volume 3, appendix 11.4.

Magnitude of Impact

185. During the baseline aerial survey programme, gannets were most abundant in the Proposed Development array area plus 2 km buffer in the breeding season. Estimated numbers peaked in August 2019 1 (5,020 birds) and July 2020 (4,449 birds), which gave a MSP of 4,735 birds. Estimated numbers were lower in the non-breeding season, with a peak of 1,081 gannets in October 2019 and 1,919 gannets in November 2020. These months correspond to the autumn migration period of the non-breeding season (Furness, 2015). The MSP for the autumn migration period was therefore 1,500 gannets. Estimated numbers in the spring migration period of the non-breeding season showed lower peaks of 321 gannets in March 2019 and 216 gannets in December 2020, which gave a MSP of 269 gannets for the spring migration period (see volume 3, appendix 11.4).

186. A complete range of displacement matrices for the Proposed Development, the Proposed Development array area and 2 km buffer as well as for the different bio-seasons for both the Developer Approach and the Scoping Approach are presented in volume 3, appendix 11.4.

187. For the Developer Approach and Scoping Approach A, annual estimated gannet mortality from displacement in the Proposed Development array area and 2 km buffer is presented in Table 11.23.

188. For Scoping Approach B, annual estimated gannet mortality from displacement in the Proposed Development array area and 2 km buffer is presented in Table 11.24. For both approaches, the impact of additional mortality due to wind farm effects has been assessed in terms of the change in the baseline mortality rate which could result. The overall baseline mortality rates were based on age-specific demographic rates and age class proportions from the PVA work as presented in Table 11.21. The potential magnitude of impact was estimated by calculating the increase in baseline mortality within each bio-season with respect to the regional populations.

189. For the breeding season assessments, the increase in baseline mortality was calculated based on the baseline adult survival rate presented in Table 11.21. For gannet, the adult baseline survival rate is estimated to be 0.954, therefore the corresponding rate for adult mortality is 0.046. For the non-breeding season assessments, it has been assumed that all age classes are equally at risk of effects, with each age class affected in proportion to its presence in the population. Therefore, a weighted average baseline mortality rate has been calculated which is appropriate for all age classes for use in assessments, calculated for those species screened in for assessment. These were calculated using the different survival rates for each age class and their relative proportions in the population (Table 11.21).

Table 11.23: Displacement Mortality Estimates for Gannet for the Proposed Development array area plus 2 km Buffer by Bio-season based on the Developer Approach (and Scoping Approach A)

Bio-season	Peak Mean Seasonal Abundance (Proposed Development Array Area and 2 km Buffer)	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population (Adults)	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Mid Mar-Sept)[1]	4,735	3,282	31	323,836	14,896	0.21
Autumn migration (Oct-Nov)	1,500	1,050	11	456,298	68,901	0.016
Spring migration (Dec-mid Mar)	269	188	2	248,385	37,506	0.005
Total	-	4,553	44	-	-	0.23

1 Breeding season assessment is for breeding adults only

2 Mortality is 1% in breeding and non-breeding seasons

Table 11.24: Displacement Mortality Estimates for Gannet for the Proposed Development array area plus 2 km buffer by bio-season based on Scoping Approach B

Bio-season	Peak Mean Seasonal Abundance (Proposed Development Array Area and 2 km Buffer)	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population (Adults)	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Mid Mar-Sept)[1]	4,735	3,282	89	323,836	14,896	0.60
Autumn migration (Oct-Nov)	1,500	1,050	32	456,298	68,901	0.046
Spring migration (Dec-mid Mar)	269	188	6	248,385	37,506	0.016
Total	-	4,553	127	-	-	0.66

1 Breeding season assessment is for breeding adults only

2 Mortality is 3% in breeding and non-breeding seasons

Breeding Season

190. During the breeding season, the mean peak abundance for gannet was 4,735 individuals within the Proposed Development array area and 2 km buffer. When considering the Developer Approach and Scoping Approach displacement rate of 70% in the Proposed Development array area and 2 km buffer,

this would affect an estimated 3,315 birds. However, this estimate includes non-breeding adults and immature birds, as well as breeding adults.

191. 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 proportions recorded on digital aerial baseline surveys in the Offshore Ornithology study area (Table 11.25) (volume 3, appendix 11.1).

Table 11.25: Proportions of Juvenile, Immature and Adult Gannets Recorded on Digital Aerial Surveys

Season	Juvenile	Immature	Adult
Breeding Season (mid Mar-Sep)	0	0.01	0.99
Autumn migration (Oct-Nov)	0.2	0.2	0.96
Spring migration (Dec-mid Mar)	0	0.2	0.98

192. Based on the proportion of immature gannets recorded on digital aerial baseline surveys in the breeding season, 1% of the population present are immature birds (Table 11.25), Although this is likely to be an underestimate, since it is not possible to age all birds recorded on surveys, this would mean that an estimated 33 gannets displaced from the Proposed Development array area and 2 km buffer during the breeding season would be immature, with 3,282 adult birds also displaced.

193. Applying the Developer Approach and Scoping Approach A mortality rate of 1%, it was calculated that the predicted theoretical additional mortality due to displacement effects was 34 gannets (all adults) in the breeding season. However, a proportion of adult birds present at colonies in the breeding season will opt not to breed in a particular breeding season. It has been estimated that 10% of adult gannets may be “sabbatical” birds in any particular breeding season (volume 3, appendix 11.6), and this has been applied for this assessment. On this basis, three adult gannets were considered to be not breeding and so 31 adult breeding gannets were taken forward for the breeding season assessment.

194. The total gannet regional baseline breeding population is estimated to be 323,836 adult birds (Table 11.9). The adult baseline survival rate is estimated to be 0.954 (Table 11.21), which means that the corresponding rate for adult mortality is 0.046. Applying this mortality rate, the estimated regional baseline mortality of gannets is 14,896 adult birds per breeding season. The additional predicted mortality of 31 breeding adult gannets for the Developer Approach and Scoping Approach A would increase the baseline mortality rate by 0.21% (Table 11.23).

195. Applying Scoping Approach B mortality rates of 3%, it was calculated that the predicted theoretical additional mortality due to displacement effects was 100 gannets (99 adults and one immature bird) in the breeding season. Accounting for 10% of adult gannets being “sabbatical” birds, this total is revised to 89 breeding adult gannets.

196. The additional predicted mortality of 89 breeding adult gannets for Scoping Approach B would increase the baseline mortality rate by 0.60% (Table 11.24).

Non-breeding Season – Autumn Migration Period

197. For the autumn migration period of the non-breeding season, the mean peak abundance for gannet was 1,500 individuals within the Proposed Development array area and 2 km buffer. When considering the Developer Approach and Scoping Approach displacement rate of 70% in the Proposed Development array area and 2 km buffer, this would affect an estimated 1,050 birds (Table 11.23 and Table 11.24).

198. Based on information presented in Furness (2015), in the non-breeding season 45% of the population present in the autumn migration period are immature birds and 55% of birds are adults. This would mean that an estimated 473 gannets displaced from the Proposed Development array area and 2 km buffer during the autumn migration period would be immature, with 577 adult birds also displaced.

199. Applying the Developer Approach and Scoping Approach A mortality rate of 1%, it was calculated that the predicted theoretical additional mortality due to displacement effects was 11 gannets (six adults and five immature birds) in the autumn migration period. Based on Furness (2015), the total gannet BDMPS regional baseline population for the autumn migration period is estimated to be 456,298 individuals (Table 11.9). Using the average baseline mortality rate of 0.151 (Table 11.21), the estimated regional baseline mortality of gannets is 68,901 birds in the autumn migration period. The additional predicted mortality of 11 gannets for the Developer Approach and Scoping Approach A would increase the baseline mortality rate by 0.016% (Table 11.23).

200. Applying the Scoping Approach B mortality rate 3%, it was calculated that 32 gannets (18 adults and 14 immature birds) displaced from the Proposed Development array area and 2 km buffer in the autumn migration period would suffer mortality as a result. The additional predicted mortality of 32 gannets for Scoping Approach B would increase the baseline mortality rate by 0.046% (Table 11.24).

Non-breeding Season – Spring Migration Period

201. For the spring migration period of the non-breeding season, the mean peak abundance for gannet was 269 individuals within the Proposed Development array area and 2 km buffer. When considering the Developer Approach and Scoping Approach displacement rate of 70% in the Proposed Development array area and 2 km buffer, this would affect an estimated 188 birds (Table 11.23 and Table 11.24).

202. Based on information presented in Furness (2015), in the non-breeding season 45% of the population present in the spring migration period are immature birds and 55% of birds are adults. This would mean that an estimated 85 gannets displaced from the Proposed Development array area and 2 km buffer during the spring migration period would be immature, with 103 adult birds also displaced.

203. Applying the Developer Approach and Scoping Approach A mortality rate of 1%, it was calculated that the predicted theoretical additional mortality due to displacement effects was two gannets (one adult and one immature bird) in the spring migration period. Based on Furness (2015), the total gannet BDMPS regional baseline population for the spring migration period is estimated to be 248,385 individuals (Table 11.9). Using the average baseline mortality rate of 0.151 (Table 11.21), the estimated regional baseline mortality of gannets is 37,506 birds in the spring migration period. The additional predicted mortality of two gannets for the Developer Approach and Scoping Approach A would increase the baseline mortality rate by 0.005% (Table 11.23).

204. Applying the Scoping Approach B mortality rate 3%, it was calculated that the predicted theoretical additional mortality due to displacement effects was six gannets (three adults and three immature birds) in the spring migration period. The additional predicted mortality of six gannets for Scoping Approach B would increase the baseline mortality rate by 0.016% (Table 11.24).

Assessment of Displacement Mortality throughout the Year

205. Predicted gannet mortality as a result of displacement in the Proposed Development array area and 2 km buffer for all seasons as calculated above, was summed for the whole year.

206. Based on an assumed displacement rate of 70% and the Developer Approach and Scoping Approach A mortality rate of 1%, the predicted theoretical annual additional mortality due to displacement effects was an estimated 44 gannets. This corresponds to an increase in the baseline mortality rate of 0.23% (Table 11.23).

207. Applying the Scoping Approach B displacement rate of 70% and mortality rate 3%, the predicted theoretical additional annual mortality due to displacement effects was an estimated 127 gannets. This corresponds to an increase in the baseline mortality rate of 0.66% (Table 11.24).

Based on the results of the displacement assessment for the Developer Approach and Scoping Approaches A and B, the magnitude of impact from displacement on the regional gannet population was considered to be negligible, as the estimated increases in the annual baseline mortality rate were below 1%.

Summary of PVA Assessment

208. Although these displacement mortality estimates did not suggest a potentially significant increase in the baseline mortality rate for gannet for either the Developer Approach or Scoping Approaches A or B, PVA analysis was conducted on the gannet regional SPA population. The PVA analysis was carried out considering a range of displacement and mortality rates as well as a range of collision scenarios. The PVA assessment for gannet is presented following the collision impact section of this chapter (see paragraph 456).

Sensitivity of the Receptor

209. For this assessment, receptor sensitivity has been based on three reviews of evidence from post-construction studies at offshore wind farms. A review of post-construction studies of seabirds at offshore wind farms in European waters concluded that gannet was one of the species which strongly or nearly completely avoided offshore wind farms (Dierschke et al., 2016). However, other factors such as flexibility of habitat use and extensive foraging range also should be considered. A review of vulnerability of Scottish seabirds to offshore wind turbines in the context of disturbance and displacement ranked gannet with a score of two, where five was the most vulnerable score and one was the least vulnerable (Furness and Wade, 2012), while a subsequent review ranked gannet with a score of three (Furness et al., 2013). Bradbury et al., (2014), classified the gannet population vulnerability to displacement from offshore wind farms as very low.

210. However, it should be noted that the inclusion of gannets within the 2km buffer to determine the total number of birds subject to displacement is precautionary, since in reality the avoidance rate is likely to fall with increasing distance from the site, as demonstrated in a study of gannet distribution in relation to the Greater Gabbard wind farm (APEM, 2014).

211. Based on analysis of breeding adult gannet tracking data from the Bass Rock presented in volume 3, appendix 11.4, annex E, it is considered that the majority of adult gannets passing through Proposed Development are in transit rather than actively foraging. In addition, this analysis demonstrates the large size of the home range in relation to the Proposed Development, together with the known wide range of prey species available to gannets foraging in the area. This, together with the evidence from reviews presented above and from post-construction studies summarised in volume 3, appendix 4, indicates that gannet sensitivity to displacement from operational offshore wind farms is likely to be medium (Table 11.16).

212. Estimated numbers of gannets recorded within the Proposed Development array area would qualify as nationally important in the breeding season (volume 3, appendix 11.1), with individuals potentially originating from a number of SPAs in the region. On this basis the conservation importance for gannet was considered to be medium.

Significance of the Effect

213. For displacement effects on gannet from the Project alone, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

214. No offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **minor** adverse significance, which is not significant in EIA terms.

Kittiwake

215. For the Developer Approach displacement assessment, a displacement rate of 30% and a mortality rate of 2% was applied for the breeding season based on an evaluation of the published literature and in line with values used previously for other Forth and Tay offshore wind farm displacement assessments. In addition, it was considered that no displacement mortality is likely to occur during the non-breeding season, therefore no displacement assessment was undertaken for the non-breeding season.

216. There were two parts to the Scoping Approach displacement assessment and these are outlined below. For Scoping Approach A, a displacement rate of 30% and a mortality rate of 1% were applied for the breeding and non-breeding seasons. For Scoping Approach B, a displacement rate of 30% and a mortality rate of 3% were applied for the breeding and non-breeding seasons.

217. Further details of differences between the Developer Approach and the Scoping Approach for the displacement assessment are presented in volume 3, appendix 11.4.

Magnitude of Impact

218. Kittiwakes were most abundant in the Proposed Development array area and 2 km buffer in the breeding season, with peak estimates of 24,949 birds in April 2019 and 17,333 birds in August 2020, which gave a MSP of 21,141 birds in the breeding season. In the autumn migration period of the non-breeding season, peak estimates were 2,997 birds in September 2019 and 19,383 birds in September 2020, which gave a MSP of 11,190 birds over the period. In the spring migration period of the non-breeding season, peak estimates were 17,174 birds in March 2019 and 10,358 birds in April 2021, which gave a MSP of 13,766 birds over the period (see volume 3, appendix 11.4).

219. A complete range of displacement matrices for the Proposed Development, the Proposed Development array area and 2 km buffer as well as for the different bio-seasons for both the Developer Approach and the Scoping Approach are presented in volume 3, appendix 11.4.

220. For the Developer Approach, annual estimated kittiwake mortality from displacement in the Proposed Development and a 2 km buffer is presented in Table 11.26.

221. For Scoping Approaches A and B, annual estimated kittiwake mortality from displacement in the Proposed Development and a 2 km buffer is presented in Table 11.27 and Table 11.28. For both Developer and Scoping Approaches, the impact of additional mortality due to wind farm effects has been assessed in terms of the change in the baseline mortality rate which could result. The overall baseline mortality rates were based on age-specific demographic rates and age class proportions from the PVA work as presented in Table 11.21. The potential magnitude of impact was estimated by calculating the increase in baseline mortality within each bio-season with respect to the regional populations.

222. For the breeding season assessments, the increase in baseline mortality was calculated based on the baseline adult survival rate presented in Table 11.21. For kittiwake, the adult baseline survival rate is estimated to be 0.855, therefore the corresponding rate for adult mortality is 0.145. For the non-breeding season assessments, it has been assumed that all age classes are equally at risk of effects, with each age class affected in proportion to its presence in the population. Therefore, a weighted average baseline mortality rate has been calculated which is appropriate for all age classes for use in assessments, calculated for those species screened in for assessment. These were calculated using the different survival rates for each age class and their relative proportions in the population (Table 11.21).

Table 11.26: Displacement Mortality Estimates for Kittiwake for the Proposed Development array area plus 2 km buffer in the breeding season for the Developer Approach

Bio-season	Peak Mean Seasonal Abundance (Proposed Development Array Area and 2 km Buffer)	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population (Adults)	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Mid Apr-Aug)[1]	21,141	6,153	111	319,126	46,274	0.24
Total	-	6,343	111	-	-	0.24

1 Breeding season assessment is for breeding adults only.

2 Mortality is 2% in breeding season.

Table 11.27: Displacement Mortality Estimates for Kittiwake for the Proposed Development array area plus 2 km buffer by bio-season for Scoping Approach A

Bio-season	Peak Mean Seasonal Abundance (Proposed Development Array Area and 2 km Buffer)	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population (Adults)	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Mid Apr-Aug)[1]	21,141	6,153	56	319,126	46,274	0.12
Autumn migration (Sep-Dec)	11,190	3,357	34	829,937	132,790	0.026
Spring migration (Jan to mid-April)	13,766	4,130	41	627,816	100,451	0.041
Total	-	13,830	131	-	-	0.19

1 Breeding season assessment is for breeding adults only.

2 Mortality is 1% in breeding and non-breeding seasons.

Table 11.28: Displacement Mortality Estimates for Kittiwake for the Proposed Development array area plus 2 km buffer by bio-season for Scoping Approach B

Bio-season	Peak Mean Seasonal Abundance (Proposed Development Array Area and 2 km Buffer)	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population (Adults)	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Mid Apr-Aug)[1]	21,141	6,153	166	319,126	46,274	0.36
Autumn migration (Sep-Dec)	11,190	3,357	101	829,937	132,790	0.076
Spring migration (Jan to mid-April)	13,766	4,130	124	627,816	100,451	0.123
Total	-	13,830	391	-	-	0.56

1 Breeding season assessment is for breeding adults only.

2 Mortality is 3% in breeding and non-breeding seasons.

<u>Breeding Season</u>

223. During the breeding season, the mean peak abundance for kittiwake is 21,141 individuals within the Proposed Development array area and 2 km buffer. When considering the Developer Approach and Scoping Approach displacement rate of 30% in the Proposed Development array area and 2 km buffer, this would affect an estimated 6,343 birds. However, this estimate includes non-breeding adults and immature birds, as well as breeding adults.

224. 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 proportions recorded on digital aerial baseline surveys in the Offshore Ornithology study area (Table 11.29) (volume 3, appendix 11.1).

Table 11.29: Proportions of Juvenile, Immature and Adult Kittiwakes Recorded on Digital Aerial Surveys

Season	Juvenile	Immature	Adult
Breeding (Mid Apr-Aug)	0.01	0.02	0.97
Autumn migration (Sep-Dec)	0.22	0.02	0.77
Spring migration (Jan-mid Apr)	0	0.16	0.84

225. Based on the proportion of immature kittiwakes recorded on digital aerial baseline surveys in the breeding season, 3% of the population present are immature birds (Table 11.29), Although this is likely to be an underestimate, since it is not possible to age all birds recorded on surveys, this would mean that an estimated 190 kittiwakes displaced from the Proposed Development array area and 2 km buffer during the breeding season would be immature birds, with 6,153 adult birds also displaced.

226. Applying the Developer Approach mortality rate of 2%, it was calculated that the predicted theoretical additional mortality due to displacement effects was 127 kittiwakes (123 adults and four immature birds) in the breeding season. However, a proportion of adult birds present at colonies in the breeding season will opt not to breed in a particular breeding season. It has been estimated that 10% of adult kittiwakes may be "sabbatical" birds in any particular breeding season (volume 3, appendix 11.6), and this has been applied for this assessment. On this basis, 12 adult kittiwakes were considered to be not breeding and so 111 adult breeding kittiwakes were taken forward for the breeding season assessment.

227. The total kittiwake regional baseline breeding population is estimated to be 319,126 adult birds (Table 11.9). The adult baseline survival rate for kittiwake is estimated to be 0.855 (Table 11.21), which means that the corresponding rate for adult mortality is 0.145. Applying this mortality rate, the estimated regional baseline mortality of kittiwakes is 46,273 adults per breeding season. The additional predicted mortality of 111 breeding adult kittiwakes for the Developer Approach would increase the baseline mortality rate by 0.24% (Table 11.26).

228. Applying the Scoping Approach A mortality rate of 1%3%, the predicted theoretical additional mortality due to displacement effects was 64 (62 adults and two immature birds) kittiwakes in the breeding season. Accounting for 10% of adult kittiwakes being "sabbatical" birds, this total is revised to 56 breeding adult kittiwakes.

229. The additional predicted mortality of 56 breeding adult kittiwakes would increase the baseline mortality rate by 0.12% (Table 11.27).

230. Applying the Scoping Approach B mortality rate of 3%, the predicted theoretical additional mortality due to displacement effects was 191 kittiwakes (185 adults and six immature birds) in the breeding season. Accounting for 10% of adult kittiwakes being "sabbatical" birds, this total is revised to 166 breeding adult kittiwakes.

231. The additional predicted mortality of 166 breeding adult kittiwakes would increase the baseline mortality rate by 0.36% (Table 11.28).

<u>Non-breeding Season – Autumn Migration Period</u>

232. For the Developer Approach, kittiwake displacement was not considered for the autumn migration period of the non-breeding season, for the reasons outlined in Paragraph 215.

233. For the autumn migration period of the non-breeding season, the mean peak abundance for kittiwake was 11,190 individuals within the Proposed Development array area and 2 km buffer. When considering the Scoping Approach displacement rate of 30% in the Proposed Development array area and 2 km buffer, this would affect an estimated 3,357 birds (Table 11.27).

234. Based on information presented in Furness (2015), in the non-breeding season 47% of the population present in the autumn migration period are immature birds and 53% of birds are adults. This would mean that an estimated 1,578 kittiwakes displaced from the Proposed Development array area and 2 km buffer during the autumn migration period would be immature birds, with 1,779 adult birds also displaced.

235. Applying the Scoping Approach A mortality rate of 1%, it was calculated that the predicted theoretical additional mortality due to displacement effects was 34 kittiwakes (26 adults and eight immature birds) in the autumn migration period. Based on Furness (2015), the total kittiwake BDMPS regional baseline population for the autumn migration period is estimated to be 829,937 individuals (Table 11.9). Using the average baseline mortality rate of 0.160 (Table 11.21), the estimated regional baseline mortality of kittiwakes is 132,790 birds in the autumn migration period of the non-breeding season. The additional predicted mortality of 34 kittiwakes for Scoping Approach A would increase the baseline mortality rate by 0.026% (Table 11.27).

236. Applying the Scoping Approach B mortality rate of 3%, it was calculated that the predicted theoretical additional mortality due to displacement effects was 101 kittiwakes (77 adults and 24 immature birds) in the autumn migration period. Based on Furness (2015), the total kittiwake BDMPS regional baseline population for the autumn migration period is estimated to be 829,937 individuals (Table 11.9). Using the average baseline mortality rate of 0.160 (Table 11.21), the estimated regional baseline mortality of kittiwakes is 132,790 birds in the autumn migration period of the non-breeding season. The additional predicted mortality of 101 kittiwakes for Scoping Approach B would increase the baseline mortality rate by 0.076% (Table 11.28).

<u>Non-breeding Season – Spring Migration Period</u>

237. For the Developer Approach, kittiwake displacement was not considered for the spring migration period of the non-breeding season, for the reasons outlined in Paragraph 215.

238. For the spring migration period of the non-breeding season, the mean peak abundance for kittiwake was 13,766 individuals within the Proposed Development array area and 2 km buffer. When considering the Scoping Approach displacement rate of 30% in the Proposed Development array area and 2 km buffer, this would affect an estimated 4,130 birds (Table 11.27).

239. Based on information presented in Furness (2015), in the non-breeding season, 47% of the population present in the spring migration period are immature birds, and 53% of birds are adults. This would mean that an estimated 1,941 kittiwakes displaced from the Proposed Development array area and 2 km buffer during the spring migration period would be immature birds, with 2,189 adult birds also displaced.

240. Applying the Scoping Approach A mortality rate of 1%, it was calculated that the predicted theoretical additional mortality due to displacement effects was 41 kittiwakes (34 adults and seven immature birds) in the spring migration period. Based on Furness (2015), the total kittiwake BDMPS regional baseline

population for the spring migration period is estimated to be 627,816 individuals (Table 11.9). Using the average baseline mortality rate of 0.160 (Table 11.21), the estimated regional baseline mortality of kittiwakes is 100,451 birds in the spring migration period. The additional predicted mortality of 41 kittiwakes for Scoping Approach A would increase the baseline mortality rate by 0.041% (Table 11.27).

241. Applying the Scoping Approach B mortality rate of 3%, it was calculated that the predicted theoretical additional mortality due to displacement effects was 124 kittiwakes (104 adults and 20 immature birds) in the spring migration period. Based on Furness (2015), the total kittiwake BDMPS regional baseline population for the spring migration period is estimated to be 627,816 individuals (Table 11.9). Using the average baseline mortality rate of 0.160 (Table 11.21), the estimated regional baseline mortality of kittiwakes is 100,451 birds in the spring migration period. The additional predicted mortality of 124 kittiwakes for Scoping Approach B would increase the baseline mortality rate by 0.123% (Table 11.28).

Assessment of Displacement Mortality throughout the Year

242. Predicted kittiwake mortality as a result of displacement in the Proposed Development array area and 2 km buffer for all seasons as calculated above, was summed for the whole year.

243. Based on an assumed displacement rate of 30% and the Developer Approach mortality rate of 2%, the predicted theoretical additional mortality due to displacement effects was an estimated 111 breeding adult kittiwakes in the breeding season only. This corresponds to an increase in the baseline mortality rate of 0.24% (Table 11.26).

244. Applying the Scoping Approach A displacement rate of 30% and mortality rate of 1% in the breeding and non-breeding seasons, the predicted theoretical additional annual mortality due to displacement effects was an estimated 131 kittiwakes. This corresponds to an increase in the baseline mortality rate of 0.19% (Table 11.27).

245. Applying the Scoping Approach B displacement rate of 30% and mortality rate of 3% in the breeding and non-breeding seasons, the predicted theoretical additional annual mortality due to displacement effects was an estimated 391 kittiwakes. This corresponds to an increase in the baseline mortality rate of 0.56% (Table 11.28).

246. Based on the results from the displacement assessment for the Developer Approach and the Scoping Approaches A and B, the magnitude of impact from displacement on the regional kittiwake population was considered to be negligible, as the estimated increases in the annual baseline mortality rate for kittiwake were below 1%.

Summary of PVA Assessment

247. Although these displacement mortality estimates did not suggest a potentially significant increase in the baseline mortality rate for kittiwake for either the Developer Approach or Scoping Approaches A and B, PVA analysis was conducted on the kittiwake regional SPA population. The regional PVA analysis was carried out considering a range of displacement and mortality rates as well as a range of collision scenarios. The regional PVA assessment for kittiwake is presented following the collision impact section of this chapter (see paragraph 548).

Sensitivity of the Receptor

248. For kittiwake, there is evidence from other operating offshore wind farm projects that displacement is not likely to occur to any significant level. A review of post-construction studies of seabirds at offshore wind farms in European waters concluded that kittiwake was one of the species which were hardly affected by offshore wind farms or with attraction and avoidance approximately equal over all studies (Dierschke et al., 2016). Two reviews of vulnerability of Scottish seabirds to offshore wind turbines in the context of disturbance and displacement ranked kittiwake with a score of two, where five was the most vulnerable score and one was the least vulnerable (Furness and Wade, 2012, Furness et al., 2013). Similarly, Bradbury et al., (2014), classified the kittiwake population vulnerability to displacement as very low.

249. On the basis of evidence from reviews presented above and from post-construction studies summarised in volume 3, appendix 4, it is considered that kittiwake has low sensitivity to (high tolerance of) offshore wind farms (Table 11.16).

250. Estimated numbers of kittiwakes recorded within the Proposed Development array area would qualify as nationally important in the breeding season (See volume 3, appendix 11.1, annex G), with individuals likely originating from a number of SPAs and non-SPAs in the region. On this basis the conservation importance for kittiwake was considered to be medium.

Significance of the Effect

251. For displacement effects on kittiwake from the Project alone, for both the Developer Approach and Scoping Approaches A and B, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

252. No offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **negligible to minor** adverse significance, which is not significant in EIA terms.

Guillemot

253. For the Developer Approach displacement assessment, a displacement rate of 50% and a mortality rate of 1% was applied to each bio-season based on evaluation of the published literature and in line with values used by other offshore wind farm displacement assessments.

254. There were two parts to the Scoping Approach displacement assessment and these are outlined below. For Scoping Approach A, a displacement rate of 60% and mortality rates of 3% for the breeding season and 1% for the non-breeding season were applied. For Scoping Approach B, a displacement rate of 60% and mortality rates of 5% for the breeding season and 3% for the non-breeding season were applied.

255. Further details of differences between the Developer Approach and the Scoping Approach for the displacement assessment are presented in volume 3, appendix 11.4.

Magnitude of Impact

256. Guillemots were the most abundant species recorded in the Offshore Ornithology study area during the aerial survey programme, with birds recorded most frequently between April and May and August and/or September in both years, coinciding with the start of the breeding season and the post-breeding flightless moult stage respectively.

257. Guillemots were most abundant in the Proposed Development array area and 2 km buffer in the breeding season with peak estimates of 94,806 birds in April 2019 and 53,499 birds in June 2020, which gave a MSP of 74,154 birds in the breeding season.

258. Overall, within the Offshore Ornithology study area, the peak population estimate occurred in April 2021, with an estimated 242,168 birds (95%CI 190,509 – 305,941) recorded (See volume 3, appendix 11.1). The regional breeding population of guillemots is currently estimated to be 353,971 birds (volume 3, 11.1), therefore the estimated population in the Offshore Ornithology study area for April 2021 would be the equivalent of 68.4% of the regional breeding population, which is considered unlikely to be the case. It is likely that many of these birds are from other breeding colonies further north, for example Shetland or Norway, and that these birds are passing through the Offshore Ornithology study area on the way to these colonies.

259. As previously noted in paragraph 48, the high estimated number of guillemots recorded in April 2021 was used to represent April 2019, as no surveys were possible in that month due to unsuitable weather conditions. This high number was therefore taken through the MSP calculations, resulting in a higher estimated number of displaced guillemots for the 2019 breeding season. This will also have inflated the predicted number of guillemot mortalities arising from displacement in the 2019 breeding season, and this should be borne in mind when looking at the assessment outputs.

260. In the non-breeding season, peak estimates were 44,146 birds in March 2020 and 44,194 birds in September 2020, which gave a MSP of 44,171 birds over the period (see volume 3, appendix 11.4).

261. A complete range of displacement matrices for the Proposed Development, the Proposed Development array area and 2 km buffer as well as for the different bio-seasons for both the Developer Approach and the Scoping Approach are presented in volume 3, appendix 11.4.

262. For the Developer Approach, annual estimated guillemot mortality from displacement in the Proposed Development array area and 2 km buffer is presented in Table 11.30.

263. For the Scoping Approach, annual estimated guillemot mortality from displacement in the Proposed Development array area and 2 km buffer is presented in Table 11.31 and Table 11.32. For both approaches, the impact of additional mortality due to wind farm effects has been assessed in terms of the change in the baseline mortality rate which could result. The overall baseline mortality rates were based on age-specific demographic rates and age class proportions from the PVA work as presented in Table 11.21. The potential magnitude of impact was estimated by calculating the increase in baseline mortality within each bio-season with respect to the regional populations.

264. For the breeding season assessments, the increase in baseline mortality was calculated based on the baseline adult survival rate presented in Table 11.21. For guillemot, the adult baseline survival rate is estimated to be 0.927, therefore the corresponding rate for adult mortality is 0.073. For the non-breeding season assessments, it has been assumed that all age classes are equally at risk of effects, with each age class affected in proportion to its presence in the population. Therefore, a weighted average baseline mortality rate has been calculated which is appropriate for all age classes for use in assessments, calculated for those species screened in for assessment. These were calculated using the different survival rates for each age class and their relative proportions in the population (Table 11.21).

Table 11.30: Displacement Mortality Estimates for Guillemot for the Proposed Development array area plus 2 km buffer by bio-season for the Developer Approach

Bio-season	Peak Mean Seasonal Abundance (Proposed Development Array Area and 2 km Buffer)	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Apr-mid Aug)[1]	74,154	18,983	177	353,971	25,840	0.68
Non-breeding (Mid Aug-Mar)	44,171	22,086	221	353,971	52,388	0.42
Total	-	40,979	398	-	-	1.1

1 Breeding season assessment is for breeding adults only

2 Mortality is 1% in breeding and non-breeding season

Table 11.31: Displacement Mortality Estimates for Guillemot for the Proposed Development array area plus 2 km buffer by bio-season for Scoping Approach A

Bio-season	Peak Mean Seasonal Abundance (Proposed Development Array Area and 2 km Buffer)	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Apr-mid Aug)[1]	74,154	44,493	636	353,971	25,840	2.5
Non-breeding (Mid Aug-Mar)	44,171	26,503	266	353,971	52,388	0.51
Total	-	70,996	902	-	-	3.01

1 Breeding season assessment is for breeding adults only.

2 Mortality is 3% in breeding season and 1% in non-breeding season.

Table 11.32: Displacement Mortality Estimates for Guillemot for the Proposed Development array area plus 2 km buffer by bio-season for Scoping Approach B

Bio-season	Peak Mean Seasonal Abundance (Proposed Development Array Area and 2 km Buffer)	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Apr-mid Aug)	74,154	44,493	1,059	353,971	25,840	4.1
Non-breeding (Mid Aug-Mar)	44,171	26,503	796	353,971	52,388	1.52
Total	-	70,996	1,855	-	-	5.62

1 Breeding season assessment is for breeding adults only.
2 Mortality is 5% in breeding season and 3% in non-breeding season.

Breeding Season

265. During the breeding season, the mean peak abundance for guillemot is 74,154 individuals within the Proposed Development array area and 2 km buffer. When considering the Developer Approach displacement rate of 50% in the Proposed Development array area and 2 km buffer, this would affect an estimated 37,077 birds. However, this estimate includes non-breeding adults and immature birds, as well as breeding adults.

266. 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 proportions from the stable age structure calculated from the population models from which PVAs were produced (Table 11.33) (volume 3, appendix 11.6).

Table 11.33: PVA Stable Age Structure for Guillemots

SPA	Immature	Adult
Forth Islands SPA	0.485	0.515
Farne Islands SPA	0.514	0.486
East Caithness Cliffs SPA	0.464	0.536
Average	0.488	0.512

267. Based on the proportion of immature guillemots from the stable age structure (Table 11.33), 48.8% of the population present are immature birds, then this would mean that an estimated 18,094 guillemots displaced from the Proposed Development array area and 2 km buffer during the breeding season would be immature birds, with 18,983 adult birds also displaced.

268. Applying the Developer Approach mortality rate of 1%, it was calculated that the predicted theoretical additional mortality due to displacement effects was 371 guillemots (190 adults and 181 immature birds) in the breeding season. However, a proportion of adult birds present at colonies in the breeding season will opt not to breed in a particular breeding season. It has been estimated that 7% of adult guillemots may be “sabbatical” birds in any particular breeding season (volume 3, appendix 11.6), and this has been applied for this assessment. On this basis, 13 adult guillemots were considered to be not breeding and so 177 adult breeding guillemots were taken forward for the breeding season assessment.

269. The total guillemot regional baseline breeding population is estimated to be 353,971 individuals (Table 11.9). The adult baseline survival rate for guillemot is estimated to be 0.927 (Table 11.21), which means that the corresponding rate for adult mortality is 0.073. Applying this mortality rate, the estimated regional baseline mortality of guillemots is 25,840 adult breeding birds per breeding season. The additional predicted mortality of 177 adult breeding guillemots would increase the baseline mortality rate by 0.68% (Table 11.30).

270. When considering the Scoping Approach displacement rate of 60% in the Proposed Development array area and 2 km buffer, this would affect an estimated 44,493 birds (Table 11.31 and Table 11.32). Assuming that 48.8% of the population present are immature birds (Table 11.33), then this would mean that an estimated 21,713 guillemots displaced from the Proposed Development array area and 2 km buffer during the breeding season would be immature birds, with 22,780 adult birds also displaced.

271. Applying the Scoping Approach A mortality rate of 3% in the breeding season, it was calculated that the predicted theoretical additional mortality due to displacement effects was 1,335 guillemots (684 adults and 651 immature birds) in the breeding season. As above, a sabbatical rate of 7% for non-breeding adult guillemots (volume 3, appendix 11.6) has been applied for this assessment. This resulted in 48 adult guillemots being considered to be not breeding and so 636 adult breeding guillemots were taken forward for the breeding season assessment.

272. Applying a mortality rate for adult guillemots of 0.073, the estimated regional baseline mortality of guillemots is 25,840 adult breeding birds per breeding season. The additional predicted mortality of 636 breeding adult guillemots would increase the baseline mortality rate by 2.5% (Table 11.31).

273. Applying the Scoping Approach B mortality rate of 5% in the breeding season, it was calculated that the predicted theoretical additional mortality due to displacement effects was 2,225 guillemots (1,139 adults and 1,086 immature birds) in the breeding season. However, a proportion of adult birds present at colonies in the breeding season will opt not to breed in a particular breeding season. Applying a proportion of 7% for “sabbatical” adult guillemots (volume 3, appendix 11.6), resulted in 80 adult guillemots being considered to be not breeding and so 1,059 adult breeding guillemots were taken forward for the breeding season assessment.

274. Applying a mortality rate for adult guillemots of 0.073, the estimated regional baseline mortality of guillemots is 25,840 adult breeding birds per breeding season. The additional predicted mortality of 1,059 breeding adult guillemots would increase the baseline mortality rate by 4.1% (Table 11.32).

Non-Breeding Season

275. During the non-breeding season, the mean peak abundance for guillemot is 44,171 individuals within the Proposed Development array area and 2 km buffer. When considering the Developer Approach displacement rate of 50% in the Proposed Development array area and 2 km buffer, this would affect an estimated 22,086 birds (Table 11.30).

276. Based on the proportion of immature guillemots from the stable age structure (Table 11.33), 48.8% of the population present are immature birds. This would mean that an estimated 10,778 guillemots displaced from the Proposed Development array area and 2 km buffer during the non-breeding season would be immature birds, with 11,308 adult birds also displaced.

277. Applying the Developer Approach mortality rate of 1%, it was calculated that the predicted theoretical additional mortality due to displacement effects was 221 guillemots (113 adults and 108 immature birds) in the non-breeding season. Scoping Opinion advice for guillemots was to use the regional breeding population within mean maximum foraging range +1S.D. as the reference population for the guillemot non-breeding season, on the basis that birds do not travel far from their breeding colonies in the non-breeding season (Buckingham *et al*. 2022). Therefore, the total guillemot regional baseline population in the non-breeding season, including breeding adults and immature birds, is estimated to be 353,971 individuals.

278. Using the average baseline mortality rate of 0.148 (Table 11.21), the estimated regional baseline mortality of guillemots is 52,388 birds per non-breeding season. The additional predicted mortality of 221 guillemots would increase the baseline mortality rate by 0.42% (Table 11.30).

279. When considering the Scoping Approach displacement rate of 60% in the Proposed Development array area and 2 km buffer, this would affect an estimated 26,503 birds (Table 11.30). Assuming that 48.8% of the population present are immature birds (Table 11.33), then this would mean that an estimated 12,933 guillemots displaced from the Proposed Development array area and 2 km buffer during the non-breeding season would be immature birds, with 13,570 adult birds also displaced.

280. Applying the Scoping Approach A mortality rate of 1% for the non-breeding season, it was calculated that the predicted theoretical additional mortality due to displacement effects was 266 guillemots (136 adults and 130 immature birds) in the non-breeding season.

281. As outlined above, Scoping Opinion advice for guillemots was to use the regional breeding population within mean maximum foraging range +1S.D. as the reference population for the guillemot non-breeding season, therefore the total guillemot regional baseline population for the non-breeding season is estimated to be 353,971 individuals. Using the average baseline mortality rate of 0.148 (Table 11.21), the estimated regional baseline mortality of guillemots is 52,388 birds per non-breeding season. The additional predicted mortality of 266 guillemots would increase the baseline mortality rate by 0.51% (Table 11.31).

282. Applying the Scoping Approach B mortality rate of 3% for the non-breeding season, it was calculated that the predicted theoretical additional mortality due to displacement effects was 796 guillemots (408 adults and 388 immature birds) in the non-breeding season.

283. As outlined above, Scoping Opinion advice for guillemots was to use the regional breeding population within mean maximum foraging range +1S.D. as the reference population for the guillemot non-breeding season, therefore the total guillemot regional baseline population for the non-breeding season is estimated to be 353,971 individuals. Using the average baseline mortality rate of 0.148 (Table 11.21), the estimated regional baseline mortality of guillemots is 52,388 birds per non-breeding season. The additional predicted mortality of 796 guillemots would increase the baseline mortality rate by 1.52% (Table 11.32).

Assessment of Displacement Mortality throughout the Year

284. Predicted guillemot mortality as a result of displacement in the Proposed Development array area and 2 km buffer for all seasons as calculated above, was summed for the whole year.

285. Based on the Developer Approach displacement rate of 50% and a mortality rate of 1% throughout the year, the predicted theoretical additional annual mortality due to displacement effects was an estimated 398 guillemots. This corresponds to an increase in the baseline mortality rate of 1.1% (Table 11.30).

286. Applying the Scoping Approach A displacement rate of 60% and mortality rates of 3% in the breeding season and 1% in the non-breeding season, the predicted theoretical additional mortality due to displacement effects was an estimated 902 guillemots. This corresponds to an increase in the baseline mortality rate of 3.01% (Table 11.31).

287. Applying the Scoping Approach B displacement rate of 60% and mortality rates of 5% in the breeding season and 3% in the non-breeding season, the predicted theoretical additional mortality due to displacement effects was an estimated 1,855 guillemots. This corresponds to an increase in the baseline mortality rate of 5.62% (Table 11.32).

288. These displacement mortality estimates suggest a potential significant increase in the baseline mortality rate for guillemot therefore PVA analysis was conducted on the guillemot regional SPA population.

Summary of PVA Assessment

289. PVA was carried out for guillemot considering a wide range of displacement and mortality rates. The results of the PVAs for predicted displacement impacts for the Project alone during the operation phase for the guillemot regional SPA population for the 35-year projection is summarised in Table 11.34. Further details of the PVA methodology, input parameters and an explanation of how to interpret the PVA results can be found in volume 3, appendix 11.6.

Table 11.34: Summary of PVA Displacement Outputs for Guillemot for the Proposed Development array area plus 2 km buffer after 35 years

Scenario and Start Population 344,608 adults[1]	Unimpacted Median Population Size	Impacted Median Population Size	Counterfactual of Population Growth Rate - Median	Counterfactual Population Size - Median	Unimpacted Centile at Impacted 50th Centile - Median
Project Alone: Developer approach	1177118	114,4276	0.999	0.974	40.1
Project Alone: Scoping approach A	1177118	1,085,147	0.998	0.923	24.1
Project Alone: Scoping approach B	1177118	1,008,205	0.996	0.855	8.7

1 Starting population taken from volume 3, appendix 11.6

Developer Approach = 50% displacement and 1% mortality throughout year

Scoping Approach A = 60% displacement and 3% displacement mortality in breeding season; 1% displacement mortality in non-breeding season.

Scoping Approach B = 60% displacement and 5% displacement mortality in breeding season; 3% displacement mortality in non-breeding season.

290. For both the with and without Project scenarios, the guillemot regional SPA population is predicted to increase over the 35-year period. For the Developer Approach, the end population size with Project scenario was slightly lower than the without Project scenario. There was a very slight predicted decrease in the counterfactual of the population growth rate, and the counterfactual of the population size was also close to 1.000, while the 50th Centile value was relatively close to 50. These values indicate that the PVA did not predict a significant negative effect from the project alone effects of displacement mortality from the Developer Approach on the guillemot regional SPA population after 35 years.

291. For Scoping Approach A, the end population size with Project scenario was lower than the without Project scenario. There was a very slight predicted decrease in the counterfactual of the population growth rate, and the counterfactual of the population size was lower than 1.000, while the 50th Centile value was 24.1. These values indicate that the PVA did predict a slight negative effect from the project-alone effects of displacement mortality from Scoping Approach A on the guillemot regional SPA guillemot population after 35 years.

292. For Scoping Approach B, the end population size with Project scenario was lower than the without Project scenario. There was a slight predicted decrease in the counterfactual of the population growth rate, and the counterfactual of the population size was lower, while the 50th Centile value was 8.7. These values indicate that the PVA did predict a larger negative effect from the project-alone effects of displacement mortality from Scoping Approach B on the guillemot regional SPA guillemot population after 35 years.

293. Based on the results from the displacement assessment and the regional PVA for the Developer Approach, the magnitude of impact on the regional guillemot population is low.

294. Based on the results from the displacement assessment and the regional PVA for Scoping Approach A, the magnitude of impact is low.

295. Based on the results from the displacement assessment and the regional PVA for Scoping Approach B, the magnitude of impact is medium.

Sensitivity of the Receptor

296. For this assessment, receptor sensitivity has been based on three reviews of evidence from post-construction studies at offshore wind farms. A review of post-construction studies of seabirds at offshore wind farms in European waters concluded that the mean outcome across 13 offshore wind farms for auks was 'weak displacement' but this was highly variable. Overall, the review concluded that there was evidence that guillemot was one of the species which showed a weak avoidance of offshore wind farms (Dierschke et al., 2016).

297. A review of vulnerability of Scottish seabirds to offshore wind turbines in the context of disturbance and displacement ranked guillemot with a score of three, where five was the most vulnerable score and one was the least vulnerable (Furness and Wade, 2012). A subsequent review ranked guillemot with a score of 14, where the highest score was 32 (Furness et al., 2013). Bradbury et al., (2014), classified the guillemot population vulnerability to displacement from offshore wind farms as moderate. Further evidence of the degree of displacement from operational offshore wind farms on guillemots is presented in volume 3, appendix 11.4.

298. On the basis of the evidence from reviews presented above and from post-construction studies summarised in volume 3, appendix 4, guillemot sensitivity to operational offshore wind farms is considered to be medium (Table 11.16).

299. Estimated numbers of guillemots recorded within the Proposed Development array area would qualify as internationally important in the breeding season, as estimated numbers regularly exceeded 20,000 birds (See volume 3, appendix 11.1, annex K), with individuals likely originating from a number of SPAs and non-SPAs in the region. On this basis the conservation importance for guillemot was considered to be high.

Significance of the Effect

300. For displacement effects on guillemot from the Project alone, for the Developer Approach, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

301. For Scoping Approach A, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

302. For Scoping Approach B, the magnitude of the impact is deemed to be medium, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **moderate** adverse significance, which is significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

303. For the Developer Approach and Scoping Approach A, no offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **minor** adverse significance, which is not significant in EIA terms.

304. For Scoping Approach B, the residual impact is considered to be of **moderate** adverse significance, which is significant in EIA terms. However, it is considered that the displacement mortality rates used in Scoping Approach B are likely to be highly precautionary, for the reasons outlined in volume 3, appendix 11.4. Consequently, no additional mitigation is proposed.

Razorbill

305. For the Developer Approach displacement assessment, a displacement rate of 50% and a mortality rate of 1% was applied to each bio-season based on evaluation of the published literature and in line with values used by other offshore wind farm displacement assessments.

306. There were two parts to the Scoping Approach displacement assessment and these are outlined below. For Scoping Approach A, a displacement rate of 60% and mortality rates of 3% for the breeding season and 1% for the non-breeding season were applied. For Scoping Approach B, a displacement rate of 60% and mortality rates of 5% for the breeding season and 3% for the non-breeding season were applied.

307. Further details of differences between the Developer Approach and the Scoping Approach for the displacement assessment are presented in volume 3, appendix 11.4.

Magnitude of Impact

308. In the breeding season, peak estimates of razorbills in the Proposed Development array area and 2 km buffer in the were recorded in July 2019 (3,258 birds) and August 2020 (4,820 birds), which gave a MSP of 4,040 birds in the breeding season. In the autumn migration period of the non-breeding season, peak estimates were 2,111 birds in September 2019 and 15,587 birds in September 2020, which gave a MSP of 8,849 birds over the period. In the winter period of the non-breeding season, peak estimates were 632 birds in December 2019 and 2,165 birds in December 2020, which gave a MSP of 1,399 birds over the period. Peak estimated numbers in the spring migration period of the non-breeding season, were 9,130 birds in March 2020 and 5,830 birds in April 2021, which gave a MSP of 7,480 birds over the period (see volume 3, appendix 11.4).

309. A complete range of displacement matrices for the Proposed Development, the Proposed Development array area and 2 km buffer as well as for the different bio-seasons for both the Developer Approach and the Scoping Approach are presented in volume 3, appendix 11.4.

310. For the Developer Approach, annual estimated razorbill mortality from displacement in the Proposed Development and a 2 km buffer is presented in Table 11.35.

311. For the Scoping Approach, annual estimated razorbill mortality from displacement in the Proposed Development and a 2 km buffer is presented in Table 11.36 and Table 11.37. For both approaches, the impact of additional mortality due to wind farm effects has been assessed in terms of the change in the baseline mortality rate which could result. The overall baseline mortality rates were based on age-specific demographic rates and age class proportions from the PVA work as presented in Table 11.21. The potential

magnitude of impact was estimated by calculating the increase in baseline mortality within each bio-season with respect to the regional populations.

312. For the breeding season assessments, the increase in baseline mortality was calculated based on the baseline adult survival rate presented in Table 11.21. For razorbill, the adult baseline survival rate is estimated to be 0.910, therefore the corresponding rate for adult mortality is 0.09. For the non-breeding season assessments, it has been assumed that all age classes are equally at risk of effects, with each age class affected in proportion to its presence in the population. Therefore, a weighted average baseline mortality rate has been calculated which is appropriate for all age classes for use in assessments, calculated for those species screened in for assessment. These were calculated using the different survival rates for each age class and their relative proportions in the population (Table 11.21).

Table 11.35: Displacement Mortality Estimates for Razorbill for the Proposed Development array area plus 2 km buffer by bio-season for the Developer Approach

Bio-season	Peak Mean Seasonal Abundance (Proposed Development Array Area and 2 km Buffer)	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Apr-mid Aug)[1]	4,040	1,079	10	84,501	7,605	0.13
Autumn migration (mid-Aug-Oct)	8,849	4,424	44	591,874	71,025	0.062
Winter (Nov-Dec)	1,399	700	7	218,622	26,235	0.027
Spring migration (Jan-Mar)	7,480	3,740	37	591,874	71,025	0.052
Total	-	9,943	98	-	-	0.27

1 Breeding season assessment is for breeding adults only.

2 Mortality is 1% in breeding and non-breeding season.

Table 11.36: Displacement Mortality Estimates for Razorbill for the Proposed Development array area plus 2 km buffer by bio-season for Scoping Approach A

Bio-season	Peak Mean Seasonal Abundance (Proposed Development Array Area and 2 km Buffer)	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Apr-mid Aug)[1]	4,040	1,295	36	84,501	7,605	0.47
Autumn migration (mid-Aug-Oct)	8,849	5,309	53	591,874	71,025	0.075
Winter (Nov-Dec)	1,399	839	8	218,622	26,235	0.03
Spring migration (Jan-Mar)	7,480	4,488	45	591,874	71,025	0.063
Total	-	11,931	142	-	-	0.64

1 Breeding season assessment is for breeding adults only

2 Mortality is 3% in breeding season and 1% in non-breeding season

Table 11.37: Displacement Mortality Estimates for Razorbill for the Proposed Development array area plus 2 km buffer by bio-season for Scoping Approach B

Bio-season	Peak Mean Seasonal Abundance (Proposed Development Array Area and 2 km Buffer)	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Apr-mid Aug)[1]	4,040	1,295	60	84,501	7,605	0.79
Autumn migration (mid-Aug-Oct)	8,849	5,309	159	591,874	71,025	0.224
Winter (Nov-Dec)	1,399	839	25	218,622	26,235	0.095
Spring migration (Jan-Mar)	7,480	4,488	135	591,874	71,025	0.19
Total	-	11,931	379	-	-	1.30

1 Breeding season assessment is for breeding adults only.

2 Mortality is 5% in breeding season and 3% in non-breeding season.

Breeding Season

313. During the breeding season, the mean peak abundance for razorbill was 4,040 individuals within the Proposed Development array area and 2 km buffer. When considering the Developer Approach displacement rate of 50% in the Proposed Development array area and 2 km buffer, this would affect an estimated 2,020 birds (Table 11.35). However, this estimate includes non-breeding adults and immature birds, as well as breeding adults.

314. 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 proportions from the stable age structure calculated from the population models from which PVAs were produced (Table 11.38) (volume 3, appendix 11.6).

Table 11.38: PVA Stable Age Structure for Razorbills

SPA	Immature	Adult
Forth Islands SPA	0.461	0.539
St. Abb's Head to Fast Castle SPA	0.499	0.501
Fowlsheugh SPA	0.420	0.580
Flamborough and Filey Coast SPA	0.484	0.516
Average	0.466	0.534

315. Based on the proportion of immature razorbills from the stable age structure, 46.6% of the population present are immature birds (Table 11.38). This would mean that an estimated 941 razorbills displaced from the Proposed Development array area and 2 km buffer during the breeding season would be immature birds, with 1,079 adult birds also displaced.

316. Applying the Developer Approach mortality rate of 1%, it was calculated that the predicted theoretical additional mortality due to displacement effects was 21 razorbills (11 adults and ten immature birds) in the breeding season. However, a proportion of adult birds present at colonies in the breeding season will opt not to breed in a particular breeding season. It has been estimated that 7% of adult razorbills may be "sabbatical" birds in any particular breeding season (volume 3, appendix 11.6), and this has been applied for this assessment. On this basis, one adult razorbill was considered to be not breeding and so ten adult breeding razorbills were taken forward for the breeding season assessment.

317. The total razorbill regional baseline breeding population is estimated to be 84,501 individuals (Table 11.9). The adult baseline survival rate for razorbill is estimated to be 0.910 (Table 11.21), which means that the corresponding rate for adult mortality is 0.09. Applying this mortality rate, the estimated regional baseline mortality of adult razorbills is 7,605 birds per breeding season. The additional predicted mortality of ten breeding adult razorbills would increase the baseline mortality rate by 0.13% (Table 11.35).

318. When considering the Scoping Approach displacement rate of 60% in the Proposed Development array area and 2 km buffer, this would affect an estimated 2,425 birds. Assuming that 46.6% of the population present are immature birds (Table 11.38), then this would mean that an estimated 1,130 razorbills displaced from the Proposed Development array area and 2 km buffer during the breeding season would be immature birds, with 1,295 adult birds also displaced.

319. Applying the Scoping Approach A mortality rate of 3% for the breeding season, it was calculated that the predicted theoretical additional mortality due to displacement effects was 73 razorbills (39 adults and 34 immature birds) in the breeding season. As above, a sabbatical rate of 7% for non-breeding adult razorbills (volume 3, appendix 11.6) has been applied for this assessment. This resulted in three adult razorbills being considered to be not breeding and so 36 adult breeding razorbills were taken forward for the breeding season assessment.

320. Applying a mortality rate for adult razorbills of 0.09, the estimated regional baseline mortality of razorbills is 7,605 adult breeding birds per breeding season. The additional predicted mortality of 36 breeding adult razorbills would increase the baseline mortality rate by 0.47% (Table 11.36).

321. Applying the Scoping Approach B mortality rate of 5% for the breeding season, it was calculated that the predicted theoretical additional mortality due to displacement effects was 122 razorbills (65 adults and 57 immature birds) in the breeding season. However, a proportion of adult birds present at colonies in the breeding season will opt not to breed in a particular breeding season. Applying a proportion of 7% for "sabbatical" adult razorbills (volume 3, appendix 11.6), resulted in five adult razorbills being considered to be not breeding and so 60 adult breeding razorbills were taken forward for the breeding season assessment.

322. Applying a mortality rate for adult razorbills of 0.09, the estimated regional baseline mortality of razorbills is 7,605 adult breeding birds per breeding season. The additional predicted mortality of 60 breeding adult razorbills would increase the baseline mortality rate by 0.79% (Table 11.37).

<u>Non-breeding Season – Autumn Migration Period</u>

323. For the autumn migration period of the non-breeding season, the mean peak abundance for razorbill was 8,849 individuals within the Proposed Development array area and 2 km buffer. When considering the Developer Approach displacement rate of 50% in the Proposed Development array area and 2 km buffer, this would affect an estimated 4,424 birds (Table 11.35).

324. Based on the proportion of immature razorbills from the stable age structure, 46.6% of the population present in the autumn migration period are immature birds (Table 11.38). This would mean that an estimated 2,062 razorbills displaced from the Proposed Development array area and 2 km buffer during the autumn migration period would be immature birds, with 2,362 adult birds also displaced.

325. Applying the Developer Approach mortality rate of 1%, it was calculated that the predicted theoretical additional mortality due to displacement effects was 44 razorbills (23 adults and 21 immature birds) in the autumn migration period. Based on Furness (2015), the total razorbill BDMPS regional baseline population for the autumn migration period is estimated to be 591,874 individuals (Table 11.9). Using the average baseline mortality rate of 0.12 (Table 11.21), the estimated regional baseline mortality of razorbills is 71,025 birds in the autumn migration period of the non-breeding season. The additional predicted mortality of 44 razorbills would increase the baseline mortality rate by 0.062% (Table 11.35).

326. When considering the Scoping Approach displacement rate of 60% in the Proposed Development array area and 2 km buffer, this would affect an estimated 5,309 birds (Table 11.36 and Table 11.37). Assuming that 46.6% of the population present are immature birds (Table 11.38), then this would mean that an estimated 2,474 razorbills displaced from the Proposed Development array area and 2 km buffer during the autumn migration period of the non-breeding season would be immature birds, with 2,835 adult birds also displaced.

327. Applying the Scoping Approach A mortality rate of 1% in the non-breeding season, it was calculated that the predicted theoretical additional mortality due to displacement effects was 53 razorbills (28 adults and 25 immature birds) in the autumn migration period. The additional predicted mortality of 53 razorbills would increase the baseline mortality rate by 0.075% (Table 11.36).

328. Applying the Scoping Approach B mortality rate of 3% in the non-breeding season, it was calculated that the predicted theoretical additional mortality due to displacement effects was 159 razorbills (85 adults and 74 immature birds) in the autumn migration period. The additional predicted mortality of 159 razorbills would increase the baseline mortality rate by 0.224% (Table 11.37).

<u>Non-breeding Season – Winter Period</u>

329. For the winter period of the non-breeding season, the mean peak abundance for razorbill was 1,399 individuals within the Proposed Development array area and 2 km buffer. When considering the Developer Approach displacement rate of 50% in the Proposed Development array area and 2 km buffer, this would affect an estimated 700 birds (Table 11.35).

330. Based on the proportion of immature razorbills from the stable age structure, 46.6% of the population present in the winter period are immature birds (Table 11.38). This would mean that an estimated 326 razorbills displaced from the Proposed Development array area and 2 km buffer during the winter period would be immature birds, with 374 adult birds also displaced.

331. Applying the Developer Approach mortality rate of 1%, it was calculated that the predicted theoretical additional mortality due to displacement effects was seven razorbills (four adults and three immature birds) in the winter period. Based on Furness (2015), the total razorbill BDMPS regional baseline population for the winter period is estimated to be 218,622 individuals (Table 11.9). Using the average baseline mortality rate of 0.12 (Table 11.21), the estimated regional baseline mortality of razorbills is 26,235 birds in the winter period. The additional predicted mortality of seven razorbills would increase the baseline mortality rate by 0.027%.

332. When considering the Scoping Approach displacement rate of 60% in the Proposed Development array area and 2 km buffer, this would affect an estimated 839 birds (Table 11.36 and Table 11.37). Assuming that 46.6% of the population present are immature birds (Table 11.38), then this would mean that an estimated 391 razorbills displaced from the Proposed Development array area and 2 km buffer during the winter period of the non-breeding season would be immature birds, with 448 adult birds also displaced.

333. Applying the Scoping Approach A mortality rate of 1% in the non-breeding season, it was calculated that the predicted theoretical additional mortality due to displacement effects was eight razorbills (four adults and four immature birds) in the winter period. The additional predicted mortality of eight razorbills would increase the baseline mortality rate by 0.03% (Table 11.36).

334. Applying the Scoping Approach B mortality rate of 3% in the non-breeding season, it was calculated that the predicted theoretical additional mortality due to displacement effects was 25 razorbills (13 adults and 12 immature birds) in the winter period. The additional predicted mortality of 25 razorbills would increase the baseline mortality rate by 0.095% (Table 11.37).

Non-breeding Season – Spring Migration Period

335. For the spring migration period of the non-breeding season, the mean peak abundance for razorbill was 7,480 individuals within the Proposed Development array area and 2 km buffer. When considering the Developer Approach displacement rate of 50% in the Proposed Development array area and 2 km buffer, this would affect an estimated 3,740 birds (Table 11.35).

336. Based on the proportion of immature razorbills from the stable age structure, 46.6% of the population present in the spring migration period are immature birds (Table 11.38). This would mean that an estimated 1,743 razorbills displaced from the Proposed Development array area and 2 km buffer during the spring migration period would be immature birds, with 1,997 adult birds also displaced.

337. Applying the Developer Approach mortality rate of 1%, it was calculated that the predicted theoretical additional mortality due to displacement effects was 37 razorbills (20 adults and 17 immature birds) in the spring migration period. Based on Furness (2015), the total razorbill BDMPS regional baseline population for the spring migration period is estimated to be 591,874 individuals (Table 11.9). Using the average baseline mortality rate of 0.12 (Table 11.21), the estimated regional baseline mortality of razorbills is 71,025 birds in the spring migration period. The additional predicted mortality of 37 razorbills would increase the baseline mortality rate by 0.052% (Table 11.35).

338. When considering the Scoping Approach displacement rate of 60% in the Proposed Development array area and 2 km buffer, this would affect an estimated 4,488 birds (Table 11.36 and Table 11.37). Assuming that 46.6% of the population present are immature birds (Table 11.38), then this would mean that an estimated 2,091 razorbills displaced from the Proposed Development array area and 2 km buffer during the spring migration period of the non-breeding season would be immature birds, with 2,397 adult birds also displaced.

339. Applying the Scoping Approach A mortality rate of 1%, it was calculated that the predicted theoretical additional mortality due to displacement effects was 45 razorbills (24 adults and 21 immature birds) in the spring migration period. The additional predicted mortality of 45 razorbills would increase the baseline mortality rate by 0.063% (Table 11.36).

340. Applying the Scoping Approach B mortality rate of 3%, it was calculated that the predicted theoretical additional mortality due to displacement effects was 135 razorbills (72 adults and 63 immature birds) in the spring migration period. The additional predicted mortality of 135 razorbills would increase the baseline mortality rate by 0.19% (Table 11.37).

Assessment of Displacement Mortality throughout the Year

341. Predicted razorbill mortality as a result of displacement in the Proposed Development array area and 2 km buffer for all bio-seasons as calculated above, was summed for the whole year.

342. Based on the Developer Approach displacement rate of 50% and mortality rate of 1%, the predicted theoretical additional annual mortality due to displacement effects is an estimated 98 razorbills each year. This corresponds to an increase in the baseline mortality rate of 0.27% (Table 11.35).

343. Applying the Scoping Approach A displacement rate of 60% and mortality rates of 3% in the breeding season and 1% in the non-breeding season, the predicted theoretical additional annual mortality due to displacement effects is an estimated 142 razorbills each year. This corresponds to an increase in the baseline mortality rate of 0.64% (Table 11.36).

344. Applying the Scoping Approach B displacement rate of 60% and mortality rates of 5% in the breeding season and 3% in the non-breeding season, the predicted theoretical additional annual mortality due to displacement effects is an estimated 379 razorbills each year. This corresponds to an increase in the baseline mortality rate of 1.30% (Table 11.37).

345. These displacement mortality estimates suggest a potential significant increase in the baseline mortality rate for razorbill for Scoping Approach B therefore PVA analysis was conducted on the razorbill regional SPA population.

Summary of PVA Assessment

346. PVA has been carried out for razorbill considering a wide range of displacement and mortality rates. The results of the PVAs for predicted displacement impacts for the Project alone during the operational phase for the razorbill regional SPA population for the 35-year projection is summarised in Table 11.39. Further details of the PVA methodology, input parameters and an explanation of how to interpret the PVA results can be found in volume 3, appendix 11.6.

Table 11.39: **Summary of PVA Displacement outputs for Razorbill for the Proposed Development array area plus 2 km buffer after 35 years**

Scenario and Start Population 113,842 adults[1]	Unimpacted Median Population Size	Impacted Median Population Size	Counterfactual of Population Growth Rate - Median	Counterfactual Population Size - Median	Unimpacted Centile at Impacted 50th Centile - Median
Project Alone: Developer Approach	366,241	363,643	1.000	0.997	48.6
Project Alone: Scoping Approach A	366,241	360,039	1.000	0.982	46.4
Project Alone: Scoping Approach B	366,241	355,002	0.999	0.966	43.7

1 Starting population taken from volume 3, appendix 11.6.

Developer Approach = 50% displacement and 1% mortality throughout year.

Scoping Approach A = 60% displacement and 3% displacement mortality in breeding season; 1% displacement mortality in non-breeding season.

Scoping Approach B = 60% displacement and 5% displacement mortality in breeding season; 3% displacement mortality in non-breeding season.

347. For both the with and without Project scenarios, the razorbill regional SPA population is predicted to increase over the 35-year period. For the Developer Approach, the end population size with Project scenario was very slightly lower than the without Project scenario. There was no predicted difference in the counterfactual of the population growth rate, and the counterfactual of the population size was also very close to 1.000, while the 50th Centile value was close to 50. These values indicate that the PVA did not predict a significant negative effect from the project alone effects of displacement mortality from the Developer Approach on the razorbill regional SPA population after 35 years.

348. For Scoping Approach A, the end population size with Project scenario was slightly lower than the without Project scenario. There was no predicted difference in the counterfactual of the population growth rate, and the counterfactual of the population size was also close to 1.000, while the 50th Centile value was close to 50. These values indicate that the PVA did not predict a significant negative effect from the project alone effects of displacement mortality from Scoping Approach A on the razorbill regional SPA population after 35 years.

349. For Scoping Approach B, the end population size with Project scenario was slightly lower than the without Project scenario. There was a very slight predicted difference in the counterfactual of the population growth rate, and the counterfactual of the population size was also close to 1.000, while the 50th Centile value was also close to 50. These values indicate that the PVA did not predict a significant negative effect from the project alone effects of displacement mortality from Scoping Approach B on the razorbill regional SPA population after 35 years.

350. Based on the results from the displacement assessment and the regional PVA for the Developer Approach and Scoping Approach A, the magnitude of impact on the regional razorbill population is negligible.

351. Based on the results from the displacement assessment and the regional PVA for Scoping Approach B, the magnitude of impact on the regional razorbill population is low.

Sensitivity of the Receptor

352. For this assessment, receptor sensitivity has been based on three reviews of evidence from post-construction studies at offshore wind farms. A review of post-construction studies of seabirds at offshore wind farms in European waters concluded that there was evidence that razorbill was one of the species which showed a weak avoidance of offshore wind farms (Dierschke et al., 2016).

353. A review of vulnerability of Scottish seabirds to offshore wind turbines in the context of disturbance and displacement ranked razorbill with a score of three, where five was the most vulnerable score and one was the least vulnerable (Furness and Wade, 2012). A subsequent review ranked razorbill with a score of 14, where the highest score was 32 (Furness et al., 2013). Bradbury et al., (2014), classified the razorbill population vulnerability to displacement from offshore wind farms as moderate. Further evidence of the degree of displacement from operational offshore wind farms on razorbills is presented in volume 3, appendix 11.4.

354. On the basis of the evidence from reviews presented above and from post-construction studies summarised in volume 3, appendix 4, razorbill sensitivity to operational offshore wind farms is considered to be medium (Table 11.16).

355. Estimated numbers of razorbills recorded within the Proposed Development array area would qualify as nationally important in the breeding season (See volume 3, appendix 11.1, annex K), with individuals likely originating from a number of SPAs and non-SPAs in the region. On this basis, the conservation importance for razorbill was considered to be medium.

Significance of the Effect

356. For displacement effects on razorbill from the Project alone, for the Developer Approach, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms.

357. For Scoping Approach A, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms.

358. For Scoping Approach B, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

359. No offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **minor** adverse significance, which is not significant in EIA terms.

Puffin

360. For the Developer Approach displacement assessment, a displacement rate of 50% and a mortality rate of 1% was applied for the breeding season only, based on an evaluation of the published literature and in line with values used by other offshore wind farm displacement assessments.

361. There were two parts to the Scoping Approach displacement assessment and these are outlined below. For Scoping Approach A, a displacement rate of 60% and a mortality rate of 3% was applied for the

breeding season only. For Scoping Approach B, a displacement rate of 60% and a mortality rate of 5% was applied for the breeding season only.

362. For both the Developer Approach and the Scoping Approaches, there was no requirement to assess puffin displacement in the non-breeding season, as per advice in the Scoping Opinion.

363. Further details of differences between the Developer Approach and the Scoping Approach for the displacement assessment are presented in volume 3, appendix 11.4.

Magnitude of Impact

364. In the breeding season, peak estimates of puffins in the Proposed Development array area and 2 km buffer were recorded in April 2019 (6,280 birds) and August 2020 (2,745 birds). The MSP for the breeding season was therefore 4,513 birds (see volume 3, appendix 11.4).

365. A complete range of displacement matrices for the Proposed Development, the Proposed Development array area and 2 km buffer in the breeding season for both the Developer Approach and the Scoping Approaches are presented in volume 3, appendix 11.4.

366. For the Developer Approach, estimated puffin mortality from displacement in the breeding season in the Proposed Development array area and 2 km buffer is presented in Table 11.40.

367. For the Scoping Approach, estimated puffin mortality from displacement in the breeding season Proposed Development array area and 2 km buffer is presented in Table 11.41 and Table 11.42. For both approaches, the impact of additional mortality due to wind farm effects has been assessed in terms of the change in the baseline mortality rate which could result. The overall baseline mortality rates were based on age-specific demographic rates and age class proportions from the PVA work as presented in Table 11.21. The potential magnitude of impact was estimated by calculating the increase in baseline mortality within each bio-season with respect to the regional populations.

368. For the breeding season assessments, the increase in baseline mortality was calculated based on the baseline adult survival rate presented in Table 11.21. For puffin, the adult baseline survival rate is estimated to be 0.901, therefore the corresponding rate for adult mortality is 0.09.

Table 11.40: Displacement Mortality Estimates for Puffin for the Proposed Development array area plus 2 km buffer in the Breeding Season for the Developer Approach

Bio-season	Peak mean Seasonal Abundance (Proposed Development Array Area and 2 km Buffer)	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population (Adults)	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Apr-mid Aug)[1]	4,513	1,122	10	237,542	23,517	0.043

1 Breeding season assessment is for breeding adults only.

2 Mortality is 1% in breeding season.

Table 11.41: Displacement Mortality Estimates for Puffin for the Proposed Development array area plus 2 km buffer in the Breeding Season for Scoping Approach A

Bio-season	Peak Mean Seasonal Abundance (Proposed Development Array Area and 2 km Buffer)	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population (Adults)	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Apr-mid Aug)[1]	4,513	1,346	38	233,550	23,121	0.16

1 Breeding season assessment is for breeding adults only.

2 Mortality is 3% in breeding season.

Table 11.42: Displacement Mortality Estimates for Puffin for the Proposed Development array area plus 2 km buffer in the Breeding Season for Scoping Approach B

Bio-season	Peak Mean Seasonal Abundance (Proposed Development Array Area and 2 km Buffer)	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population (Adults)	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Apr-mid Aug)[1]	4,513	1,346	63	233,550	23,1212	0.27

1 Breeding season assessment is for breeding adults only.

2 Mortality is 5% in breeding season.

Breeding Season

369. During the breeding season, the mean peak abundance for puffin was 4,513 individuals within the Proposed Development array area and 2 km buffer. When considering the Developer Approach displacement rate of 50% in the Proposed Development array area and 2 km buffer, this would affect an estimated 2,257 birds (Table 11.40). However, this estimate includes non-breeding adults and immature birds, as well as breeding adults.

370. 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 proportions from the stable age structure calculated from the population models from which PVAs were produced (Table 11.43) (volume 3, appendix 11.6).

Table 11.43: PVA Stable Age Structure for Puffins

SPA	Immature	Adult
Forth Islands SPA	0.523	0.477
Farne Islands SPA	0.557	0.443
North Caithness Cliffs SPA	0.429	0.571
Average	0.503	0.497

371. Based on the proportion of immature puffins from the stable age structure, 50.3% of the population present are immature birds (Table 11.43). This would mean that an estimated 1,135 puffins displaced from the Proposed Development array area and 2 km buffer during the breeding season would be immature birds, with 1,122 adult birds also displaced.

372. Applying the Developer Approach mortality rate of 1%, it was calculated that the predicted theoretical additional mortality due to displacement effects was 23 puffins (11 adults and 12 immature birds) in the breeding season. However, a proportion of adult birds present at colonies in the breeding season will opt not to breed in a particular breeding season. It has been estimated that 7% of adult puffins may be “sabbatical” birds in any particular breeding season (volume 3, appendix 11.6), and this has been applied for this assessment. On this basis, one adult puffin was considered to be not breeding and so ten adult breeding puffins were taken forward for the breeding season assessment.

373. The total puffin regional baseline breeding population is estimated to be 233,550 individuals (Table 11.9). The adult baseline survival rate for puffin is estimated to be 0.901 (Table 11.21), which means that the corresponding rate for adult mortality is 0.099. Applying this mortality rate, the estimated regional baseline mortality of puffins is 23,121 adult birds per breeding season. The additional predicted mortality of ten breeding adult puffins would increase the baseline mortality rate by 0.043% (Table 11.40).

374. When considering the Scoping Approach displacement rate of 60% in the Proposed Development array area and 2 km buffer, this would affect an estimated 2,708 birds (Table 11.41 and Table 11.42). However, this estimate includes non-breeding adults and immature birds, as well as breeding adults. Assuming that 50.3% of the population present are immature birds (Table 11.43), then this would mean that an estimated 1,362 puffins displaced from the Proposed Development array area and 2 km buffer during the breeding season would be immature birds, with 1,346 adult birds also displaced.

375. Applying the Scoping Approach A mortality rate of 3%, it was calculated that the predicted theoretical additional mortality due to displacement effects was 82 puffins (41 adults and 41 immature birds) in the breeding season. As above, a sabbatical rate of 7% for non-breeding adult puffins (volume 3, appendix 11.6) has been applied for this assessment. On this basis, three adult puffins were considered to be not breeding and so 38 adult breeding puffins were taken forward for the breeding season assessment.

376. Applying the adult mortality rate of 0.099, the estimated regional baseline mortality of puffins is 23,121 adult birds per breeding season. The additional predicted mortality of 38 breeding adult puffins would increase the baseline mortality rate by 0.16% (Table 11.41).

377. Applying the Scoping Approach B mortality rate of 5%, it was calculated that the predicted theoretical additional mortality due to displacement effects was 136 puffins (68 adults and 68 immature birds) in the breeding season. However, it has been estimated that 7% of adult puffins may be “sabbatical” non-breeding birds in any particular breeding season (volume 3, appendix 11.6), and this has been applied for this assessment. On this basis, five adult puffins were considered to be not breeding and so 63 adult breeding puffins were taken forward for the breeding season assessment.

378. Applying the adult mortality rate of 0.099, the estimated regional baseline mortality of puffins is 23,121 adult birds per breeding season. The additional predicted mortality of 63 breeding adult puffins would increase the baseline mortality rate by 0.27% (Table 11.42).

379. Although these displacement mortality estimates did not suggest a potential significant increase in the baseline mortality rate for puffin for the Developer or Scoping Approaches, PVA analysis was conducted on the puffin regional SPA population.

Summary of PVA Assessment

PVA has been carried out for puffin considering a wide range of displacement and mortality rates. The results of the PVAs for predicted displacement impacts for the Project alone during the operational phase for the puffin regional SPA population for the 35-year projection is summarised in Table 11.44. Further details of the PVA methodology, input parameters and an explanation of how to interpret the PVA results can be found in volume 3, appendix 11.6.

Table 11.44: Summary of PVA Displacement outputs for Puffin for the Proposed Development array area plus 2 km buffer after 35 years

Scenario and Start Population of 177,778 Adults[1]	Unimpacted Median Population Size	Impacted median population size	Counterfactual of Population Growth Rate - Median	Counterfactual Population Size - Median	Unimpacted Centile at Impacted 50th Centile - Median
Project Alone: Developer approach	756,984	752,063	1.000	0.995	49.1
Project Alone: Scoping approach A	756,984	749,107	1.000	0.996	48.7
Project Alone: Scoping approach B	756,984	748,853	1.000	0.988	48.7

1 Starting population taken from volume 3, appendix 11.6.
Developer Approach = 50% displacement and 1% mortality throughout year.
Scoping Approach A = 60% displacement and 3% displacement mortality in breeding season; 1% displacement mortality in non-breeding season.
Scoping Approach B = 60% displacement and 5% displacement mortality in breeding season; 3% displacement mortality in non-breeding season.

380. For both the with and without Project scenarios, the puffin regional SPA population is predicted to increase over the 35-year period. For the Developer Approach, the end population size with Project scenario was slightly lower than the without Project scenario. There was no predicted difference in the counterfactual of the population growth rate, and the counterfactual of the population size was also very close to 1.000, while the 50th Centile value was close to 50. These values indicate that the PVA did not predict a significant negative effect from the project alone effects of displacement mortality from the Developer Approach on the puffin regional SPA population after 35 years.

381. For Scoping Approach A, the end population size with Project scenario was lower than the without Project scenario. There was no predicted difference in the counterfactual of the population growth rate, and the counterfactual of the population size was also close to 1.000, while the 50th Centile value was close to 50. These values indicate that the PVA did not predict a significant negative effect from the project alone effects of displacement mortality from Scoping Approach A on the puffin regional SPA population after 35 years.

382. For Scoping Approach B, the end population size with Project scenario was lower than the without Project scenario. There was no predicted difference in the counterfactual of the population growth rate, and the counterfactual of the population size was also close to 1.000, while the 50th Centile value was also close to 50. These values indicate that the PVA did not predict a significant negative effect from the project alone effects of displacement mortality from Scoping Approach B on the puffin regional SPA population after 35 years.

383. Based on the results from the displacement assessment and the regional PVA for the Developer Approach and Scoping Approaches A and B, the magnitude of impact on the regional puffin population is considered to be negligible.

Sensitivity of the Receptor

384. Previous reviews of displacement effects concluded that results for guillemot and razorbill should also be applied for puffin (e.g. Dierschke et al. 2016 and APEM, 2022). A review of vulnerability of Scottish seabirds to offshore wind turbines in the context of disturbance and displacement ranked puffin with a score of two, where five was the most vulnerable score and one was the least vulnerable (Furness and Wade, 2012). A subsequent review ranked puffin with a score of ten, where the highest score was 32 (Furness et al., 2013). Bradbury et al., (2014), classified the puffin population vulnerability to displacement from offshore wind farms as low. Further evidence of the degree of displacement from operational offshore wind farms on puffins is presented in volume 3, appendix 11.4.

385. On the basis of the evidence from reviews presented above and from post-construction studies summarised in volume 3, appendix 4, puffin sensitivity to operational offshore wind farms is considered to be medium (Table 11.16).

386. Estimated numbers of puffins recorded within the Proposed Development array area would qualify as nationally important in the breeding season (see appendix 11.1, annex K), with individuals likely originating from a number of SPAs and non-SPAs in the region. On this basis the conservation importance for puffin was considered to be medium.

Significance of the Effect

387. For displacement effects on puffin from the Project alone, for the Developer Approach, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms.

388. For Scoping Approach A, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms.

389. For Scoping Approach B, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

390. No offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **minor** adverse significance, which is not significant in EIA terms.

COLLISION EFFECTS FROM WIND TURBINES DURING OPERATION PHASE

391. There is potential risk to birds from operating offshore wind farms arising from collision with wind turbines resulting in injury or fatality. This may occur when birds fly through an offshore wind farm whilst foraging for food, commuting between breeding colonies and foraging areas, or during migration.

392. Extensive CRM has been undertaken for the Proposed Development, with detailed methods and results presented in volume 3, appendix 11.3. The Proposed Development will comprise up to 307 wind turbines, with the final number of wind turbines dependent on the capacity of individual wind turbines used, and also environmental and engineering survey results. The PDE considers a range of wind turbines with parameters reflective of potential generating capacities, allowing for a degree of flexibility to account for any anticipated developments in wind turbine technology while still allowing the production of the MDS for the assessment of effects. Consent is therefore sought for the physical parameters of the wind turbines which form the basis of the MDS such as maximum tip height or rotor diameter, as presented in the PDE rather than actual installed capacity of the wind turbine.

393. The maximum design scenario, outlined in Table 11.13, describes the elements of the proposed project considered within this assessment. In all cases, the 14 MW x 307 wind turbines using the deterministic Band (2012) model resulted in the worst-case scenario. For all species, the number of collisions tended to decrease with increasing wind turbine size. Further details are presented in volume 3, appendix 11.3.

394. Operation and Maintenance Phase

395. Consultation Representations and Advice from MSS and NatureScot (4 February 2022) and discussions through the Ornithology Road Map process (volume 3, appendix 11.8), led to agreement that a CRM assessment was required for eight species:

- gannet;
- herring gull;
- lesser black-backed gull;
- kittiwake;
- little gull;
- common tern;
- Arctic tern; and
- great skua.

396. These eight species were selected based on their abundance within the Proposed Development, highlighted by the two years of baseline data (volume 3, appendix 11.1), and on evidence about their sensitivity to collision effects (Furness et al., 2013).

397. Two approaches to CRM were used:

- Deterministic offshore Band CRM (Band, 2012); and
- Stochastic CRM (sCRM) (Masden, 2015; McGregor *et al.,* 2018).

398. The deterministic Band model was used following the advice issued in the Scoping Opinion (4 February 2022) and provides the primary estimates for assessment of collision risk within the Proposed Development. The sCRM approach, which takes account of the variability around input parameters, was used only for comparative purposes, as agreed via the Ornithology Road Map process and following the Scoping Opinion advice.

399. Following the advice issued in the Scoping Opinion (4 February 2022), the Applicant determined to undertake a 'dual assessment' approach of the collision risk posed by the Proposed Development:

- The 'Scoping Approach'; and
- The 'Developer Approach'.

400. With respect to estimating collision risk, the Developer Approach is largely in accordance with the Scoping Opinion, as the two approaches differ only in their use of input monthly density estimates of flying birds of the assessed species within the Proposed Development. Justification for this difference is presented in volume 3, appendix 11.3.

401. The Scoping Approach is based on the Scoping Consultation responses from NatureScot and MSS which advised the use of monthly maximum density of relevant seabird species within the Proposed Development in the CRMs.

402. The Developer Approach follows the approach recommended in the industry guidance (Band, 2012) and as undertaken in all recent UK offshore wind farm assessments that the Applicant is aware of. This approach uses the mean of the two estimates of the density of flying birds within the Proposed Development for each month. The Applicant is unaware of any change to the evidence base to support a change from this approach, noting that in their advice for the revised designs of the Forth and Tay projects MSS stated that an approach of using the maximum monthly density values within the CRM "runs the very high risk of producing an estimated effect that is highly likely to be unreasonable and unrealistically high." (Marine Scotland, 2017a, Marine Scotland, 2017b).

403. The CRM assessments for the eight key species are presented below.

Collision assessment for migratory species

404. In order to assess potential collision risk for migratory water birds and seabirds on passage, Scoping Opinion advice was to assess these species with reference to site-specific survey results and the Marine Scotland commissioned update to the 2014 report on 'strategic assessment of collision risk of Scottish offshore wind farms to migrating birds' (WWT, 2014).

405. In the absence of the revised update, Scoping Opinion advice was to assess any SPA migratory waterbird species relevant to the Proposed Development which are not considered in the 2014 Report on a qualitative basis. As of August 2022, the updated report was not publicly available, therefore the collision assessment for migratory species was conducted based on the WWT (2014) report, with any SPA migratory waterbird species relevant to the Proposed Development which are not considered in the 2014 Report being assessed on a qualitative basis.

406. The collision assessment for migratory species is presented in paragraph 637 onwards.

Reference Populations

407. For each of the eight key species assessed for collision impacts during the operation phase, relevant reference populations were required for comparison with the number of birds considered likely to suffer mortality in the different bio-seasons across a year. For the breeding season assessment, the total number of breeding adults from all colonies within mean maximum foraging range + 1 S.D. were used, as estimated by Woodward et al., (2019) (Table 11.9).

408. Corresponding reference populations for the BDMPS bio-seasons that make up the non-breeding season were taken from Furness (2015) (Table 11.9).

Parameters used in CRM Assessment

Wind turbine parameters

409. Details of all wind turbine parameters used in the CRM are presented in volume 3, appendix 11.3.

Seabird Densities

410. Monthly densities of flying birds in the Proposed Development only (excluding the 16 km buffer of the Offshore Ornithology study area) were estimated using design-based strip transect methods from the HiDef digital aerial surveys conducted between March 2019 – April 2021. The estimates for all species were based on counts that had been apportioned for non-identified birds during the surveys. Further detail is provided in volume 3, appendix 11.1.

411. Estimates of mean (Developer Approach) and maximum (Scoping Approach) monthly densities and pooled standard deviations (the latter only required for sCRM) for flying birds only were used as input to the CRMs. Further details are presented in volume 3, appendix 11.3.

Seabird Biological Parameters

412. Discussions through the Ornithology Road Map process (Road Map Meeting 3 28 September 2021 and NatureScot advice 7 October 2021) were used to agree sources of seabird morphological and behavioural parameters (for example flight speed and wing span) to parameterise the CRMs. Body length, wingspan and flight speed measurements were sourced from Robinson (2005), Pennycuick (1997) and Alerstam *et al.* (2007). This information was not available for Arctic tern, so the morphological and behavioural parameters for common tern were used instead as the two species are very similar.

413. NatureScot provided advice for gannet based on an analysis of nocturnal activity of tagged birds which showed there to be very low levels of activity after dark (Furness *et al.,* 2018 and references therein). For herring, lesser black-backed and little gulls, Arctic and common terns and great skua, the nocturnal activity scores were taken from Garthe and Hüppop (2004). The nocturnal activity score for kittiwake was taken from the previously accepted Seagreen 1 EIA (Optimised Project Addendum 2018). All values used followed the Scoping Opinion and the agreement reached at the Ornithology Road Map 6 meeting (10t May 2022).

414. Flight type was set as flapping for all species except gannet, which was set to gliding following advice from NatureScot in their Scoping Consultation response (7 December 2021).

415. Further details on the biological parameters used for CRM are presented in volume 3, appendix 11.3.

Avoidance Rates

416. For the deterministic Band model, avoidance rates for all species were sourced from the SNCBs joint response on approved avoidance rates (SNCBs, 2014; Cook *et al.,* 2014) (Table 11.45). Use of SNCBs (2014) avoidance rates for the primary CRM assessment was advised in the Scoping Opinion (4 February 2022). In addition, an avoidance rate of 0.980 for gannet was also presented for context, following RSPB's consultation representation, as specified in the Scoping Opinion.

417. There are no SNCBs endorsed avoidance rates for kittiwake or gannet for the extended Band model (Option 3). Therefore, avoidance rates from Bowgen and Cook (2018) were used for comparison, noting that an avoidance rate for use in the extended model is not provided.

418. For the sCRM, avoidance rates for kittiwake, gannet, herring gull and lesser black-backed gull were taken from Bowgen and Cook (2018). SNCBs advice on their preferred avoidance rates for sCRM was not available, but agreement to use rates from Bowgen and Cook (2018) was obtained through the Ornithology Road Map process and confirmed in the Scoping Opinion (4 February 2022). Avoidance rates for sCRM

for common and Arctic terns, little gull and great skua were set at 0.980, which followed SNCB advice (SNCBs, 2014).

Table 11.45: Avoidance rates (± 2 SD) used for Deterministic Basic (Options 1 and 2) and Extended (Option 3) Band Model (2012) (SNCBs, 2014), and sCRM (with 95% Confidence Intervals) (Bowgen and Cook 2018)

Species	Band model (2012)[1]		sCRM model[2]	
	Basic	Extended	Basic	Extended
Kittiwake	0.989 (0.002)	N/A	0.994 (0.976 – 0.998)[1]	0.970 (0.871 – 0.989)
Herring gull	0.995 (0.001)	0.990 (0.002)	0.997 (0.992 – 0.999)	0.990 (0.974 – 0.995)
Lesser black-backed gull	0.995 (0.001)	0.989 (0.002)	0.997 (0.992 – 0.999)	0.990 (0.974 – 0.995)
Gannet	0.989 (0.002)	N/A	N/A	N/A

1 Values in brackets are ± Standard Deviation.

2 Values in brackets are 95% confidence limits.

419. It should be noted that the avoidance rate of 0.989 recommended for gannet by SNCBs (2014) does not account for macro-avoidance and so there is a case for incorporating an additional macro-avoidance rate for this species, which would reduce collision estimates substantially.

420. Further details on the avoidance rates used for CRM are presented in volume 3, appendix 11.3.

<u>Flight height</u>

421. It was agreed through the Ornithology Road Map process (RM4, 8 December 2021) that the CRM should utilise the generic modelled flight heights from Johnston *et al.* (2014a; 2014b) for the primary assessment (Band Option 2 and 3). These flight height data were collated from seabird surveys at 32 offshore wind farms in the UK and Europe. Most surveys were boat-based, with height measurements taken visually and assigned to height bands, to derive continuous flight height distributions for 25 seabird species. Further details on the flight heights used for CRM are presented in volume 3, appendix 11.3.

422. In addition, collision estimates for kittiwake based on site-specific boat-based flight heights from observer and rangefinder are presented in volume 3, appendix 11.3 annex B, for context. Compared to estimated annual number of collisions using the generic flight height data for kittiwake for the Developer Approach and the Scoping Approach, the results from using site-specific kittiwake flight heights from rangefinder and visual observer data were considerably lower. This illustrates that the CRM estimates for kittiwake based on the generic flight height data is likely to be precautionary, and this should be kept in mind when reviewing the below results.

Worst-Case Collision Estimates

423. Collision estimates for the worst-case design scenario (307x14 MW wind turbines) for the eight key species are presented in Table 11.46. Estimated collisions for the Developer Approach (mean densities) and Scoping Approach (maximum densities) are presented. Estimates are rounded to nearest whole bird, apart from for great skua, where very low annual collision numbers were estimated, considerably less than one bird.

424. Relevant avoidance rates used are shown, along with outputs using the sCRM model for comparison. For the sCRM outputs, the mortality estimates for the ‘equivalent’ maximum design scenario are provided, but the scenario is not entirely equivalent to the Band model maximum design due to the different avoidance rates used.

425. For the Developer Approach, results from the sCRM for kittiwake were considerably lower (-46%). Similarly, sCRM estimates were also lower for lesser black-backed gull (-33%) and herring gulls (-58%) unchanged for common tern, and higher for Arctic tern (+43%), little gull (+80%) and great skua (+83%). A similar pattern was also obtained when using the Scoping Approach. The results from the sCRM were lower for kittiwake, herring gull and lesser black-backed gull (-46%, -36%, -33% respectively). For other species, sCRM estimates were unchanged for common tern, and higher for Arctic tern (+36%), little gull (+64%) and great skua (+65%).

426. Due to its stochastic nature, estimates from the sCRM are not directly comparable with Band outputs because the output is a distribution rather than a single estimate of collisions. Recommended avoidance rates also differ between Band and sCRM methods. Further outputs are presented in volume 3, appendix 11.3 annex C.

Table 11.46: Worst-case estimates for each species identified from the deterministic Band CRM using the generic flight height data (Options 2 and 3) and SNCBs (2014) avoidance rates for the Developer Approach and Scoping Approach. Estimates are rounded to nearest whole bird

Species	CRM Option	Avoidance Rate	Estimated Annual Collisions (SNCBs Guidance)		sCRM Annual Collision (SD[1]; Bowgen and Cook)	
			Developer Approach	Scoping Approach	Developer Approach	Scoping Approach
Kittiwake	2	0.989	685	986	371 (38)	536 (34)
Herring gull	2	0.995	30	50	19(5)	32 (4)
Lesser black-backed gull	2	0.995	6	9	4 (2)	6 (2)
Gannet	2	0.989	153	191	N/A	N/A
Arctic tern	2	0.980	8	14	14 (15)	22 (20)
Common tern	2	0.980	6	9	6 (2)	9 (2)
Little gull	2	0.980	2	5	10 (28)	14 (36)
Great skua	2	0.980	0	0	1 (0)	1 (0)

1 Values in brackets show Standard Deviation for sCRM.

<u>PVA Approach</u>

427. For gannet and kittiwake, a regional PVA of combined predicted collision and displacement mortality was conducted for breeding colonies within multiple SPAs. For herring gull and lesser black-backed gull, a regional PVA of predicted collision mortality was conducted for breeding colonies within multiple SPAs. The species/ SPA combinations modelled were chosen using a threshold approach advised in the Scoping Opinion (MS-LOT, 2022) and confirmed through the Ornithology Roadmap process (Meeting 6, 10 May

2022). Further details of the SPA combinations and impact scenarios used are presented in volume 3, appendix 11.6.

428. For each of these species, results for the 35-year period are presented and discussed below.

429. It should be noted that for seven of the key seabird species considered here, the regional populations as defined in the breeding and non-breeding seasons in this chapter are different (i.e., they derive from a very different composition of source populations/colonies). The PVAs are relevant to the regional population as defined for the breeding season but not to that defined for the non-breeding season (with the exception of herring gull). The PVAs also account for effects on this regional breeding population during both breeding and non-breeding periods. However, overall, the results of the regional PVAs are considered indicative for assessment purposes.

430. The CRM assessments are presented for each species below.

Gannet

431. For the Developer Approach, annual estimated gannet mortality from collision impacts in the Proposed Development was based on mean densities of flying birds recorded on baseline digital aerial surveys. For the Scoping Approach, this was based on maximum densities of flying birds recorded on baseline digital aerial surveys.

432. A complete range of collision numbers for the Proposed Development, and the different design scenarios for both the Developer Approach and the Scoping Approach are presented in volume 3, appendix 11.3.

433. The estimated number of collisions per bio-season for gannet based on the Developer Approach and the Scoping Approach are presented in Table 11.47. Figures are presented for the breeding season and the autumn and spring migration periods of the non-breeding season, based on the maximum design scenario (307x14 1MW wind turbines). Highest numbers of collisions were predicted for the breeding season, for both approaches, with lower numbers of collisions predicted for the autumn and spring migration periods of the non-breeding season.

Table 11.47: Estimated Number of Collisions for Gannet by bio-season in the Proposed Development array area for the Worst-case Scenario (SNCBs avoidance rates, wind turbine 14 MW, Option 2) for the Developer Approach and Scoping Approach. Estimates are rounded to nearest whole bird.

	Breeding Season	Autumn Migration	Spring Migration	Total
Developer Approach	138	13	2	153
Scoping Approach	170	18	3	191

434. In addition, monthly estimated collisions based on an avoidance rate of 0.980 for the breeding season (mid-March to September) are presented in Table 11.48, for context, as requested in the Scoping Opinion. In both Developer and Scoping Approaches, peak collisions were estimated in the second half of the breeding season, between July and September.

Table 11.48: Estimated Collisions for Gannet in the Proposed Development array area based on Avoidance Rate of 0.980, wind turbine 14 MW, Option 2 and Generic Flight Height, in Breeding Season for the Developer Approach and Scoping Approach

	Mar	Apr	May	Jun	Jul	Aug	Sep	Breeding season total
Developer Approach								
	5.71*	16.67	24.50	38.02	67.10	42.05	60.43	251.62
Scoping Approach								
	6.58	22.23	31.24	39.85	68.24	56.22	87.48	308.55

*March collision estimates presented are for the entire month. Gannet breeding season is estimated to start in mid-March (NatureScot, 2020), therefore, only half of the collisions for the month of March were counted in the total breeding season collision estimates.

Magnitude of Impact

435. The overall baseline mortality rates were based on age-specific demographic rates and age class proportions as presented in Table 11.21. The potential magnitude of impact was estimated by calculating the increase in baseline mortality within each bio-season with respect to the regional populations.

Table 11.49: Estimated Collision Mortality for Gannet in the Proposed Development array area by bio-season in Relation to Baseline Mortality, for the Developer Approach

Bio-season	Estimated Seasonal Collision Mortality	Regional Baseline Population (Adults)	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Mid Mar-Sep)[1]	123	323,836	14,896	0.826
Autumn migration (Oct-Nov)	13	456,298	68,901	0.019
Spring migration (Dec-mid Mar)	2	248,385	37,506	0.005
Total	138	-	-	0.85

1 Breeding season assessment is for breeding adults only.

Table 11.50: Estimated Collision Mortality for Gannet in the Proposed Development array area by bio-season in Relation to Baseline Mortality, for the Scoping Approach

Bio-season	Estimated Seasonal Collision Mortality	Regional Baseline Population (Adults)	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Mid Mar-Sep)[1]	151	323,836	14,896	1.01

Bio-season	Estimated Seasonal Collision Mortality	Regional Baseline Population (Adults)	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Autumn migration (Oct-Nov)	18	456,298	68,901	0.026
Spring migration (Dec-mid Mar)	3	248,385	37,506	0.008
Total	172	-	-	1.04

1 Breeding season assessment is for breeding adults only.

Breeding Season

436. For the Developer Approach in the breeding season, the total estimated number of gannet collisions was 138 birds (Table 11.47). However, this includes non-breeding adults and immature birds, as well as breeding adults. Based on the proportion of immature gannets recorded on digital aerial baseline surveys in the breeding season, 1% of the population present in the breeding season are immature birds (Table 11.25). This would mean that 137 adult gannets and one immature bird are predicted to collide with wind turbines in the breeding season, based on the worst-case design scenario. However, a proportion of adult birds present at colonies in the breeding season will opt not to breed in a particular breeding season. It has been estimated that 10% of adult gannets may be "sabbatical" birds in any particular breeding season (volume 3, appendix 11.6), and this has been applied for this assessment. On this basis, 14 adult gannets were considered to be not breeding and so 123 adult breeding gannets were taken forward for the breeding season assessment.

437. The total gannet regional baseline breeding population is estimated to be 323,836 individuals (Table 11.9). The adult baseline survival rate is estimated to be 0.954 (Table 11.21), which means that the corresponding rate for adult mortality is 0.046. Applying this mortality rate, the estimated baseline mortality of gannets is 14,896 adult birds per breeding season. The additional predicted mortality of 123 breeding adult gannets would increase the baseline mortality rate by 0.826 (Table 11.49).

438. For the Scoping Approach in the breeding season, the total estimated number of gannet collisions was 170 birds (Table 11.47). However, this includes non-breeding adults and immature birds, as well as breeding adults. Assuming that 1% of the population present in the breeding season are immature birds (Table 11.25), then this would mean that 168 adult gannets and two immature birds are predicted to collide with wind turbines in the breeding season, based on the worst-case design scenario. However, it has been estimated that 10% of adult gannets may be "sabbatical" non-breeding birds in any particular breeding season (volume 3, appendix 11.6), and this has been applied for this assessment. On this basis, 17 adult gannets were considered to be not breeding and so 151 breeding adult gannets were taken forward for the breeding season assessment.

439. Applying the adult baseline mortality rate of 0.046, the estimated baseline mortality of gannets is 14,896 adult birds per breeding season. The additional predicted mortality of 151 breeding adult gannets would increase the baseline mortality rate by 1.01% (Table 11.50).

Non-breeding Season – Autumn Migration Period

440. For the Developer Approach in the autumn migration period, the total estimated number of gannet collisions was 13 birds (Table 11.49), however, this includes adult and immature birds. Based on information presented in Furness (2015), in the non-breeding season 45% of the population present are immature birds and 55% of birds are adults This would mean that seven adult gannets and six immature birds are predicted to collide with wind turbines, based on the worst-case design scenario.

441. Based on Furness (2015), the total gannet BDMPS regional baseline population for the autumn migration period is estimated to be 456,298 individuals (Table 11.9). Using the average baseline mortality rate of 0.151 (Table 11.21), the estimated regional baseline mortality of gannets is 68,901 birds in the autumn migration period. The additional predicted mortality of 13 gannets would increase the baseline mortality rate by 0.019% (Table 11.49).

442. For the Scoping Approach in the autumn migration period, the total estimated number of gannet collisions was 18 birds (Table 11.50), however, this includes adult and immature birds. Based on Furness (2015), in the non-breeding season 45% of the population present are immature birds and 55% of birds are adults. This would mean that ten adult gannets and eight immature birds are predicted to collide with wind turbines, based on the worst-case design scenario. The additional predicted mortality of 18 gannets would increase the baseline mortality rate by 0.026% (Table 11.50).

Non-breeding Season – Spring Migration Period

443. For the Developer Approach in the spring migration period, the total estimated number of gannet collisions was two birds (Table 11.49), however, this includes adult and immature birds. Based on Furness (2015), in the non-breeding season 45% of the population present are immature birds and 55% of birds are adults. This would mean that one adult and one immature gannets are predicted to collide with wind turbines, based on the worst-case design scenario.

444. Based on Furness (2015), the total gannet BDMPS regional baseline population for the spring migration period is estimated to be 248,385 individuals (Table 11.9). Using the average baseline mortality rate of 0.151 (Table 11.21), the estimated baseline mortality of gannets is 37,506 birds in the spring migration period. The additional predicted mortality of two gannets would increase the baseline mortality rate by 0.005% (Table 11.49).

445. For the Scoping Approach in the spring migration period, the total estimated number of gannet collisions was three birds (Table 11.49), however, this includes adult and immature birds. Based on Furness (2015), in the non-breeding season 45% of the population present are immature birds and 55% of birds are adults. This would mean that two adult and one immature gannets are predicted to collide with wind turbines, based on the worst-case design scenario. The additional predicted mortality of three gannets would increase the baseline mortality rate by 0.008% (Table 11.50).

Assessment of Collision Mortality throughout the Year

446. Predicted gannet mortality as a result of collision in the Proposed Development array area for all bio-seasons as calculated above, was summed for the whole year.

447. Using the Developer Approach, the predicted theoretical additional annual mortality due to collision was an estimated 138 gannets. This corresponds to an increase in the baseline mortality rate of 0.85% (Table 11.49).

448. Using the Scoping Approach, the predicted theoretical additional annual mortality due to collision was an estimated 172 gannets. This corresponds to an increase in the baseline mortality rate of 1.04% (Table 11.50).

449. For the Developer Approach, the estimated increase in the annual baseline mortality rate was below 1% and was therefore not considered to be significant in EIA terms.

450. For the Scoping Approach, the estimated increase in the annual baseline mortality rate was just over 1% and therefore were considered to be potentially significant in EIA terms. However, NS advice in the Scoping Opinion was that collision and displacement impacts should be considered as additive within the assessment for gannet, therefore these assessments have been combined.

Collision and Displacement Impacts Combined

451. Following NS advice in the Scoping Opinion results from the collision and displacement assessments were combined, using the annual predicted mortality totals for both the Developer Approach and the Scoping Approach (Table 11.51 and Table 11.52).

Table 11.51: Combined Annual Estimated Numbers of Collisions and Displacement Mortality for Gannet for the Developer Approach

Bio-season	Combined Estimated Mortality	Increase in Baseline Mortality (%)
Total Collisions	138	0.85
Total Displacement	44	0.23
Combined Total	182	1.08

Table 11.52: Combined Annual Estimated Numbers of Collisions and Displacement Mortality for Gannet for the Scoping Approach

Bio-season	Combined Estimated Mortality	Increase in Baseline Mortality (%)
Total Collisions	172	1.04
Total Displacement	44-127	0.23-0.66
Combined Total	216-299	1.27-1.70

452. Using the Developer Approach, the predicted theoretical additional annual mortality due to collision and displacement was a combined total of 182 gannets. This corresponds to an increase in the baseline mortality rate of 1.08% (Table 11.51).

453. Using the Scoping Approach, the predicted theoretical additional annual mortality due to collision and displacement was a combined total of between 216 and 299 gannets. This corresponds to an increase in the baseline mortality rate of between 1.27% and 1.70% (Table 11.52).

454. It should be noted that this approach is considered highly precautionary. As highlighted by NS in the NnG Scoping Opinion (Marine Scotland, 2017a), collision risk and displacement are considered to be mutually exclusive impacts, and therefore combining mortality estimates for displacement and collision should be considered extremely precautionary.

455. These combined collision and displacement mortality estimates suggest a potential significant increase in the baseline mortality rate for gannet for both the Developer Approach and the Scoping Approach, therefore PVA analysis was conducted on the gannet regional SPA population.

Summary of Regional PVA Assessment

456. PVA has been carried out on the regional gannet SPA population considering a wide range of displacement and mortality rates and also a range of collision scenarios. The results of the regional PVAs for predicted displacement and collision impacts for the Project alone during the operation phase for the gannet regional SPA population for the 35 year projection is summarised in Table 11.53. Further details of the PVA methodology, input parameters and an explanation of how to interpret the PVA results can be found in volume 3, appendix 11.6.

Table 11.53: Summary of PVA Displacement and Collision Outputs for Gannet for the Proposed Development array area plus 2 km buffer after 35 years

Scenario and Start Population 288,394 Adults[1]	Unimpacted Median Population Size	Impacted Median Population Size	Counterfactual of Population Growth Rate - Median	Counterfactual Population Size - Median	Unimpacted Centile at Impacted 50th Centile - Median
Project Alone: Developer approach	1,986,443	1,964,645	1.000	0.987	47.2
Project Alone: Scoping approach A	1,986,443	1,960,712	1.000	0.984	46.6
Project Alone: Scoping approach B	1,986,443	1,948,624	0.999	0.980	45.2

1 Starting population taken from volume 3, appendix 11.6.

Developer Approach = 70% displacement and 1% mortality throughout year and mean monthly density for CRM.

Scoping Approach A = 70% displacement; 1% displacement mortality throughout year and maximum monthly density for CRM.

Scoping Approach B = 70% displacement; 3% displacement mortality throughout year and maximum monthly density for CRM.

457. For both the with and without Project scenarios, the gannet regional SPA population is predicted to increase over the 35-year period. For the Developer Approach, the end population size with Project scenario was slightly lower than the without Project scenario. There was no predicted difference in the counterfactual of the population growth rate, and the counterfactual of the population size was also very close to 1.000, while the 50th Centile value was close to 50. These values indicate that the PVA did not predict a significant negative effect from the project alone effects of displacement mortality and collision mortality from the Developer Approach on the gannet regional SPA population after 35 years.

458. For Scoping Approach A, the end population size with Project scenario was lower than the without Project scenario. There was no difference in the counterfactual of the population growth rate, and the counterfactual of the population size was also close to 1.000, while the 50th Centile value was close to 50. These values indicate that the PVA did not predict a significant negative effect from the project alone effects of displacement mortality and collision mortality from Scoping Approach A on the puffin regional SPA population after 35 years.

459. For Scoping Approach B, the end population size with Project scenario was lower than the without Project scenario. There was a very slight predicted difference in the counterfactual of the population growth rate, and the counterfactual of the population size was also close to 1.000, while the 50th Centile value was also close to 50. These values indicate that the PVA did not predict a significant negative effect from the project alone effects of displacement mortality and collision mortality from Scoping Approach B on the gannet regional SPA population after 35 years.

460. Based on the results from the displacement and CRM assessments and the combined regional PVA for the Developer Approach and Scoping Approaches A and B, the magnitude of impact on the regional gannet population is considered to be low.

Sensitivity of the Receptor

461. For gannet, there is evidence that gannets show a high degree of avoidance of offshore wind farms. A detailed study (Krijgsveld et al., 2011) using radar and visual observations to monitor the post-construction effects of the Windpark Egmond aan Zee OWEZ established that 64% of gannets avoided entering the wind farm (macro-avoidance) and a similar result (80% macro avoidance) was also observed during a study at the Thanet wind farm (Skov et al., 2018). Leopold et al. (2013) reported that most gannets avoided Dutch offshore wind farms and did not forage within these. Dierschke et al. (2016) concluded that gannets strongly or nearly completely avoid offshore wind farms.

462. In addition, the Year 1 post-construction study report for Beatrice offshore wind farm reported that gannet showed a marked difference in distribution within the wind farm on post-construction surveys than on pre-construction surveys, with only two birds recorded within the wind farm boundary across all post-construction six surveys undertaken in Year 1. Spatial modelling indicated a significant decrease centred on the wind farm and extending towards the coast with no areas of significant increase. Beyond the region of decrease, the density in the remainder of the survey area was almost identical when comparing pre-and post-construction data (MacArthur Green, 2021).

463. Gannet sensitivity to displacement is discussed in paragraph 209 onwards. Based on evidence from other operational offshore wind farms and a review of gannet GPS tracking data from the Bass Rock, it is considered that the majority of adult gannets passing through the Proposed Development are in transit rather than actively foraging. In addition, the home range of birds breeding on the Bass Rock is very large, in relation to the size of the Proposed Development, while gannets are also known to feed on a wide range of prey species.

464. Based on evidence from post-construction studies, it is considered that collision impacts as estimated for the CRM assessment for gannet are likely to be over-estimates, as it is highly likely that the majority of gannets will avoid the Proposed Development. The first year of post-construction monitoring at Beatrice Offshore Wind Farm recorded virtually no gannets within the wind farm, and concluded that the current collision avoidance rate of 98.9% used in CRM may well be an underestimate of the level of avoidance this species performs (MacArthur Green, 2021).

465. On the basis of these results, which highlight the high degree of avoidance of wind turbines, gannet sensitivity to collision and displacement impacts from operational offshore wind farms is considered to be medium (Table 11.16).

466. In addition, estimated numbers of gannets recorded within the Proposed Development would qualify as nationally important in the breeding season (See volume 3, appendix 11.1, annex G), with individuals likely originating from a number of SPAs in the region. On this basis the conservation importance for gannet was considered to be medium.

Significance of the Effect

467. For combined displacement and collision effects on gannet from the Project alone, for the Developer Approach, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

468. For Scoping Approach A, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

469. For Scoping Approach B, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

470. No offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **minor** adverse significance, which is not significant in EIA terms.

Herring Gull

471. For the Developer Approach, annual estimated herring gull mortality from collision impacts in the Proposed Development was based on mean densities of flying birds recorded on baseline digital aerial surveys. For the Scoping Approach, this was based on maximum densities of flying birds recorded on baseline digital aerial surveys.

472. For assessment purposes, the breeding season for herring gull has been defined as April to August (NatureScot, 2020). The corresponding non-breeding season for herring gull was based on Furness (2015) but adjusted for overlaps with the previously defined NatureScot breeding season definition, and therefore covered September to March for this species.

473. The estimated number of collisions per bio-season for herring gull based on the Developer Approach and the Scoping Approach are presented in Table 11.54. Figures are presented for the breeding and non-breeding seasons, based on the worst-case design scenario (307x14 MW wind turbines). For both approaches, highest numbers of collisions were predicted for the breeding season, with lower numbers of collisions predicted for the non-breeding season.

474. A complete range of collision numbers for the Proposed Development, and the different design scenarios for both the Developer Approach and the Scoping Approach are presented in volume 3, appendix 11.3.

Table 11.54: Estimated Number of Collisions for Herring Gull by Bio-season in the Proposed Development for the Worst-Case Scenario (SNCBs avoidance rates, wind turbine 14 MW, Option 2) for the Developer Approach and Scoping Approach. Estimates are rounded to nearest whole bird.

	Breeding Season	Non-breeding Season	Total
Developer Approach	26	4	30
Scoping Approach	43	7	50

Magnitude of Impact

475. The overall baseline mortality rates were based on age-specific demographic rates and age class proportions as presented in Table 11.21. The potential magnitude of impact was estimated by calculating the increase in baseline mortality within each bio-season with respect to the regional populations.

Table 11.55: Estimated Numbers of Collisions for Herring Gull in the Proposed Development array area by Bio-season in Relation to Baseline Mortality, for the Developer Approach

Bio-season	Estimated Seasonal Collision Mortality	Regional Baseline Population (Adults)	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Apr-Aug)[1]	16	29,600	3,611	0.44
Non-breeding (Sep-Mar)	4	49,432	6,970	0.06
Total	20	-	-	0.50

1 Breeding season assessment is for breeding adults only.

Table 11.56: Estimated Numbers of Collisions for Herring Gull in the Proposed Development array area by Bio-season in Relation to Baseline Mortality, for the Scoping Approach

Bio-season	Estimated Seasonal Collision Mortality	Regional Baseline Population (Adults)	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Apr-Aug)[1]	26	29,600	3,611	0.72
Non-breeding (Sep-Mar)	7	49,432	6,970	0.10
Total	33	-	-	0.82

1 Breeding season assessment is for breeding adults only.

Breeding Season

476. For the Developer Approach in the breeding season, the total estimated number of herring gull collisions was 26 birds (Table 11.54). However, this includes non-breeding adults and immature birds, as well as breeding adults. Based on the proportion of immature herring gulls recorded on digital aerial baseline surveys in the breeding season, 8% of the population present in the breeding season are immature birds (Table 11.57).

Table 11.57: Proportions of juvenile, immature and adult Herring Gulls recorded on Digital Aerial Surveys

Season	Juvenile	Immature	Adult
Breeding (Apr-Aug)	0.01	0.07	0.92
Non-breeding (Sep-Mar)	0.02	0.32	0.66

477. This would mean that 24 adult herring gulls and two immature birds are predicted to collide with wind turbines in the breeding season, based on the worst-case design scenario. However, a proportion of adult birds present at colonies in the breeding season will opt not to breed in a particular breeding season. It has been estimated that 35% of adult herring gulls may be "sabbatical" birds in any particular breeding season (volume 3, appendix 11.6), and this has been applied for this assessment. On this basis, eight adult herring gulls were considered to be not breeding and so 16 breeding adult herring gulls were taken forward for the breeding season assessment.

478. The total herring gull regional baseline breeding population is estimated to be 29,600 individuals (Table 11.9). However, it should be noted that this figure is considered likely to be an under-estimate due to limited surveys of urban gull colonies, which have increased in the region in recent years (Welch, 2019a). A larger regional population would result in a corresponding larger figure for the estimated regional baseline mortality figure, and therefore a lower predicted increase in additional mortality, and this should be borne in mind for this assessment.

479. The adult baseline survival rate is estimated to be 0.878 (Table 11.21), which means that the corresponding rate for adult mortality is 0.122. Applying this mortality rate, the estimated regional baseline mortality of herring gulls is 3,611 adult birds per breeding season. The additional predicted mortality of 16 breeding adult herring gulls would increase the baseline mortality rate by 0.44% (Table 11.55).

480. For the Scoping Approach in the breeding season, the total estimated number of herring gull collisions was 43 birds (Table 11.54). However, this includes non-breeding adults and immature birds, as well as breeding adults. Based on the proportion of immature herring gulls recorded on digital aerial baseline surveys in the breeding season, 8% of the population present in the breeding season are immature birds (Table 11.57). This would mean that 40 adult herring gulls and three immature birds are predicted to collide with wind turbines in the breeding season, based on the worst-case design scenario.

481. As above, a sabbatical rate of 35% for non-breeding adult herring gulls (volume 3, appendix 11.6) has been applied for this assessment. On this basis, 14 adult herring gulls were considered to be not breeding and so 26 breeding adult herring gulls were taken forward for the breeding season assessment.

482. Applying the adult baseline mortality rate of 0.122, the estimated baseline mortality of herring gulls is 3,611 adult birds per breeding season. The additional predicted mortality of 26 breeding adult herring gulls would increase the baseline mortality rate by 0.72% (Table 11.56).

Non-breeding Season

483. For the Developer Approach in the non-breeding season, the total estimated number of herring gull collisions was four birds (Table 11.55, however, this includes adult and immature birds. Based on information presented in Furness (2015), in the non-breeding season 52% of the population present are immature birds and 48% of birds are adults. This would mean that two adult and two immature herring gulls are predicted to collide with wind turbines in the non-breeding season, based on the worst-case design scenario.

484. Scoping Opinion advice for herring gulls was to use the regional breeding population within mean maximum foraging range +1S.D (29,600 birds). as the reference population for the non-breeding season. However, a correction factor was required to account for the influx of continental breeding birds into eastern Scotland/UK in the non-breeding season. At the road map meetings, MSS advised (volume 3, appendix 11.8) that this correction factor should be calculated from the proportions of overseas and western UK birds in the UK North Sea and Channel BDMPS (Furness 2015). This correction factor was calculated to be 0.67 (volume 3, appendix 11.5), which results in an additional 19,832 herring gulls as the estimated influx of continental breeding birds. The total herring gull regional baseline population in the non-breeding season, is therefore estimated to be 49,432 individuals. Using the average baseline mortality rate of 0.141 (Table 11.21), the estimated regional baseline mortality of herring gulls is 6,970 birds in the non-breeding season. The additional predicted mortality of four herring gulls would increase the baseline mortality rate by 0.06% (Table 11.55).

485. For the Scoping Approach in the non-breeding season, the total estimated number of herring gull collisions was seven birds (Table 11.54), however, this includes adult and immature birds. Based on Furness (2015), 52% of the population present in the non-breeding season are immature birds, then this would mean that three adult and four immature herring gulls are predicted to collide with wind turbines in the non-breeding season, based on the worst-case design scenario. The regional baseline mortality of herring gulls is estimated to be 6,970 birds in the non-breeding season. The additional predicted mortality of seven herring gulls would increase the baseline mortality rate by 0.10% (Table 11.56).

Assessment of Collision Mortality throughout the Year

486. Predicted herring gull mortality as a result of collision in the Proposed Development array area for all bio-seasons as calculated above, was summed for the whole year.

487. Using the Developer Approach, the predicted theoretical additional annual mortality due to collision was an estimated 20 herring gulls. This corresponds to an increase in the baseline mortality rate of 0.50% (Table 11.55).

488. Using the Scoping Approach, the predicted theoretical additional annual mortality due to collision was an estimated 33 herring gulls. This corresponds to an increase in the baseline mortality rate of 0.82% (Table 11.56).

489. For both the Developer Approach and Scoping Approach, the estimated increases in the annual baseline mortality rate were below 1% and were therefore not considered to be significant in EIA terms.

490. Although these collision mortality estimates did not suggest a potentially significant increase in the baseline mortality rate for herring gull for either the Developer Approach or the Scoping Approach, PVA analysis was conducted on the herring gull regional SPA population.

Summary of Regional PVA Assessment

491. PVA has been carried out on the regional herring gull SPA population considering a range of collision scenarios. The results of the PVA for predicted collision impacts for the Project alone during the operation phase for the herring gull regional SPA population for the 35-year projection is summarised in Table 11.58. Further details of the PVA methodology, input parameters and an explanation of how to interpret the PVA results can be found in volume 3, appendix 11.6.

Table 11.58: Summary of PVA Collision Outputs for Herring Gull for the Proposed Development array area after 35 years

Scenario and Start Population 15,390 Adults[1]	Unimpacted Median Population Size	Impacted Median Population Size	Counterfactual of Population Growth Rate - Median	Counterfactual Population Size - Median	Unimpacted Centile at Impacted 50th Centile - Median
Project Alone: Developer approach	158404	155612	1.000	0.981	47.1
Project Alone: Scoping approach	158404	153719	0.999	0.968	44.7

1 Starting population taken from volume 3, appendix 11.6.

Developer Approach = CRM based on mean monthly density.

Scoping Approach = CRM based on maximum monthly density.

492. For both the with and without Project scenarios, the herring gull regional SPA population is predicted to increase over the 35-year period. For the Developer Approach, the end population size with Project scenario was slightly lower than the without Project scenario. There was no predicted difference in the counterfactual of the population growth rate, and the counterfactual of the population size was also very close to 1.000, while the 50th Centile value was close to 50. These values indicate that the PVA did not predict a significant negative effect from the project alone effects of collision mortality from the Developer Approach on the herring gull regional SPA population after 35 years.

493. For the Scoping Approach, the end population size with Project scenario was lower than the without Project scenario. There was a very slight predicted difference in the counterfactual of the population growth rate, and the counterfactual of the population size was also close to 1.000, while the 50th Centile value was close to 50. These values indicate that the PVA did not predict a significant negative effect from the project alone effects of collision mortality from Scoping Approach A on the herring gull regional SPA population after 35 years.

494. Based on the results from the collision assessment and the regional PVA assessment for both the Developer Approach and the Scoping Approach, the magnitude of collision impacts on the regional SPA herring gull population is negligible.

Sensitivity of the Receptor

495. A review of post-construction studies of seabirds at offshore wind farms in European waters concluded that herring gull was one of the species that showed a weak attraction to offshore wind farms (Dierschke et al., 2016). A review of vulnerability of Scottish seabirds to offshore wind turbines ranked herring gull

with the second highest score in the context of collision impacts, based on flight activity at blade height, manoeuvrability, time spent in flight, nocturnal flight activity and conservation importance (Furness and Wade, 2012). Similarly, Furness et al., (2013) scored herring gull as the species of highest concern in the context of collision impacts, while Bradbury et al., (2014), classified the herring gull population vulnerability to collision mortality as very high.

496. On this basis, herring gull sensitivity to collision from operational offshore wind farms is considered to be very high (Table 11.16).

497. In addition, estimated numbers of herring gulls recorded within the Proposed Development would occasionally qualify as nationally important in the breeding season (See volume 3, appendix 11.1, annex G), with individuals likely originating from a number of SPAs and non-SPAs in the region. On this basis the conservation importance for herring gull was considered to be medium.

Significance of the Effect

498. For collision effects on herring gull from the Project alone, for the Developer Approach, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be very high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

499. For the Scoping Approach, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be very high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

500. No offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **minor** adverse significance, which is not significant in EIA terms.

Lesser Black-backed Gull

501. For the Developer Approach, annual estimated lesser black-backed gull mortality from collision impacts in the Proposed Development array area was based on mean densities of flying birds recorded on baseline digital aerial surveys. For the Scoping Approach, this was based on maximum densities of flying birds recorded on baseline digital aerial surveys.

502. The estimated number of collisions per bio-season for lesser black-backed gull based on the Developer Approach and the Scoping Approach are presented in Table 11.59. Figures are presented for the breeding and non-breeding seasons, based on the worst-case design scenario (307x14 MW wind turbines).

503. For assessment purposes, the breeding season for lesser black-backed gull has been defined as mid-March to August (NatureScot, 2020). As no lesser black-backed gull collisions were predicted for the non-breeding season for either the Developer Approach or the Scoping Approach, no further assessment was undertaken for this period.

504. A complete range of collision numbers for the Proposed Development, and the different design scenarios for both the Developer Approach and the Scoping Approach are presented in volume 3, appendix 11.3.

Table 11.59: Estimated number of collisions for Lesser Black-backed Gull by bio-season in the Proposed Development for the Worst-Case Scenario (SNCBs avoidance rates, wind turbine 14 MW, Option 2) for the Developer Approach and Scoping Approach. Estimates are rounded to nearest whole bird.

	Breeding Season	Non-breeding season	Total
Developer Approach	6	0	6
Scoping Approach	9	0	9

Magnitude of Impact

505. The overall baseline mortality rates were based on age-specific demographic rates and age class proportions as presented in Table 11.21. The potential magnitude of impact was estimated by calculating the increase in baseline mortality within each bio-season with respect to the regional populations.

Table 11.60: Estimated Numbers of Collisions for Lesser Black-backed Gull in the Proposed Development array area by bio-season in Relation to Baseline Mortality for the Developer Approach

Bio-season	Estimated Seasonal Collision Mortality	Regional Baseline Population (Adults)	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Mid Mar-Aug)1	3	13,994	1,217	0.25
Non-breeding (Sep-mid Mar)	0	-	-	0
Total	3	-	-	0.25

1 Breeding season assessment is for breeding adults only.

Table 11.61: Estimated Numbers of Collisions for Lesser Black-backed Gull in the Proposed Development array area by bio-season in Relation to Baseline Mortality for the Scoping Approach

Bio-season	Estimated Seasonal Collision Mortality	Regional Baseline Population (Adults)	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Mid Mar-Aug)[1]	5	13,994	1,217	0.41
Non-breeding (Sep-mid Mar)	0	-	-	0
Total	5	-	-	0.41

1 Breeding season assessment is for breeding adults only.

Breeding Season

506. For the Developer Approach in the breeding season, the total estimated number of lesser black-backed gull collisions was six birds (Table 11.59). However, this includes non-breeding adults and immature birds, as well as breeding adults. Based on the proportion of immature lesser black-backed gulls recorded on digital aerial baseline surveys in the breeding season, 9% of the population present in the breeding season are immature birds (Table 11.62).

Table 11.62: Proportions of Juvenile, Immature and Adult Lesser Black-backed Gulls Recorded in the Breeding Season on Digital Aerial Surveys

Season	Juvenile	Immature	Adult
Breeding (mid Mar-Aug)	0	0.09	0.91

507. This would mean that five adult lesser black-backed gulls and one immature bird are predicted to collide with wind turbines in the breeding season, based on the maximum design scenario. However, a proportion of adult birds present at colonies in the breeding season will opt not to breed in a particular breeding season. It has been estimated that 35% of adult lesser black-backed gulls may be "sabbatical" birds in any particular breeding season (volume 3, appendix 11.6), and this has been applied for this assessment. On this basis, two adult lesser black-backed gulls were considered to be not breeding and so three breeding adult lesser black-backed gulls were taken forward for the breeding season assessment.

508. The total lesser black-backed gull regional baseline breeding population is estimated to be 13,994 individuals (Table 11.9). However, it should be noted that this figure is considered likely to be an under-estimate due to limited surveys of urban gull colonies, which have increased in the region in recent years (Welch, 2019b). A larger regional population would result in a corresponding larger figure for the estimated regional baseline mortality figure, and therefore a lower predicted increase in additional mortality, and this should be borne in mind for this assessment.

509. The adult baseline survival rate is estimated to be 0.913 (Table 11.21), which means that the corresponding rate for adult mortality is 0.087. Applying this mortality rate, the estimated regional baseline mortality of lesser black-backed gulls is 1,217 adult birds per breeding season. The additional predicted mortality of three adult lesser black-backed gulls would increase the baseline mortality rate by 0.25% (Table 11.60).

510. For the Scoping Approach in the breeding season, the total estimated number of lesser black-backed gull collisions was nine birds (Table 11.59). However, this includes non-breeding adults and immature birds, as well as breeding adults. Based on the proportion of immature lesser black-backed gulls recorded on digital aerial baseline surveys in the breeding season,9% of the population present in the breeding season are immature birds (Table 11.62). This would mean that eight adult lesser black-backed gulls and one immature bird are predicted to collide with wind turbines, based on the worst-case design scenario.

511. As above, a sabbatical rate of 35% for non-breeding adult lesser black-backed gulls (volume 3, appendix 11.6) has been applied for this assessment. On this basis, three adult lesser black-backed gulls were considered to be not breeding and so five breeding adult lesser black-backed gulls were taken forward for the breeding season assessment.

512. The regional baseline mortality of lesser black-backed gulls is estimated to be 1,217 adult birds per breeding season. The additional predicted mortality of five adult lesser black-backed gulls would increase the baseline mortality rate by 0.41% (Table 11.61).

Non-breeding Season

513. No lesser black-backed gull collisions were predicted for either the Developer Approach or the Scoping Approach in the non-breeding season (Table 11.59), therefore no further assessment for the non-breeding season was undertaken.

Assessment of Collision Mortality throughout the Year

514. As there were no predicted lesser black-backed gull collisions for the non-breeding season, the totals for the breeding season therefore represent the annual collision totals for this species.

515. Using the Developer Approach, the predicted theoretical additional annual mortality due to collision was an estimated three adult lesser black-backed gulls. This corresponds to an increase in the baseline mortality rate of 0.25% (Table 11.60).

516. Using the Scoping Approach, the predicted theoretical additional annual mortality due to collision was an estimated five adult lesser black-backed gulls. This corresponds to an increase in the baseline mortality rate of 0.41% (Table 11.61).

517. Although these collision mortality estimates did not suggest a potential significant increase in the baseline mortality rate for lesser black-backed gull for the Developer or Scoping Approaches, PVA analysis was conducted on the lesser black-backed gull regional SPA population.

Summary of PVA Assessment

518. PVA was carried out on the lesser black-backed gull regional SPA population considering a range of collision scenarios. The results of the PVA for predicted collision impacts for the Project alone during the operation phase for the lesser black-backed gull regional SPA population for the 35-year projection is summarised in Table 11.63. Further details of the PVA methodology, input parameters and an explanation of how to interpret the PVA results can be found in volume 3, appendix 11.6.

Table 11.63: Summary of PVA Collision Outputs for Lesser Black-backed Gull for the Proposed Development array area after 35 years

Scenario and Start Population 5,408 Adults[1]	Unimpacted Median Population Size	Impacted Median Population Size	Counterfactual of Population Growth Rate - Median	Counterfactual Population Size - Median	Unimpacted Centile at Impacted 50th Centile - Median
Project Alone: Developer approach	25991	25659	1.000	0.989	47.1
Project Alone: Scoping approach	25991	25514	0.999	0.982	45.7

1 Starting population taken from volume 3, appendix 11.6.
Developer Approach = CRM based on mean monthly density.
Scoping Approach = CRM based on maximum monthly density.

519. For both the with and without Project scenarios, the lesser black-backed gull regional SPA population is predicted to increase over the 35-year period. For the Developer Approach, the end population size with Project scenario was very slightly lower than the without Project scenario. There was no predicted difference in the counterfactual of the population growth rate, and the counterfactual of the population size was also very close to 1.000, while the 50th Centile value was close to 50. These values indicate that the PVA did not predict a significant negative effect from the project alone effects of collision mortality from the Developer Approach on the lesser black-backed gull regional SPA population after 35 years.

520. For the Scoping Approach, the end population size with Project scenario was slightly lower than the without Project scenario. There was a very slight predicted difference in the counterfactual of the population growth rate, and the counterfactual of the population size was also close to 1.000, while the 50th Centile value was close to 50. These values indicate that the PVA did not predict a significant negative effect from the project alone effects of collision mortality from the Scoping Approach on the lesser black-backed gull regional SPA population after 35 years.

521. Based on the results from the collision assessment and the regional PVA assessment for both the Developer Approach and the Scoping Approach, the magnitude of collision impacts on the regional SPA lesser black-backed gull population is negligible.

Sensitivity of the Receptor

522. A review of post-construction studies of seabirds at offshore wind farms in European waters concluded that lesser black-backed gull was one of the species that showed a weak attraction to offshore wind farms (Dierschke et al., 2016). A review of vulnerability of Scottish seabirds to offshore wind turbines ranked lesser black-backed gull with the third highest score in the context of collision impacts, based on flight activity at blade height, manoeuvrability, time spent in flight, nocturnal flight activity and conservation importance (Furness and Wade, 2012). Similarly, Furness et al., (2013) scored lesser black-backed gull as the third-highest species of concern in the context of collision impacts, while Bradbury et al., (2014), classified the lesser black-backed gull population vulnerability to collision mortality as very high.

523. On this basis, lesser black-backed gull sensitivity to collision from operational offshore wind farms is considered to be very high (Table 11.16).

524. In addition, estimated numbers of lesser black-backed gulls recorded within the Proposed Development would occasionally qualify as nationally important in the breeding season (See volume 3, appendix 11.1, annex G), with individuals likely originating from a number of SPAs and non-SPAs in the region. On this basis the conservation importance for lesser black-backed gull was considered to be medium.

Significance of the Effect

525. For collision effects on lesser black-backed gull from the Project alone, for the Developer Approach, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be very high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

526. For the Scoping Approach, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be very high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

527. No offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **minor** adverse significance, which is not significant in EIA terms.

Kittiwake

528. For the Developer Approach, annual estimated kittiwake mortality from collision impacts in the Proposed Development was based on mean densities of flying birds recorded on baseline digital aerial surveys. For the Scoping Approach, this was based on maximum densities of flying birds recorded on baseline digital aerial surveys.

529. The estimated number of collisions per bio-season for kittiwake based on the Developer Approach and the Scoping Approach are presented in Table 11.64. Figures are presented for the breeding season and the autumn and spring migration periods of the non-breeding seasons, based on the worst-case design scenario (307x14 MW wind turbines). Highest numbers of collisions were predicted for the breeding season, for both approaches, with lower numbers of collisions predicted for the autumn and spring migration periods of the non-breeding season.

530. A complete range of collision numbers for the Proposed Development, and the different design scenarios for both the Developer Approach and the Scoping Approach are presented in volume 3, appendix 11.3.

Table 11.64: Estimated number of collisions for kittiwake by bio-season in the Proposed Development for the Worst-Case Scenario (SNCBs avoidance rates, wind turbine 14 MW, Option 2) for the Developer Approach and the Scoping Approach. Estimates are rounded to nearest whole bird.

	Breeding Season	Autumn Migration	Spring Migration	Total
Developer Approach	426	155	104	685
Scoping Approach	617	190	179	986

Magnitude of Impact

531. The overall baseline mortality rates were based on age-specific demographic rates and age class proportions from aerial surveys as presented in Table 11.21. The potential magnitude of impact was estimated by calculating the increase in baseline mortality within each bio-season with respect to the regional populations.

Table 11.65: Estimated Numbers of Collisions for Kittiwake in the Proposed Development array area by bio-season in Relation to Baseline Mortality, for the Developer Approach

Bio-season	Estimated Seasonal Collision Mortality	Regional Baseline Population (Adults)	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Mid Apr-Aug)[1]	372	319,126	46,273	0.80
Autumn migration (Sep-Dec)	155	829,937	132,790	0.12
Spring migration (Jan to mid-April)	104	627,816	100,451	0.10
Total	631	-	-	1.02

1 Breeding season assessment is for breeding adults only.

Table 11.66: Estimated Numbers of Collisions for Kittiwake in the Proposed Development array area by bio-season in Relation to Baseline Mortality, for the Scoping Approach

Bio-season	Estimated Seasonal Collision Mortality	Regional Baseline Population (Adults)	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Mid Apr-Aug)[1]	538	319,126	46,273	1.16
Autumn migration (Sep-Dec)	190	829,937	132,790	0.14
Spring migration (Jan to mid-April)	179	627,816	100,451	0.18
Total	907	-	-	1.48

1 Breeding season assessment is for breeding adults only.

Breeding Season

532. For the Developer Approach in the breeding season, the total estimated number of kittiwake collisions was 426 birds (Table 11.64). However, this includes non-breeding adults and immature birds, as well as breeding adults. Based on the proportion of immature kittiwakes recorded on digital aerial baseline surveys in the breeding season, 3% of the population present in the breeding season are immature birds (Table 11.29). This would mean that 413 adult kittiwakes and 13 immatures bird are predicted to collide with wind turbines in the breeding season, based on the worst-case design scenario.

533. However, a proportion of adult birds present at colonies in the breeding season will opt not to breed in a particular breeding season. It has been estimated that 10% of adult kittiwakes may be "sabbatical" non-breeding birds in any particular breeding season (volume 3, appendix 11.6), and this has been applied for this assessment. On this basis, 41 adult kittiwakes were considered to be not breeding and so 372 breeding adult kittiwakes were taken forward for the breeding season assessment.

534. The total kittiwake regional baseline breeding population is estimated to be 319,126 individuals (Table 11.9). The adult baseline survival rate is estimated to be 0.855 (Table 11.21), which means that the corresponding rate for adult mortality is 0.145. Applying this mortality rate, the estimated baseline mortality of kittiwakes is 46,273 adult birds per breeding season. The additional predicted mortality of 372 breeding adult kittiwakes would increase the baseline mortality rate by 0.80% (Table 11.65).

535. For the Scoping Approach in the breeding season, the total estimated number of kittiwake collisions was 617 birds (Table 11.64). However, this includes non-breeding adults and immature birds, as well as breeding adults. Based on the proportion of immature kittiwakes recorded on digital aerial baseline surveys in the breeding season, 3% of the population present in the breeding season are immature birds (Table 11.29). This would mean that 598 adult kittiwakes and 19 immature birds are predicted to collide with wind turbines in the breeding season, based on the worst-case design scenario.

536. As above, a sabbatical rate of 10% for non-breeding adult kittiwakes (volume 3, appendix 11.6) has been applied for this assessment. On this basis, 60 adult kittiwakes were considered to be not breeding and so 538 breeding adult kittiwakes were taken forward for the breeding season assessment.

537. Applying the adult baseline mortality rate of 0.145, the estimated baseline mortality of kittiwakes is 46,273 adult birds per breeding season. The additional predicted mortality of 538 breeding adult kittiwakes would increase the baseline mortality rate by 1.16% (Table 11.66).

Non-breeding Season – Autumn Migration Period

538. For the Developer Approach in the autumn migration period, the total estimated number of kittiwake collisions was 155 birds (Table 11.64), however, this includes adult and immature birds. Based on information presented in Furness (2015), in the non-breeding season 47% of the population present are immature birds and 53% of birds are adults. This would mean that 82 adult kittiwakes and 73 immature birds are predicted to collide with wind turbines, in the autumn migration period of the non-breeding season, based on the worst-case design scenario.

539. Based on Furness (2015), the total kittiwake BDMPS regional baseline population for the autumn migration period is estimated to be 829,937 individuals (Table 11.9). Using the average baseline mortality rate of 0.160 (Table 11.21), the estimated regional baseline mortality of kittiwakes is 132,790 birds in the autumn migration period. The additional predicted mortality of 155 kittiwakes would increase the baseline mortality rate by 0.12% (Table 11.65).

540. For the Scoping Approach in the autumn migration period, the total estimated number of kittiwake collisions was 190 birds (Table 11.64), however, this includes adult and immature birds. Based on Furness (2015), 47% of the population present in the non-breeding season are immature birds and 53% of birds are adults. This would mean that 101 adult and 89 immature kittiwakes are predicted to collide with wind turbines, based on the worst-case design scenario. The estimated regional baseline mortality of kittiwakes in the autumn migration period is 132,790 birds. The additional predicted mortality of 190 kittiwakes would increase the baseline mortality rate by 0.14% (Table 11.66).

Non-breeding Season – Spring Migration Period

541. For the Developer Approach in the spring migration period, the total estimated number of kittiwake collisions was 104 birds (Table 11.64), however, this includes adult and immature birds. Based on Furness (2015), 47% of the population present in the non-breeding season are immature birds and 53% of birds are adults. This would mean that 55 adult and 49 immature kittiwakes are predicted to collide with wind turbines in the spring migration period of the non-breeding season, based on the worst-case design scenario.

542. Based on Furness (2015), the total kittiwake BDMPS regional baseline population for the spring migration period is estimated to be 627,816 individuals (Table 11.9). Using the average baseline mortality rate of 0.160 (Table 11.21), the estimated baseline mortality of kittiwakes is 100,451 birds in the spring migration period. The additional predicted mortality of 104 kittiwakes would increase the baseline mortality rate by 0.10% (Table 11.65).

543. For the Scoping Approach in the spring migration period, the total estimated number of kittiwake collisions was 179 birds (Table 11.64), however, this includes adult and immature birds. Based on Furness (2015), 47% of the population present in the non-breeding season are immature birds and 53% of birds are adults. This would mean that 95 adult and 84 immature kittiwakes are predicted to collide with wind turbines in the spring period of the non-breeding season, based on the worst-case design scenario. The additional predicted mortality of 179 kittiwakes would increase the baseline mortality rate by 0.18% (Table 11.66).

Assessment of Collision Mortality throughout the Year

544. Predicted kittiwake mortality as a result of collision in the Proposed Development array area for all bio-seasons as calculated above, was summed for the whole year.

545. Using the Developer Approach, the predicted theoretical additional annual mortality due to collision was an estimated 631 kittiwakes. This corresponds to an increase in the baseline mortality rate of 1.02% (Table 11.65).

546. Using the Scoping Approach, the predicted theoretical additional annual mortality due to collision was an estimated 907 kittiwakes. This corresponds to an increase in the baseline mortality rate of 1.48% (Table 11.66).

547. These collision mortality estimates suggest a potential significant increase in the baseline mortality rate for kittiwake for the Developer Approach and the Scoping Approach, therefore PVA analysis was conducted on the kittiwake regional SPA population. Conclusions on displacement and collision mortality are presented below.

Summary of PVA Assessment

548. PVA was carried out on the regional kittiwake SPA population for a range of collision scenarios as well as a range of displacement and mortality rates.

549. The results of the PVAs for predicted displacement and collision impacts for the Project alone during the operation phase for the kittiwake regional SPA population for the 35-year projection is summarised in Table 11.67. Further details of the PVA methodology, input parameters and an explanation of how to interpret the PVA results can be found in volume 3, appendix 11.6.

Table 11.67: Summary of PVA Displacement and Collision Outputs for Kittiwake for the Proposed Development array area plus 2 km buffer after 35 years

Scenario and Start Population 247,678 Adults[1]	Unimpacted Median Population Size	Impacted Median Population Size	Counterfactual of Population Growth Rate - Median	Counterfactual Population Size - Median	Unimpacted Centile at Impacted 50th Centile - Median
Project Alone: Developer approach	216118	212,612	0.999	0.983	47.3
Project Alone: Scoping approach A	216118	209,560	0.999	0.966	44.7
Project Alone: Scoping approach B	216118	207,506	0.999	0.961	43.1

1 Starting population taken from volume 3, appendix 11.6.

Developer Approach = 30% displacement and 1% mortality in breeding season and mean monthly density for CRM.

Scoping Approach A = 30% displacement and 1% displacement mortality throughout year and maximum monthly density for CRM.

Scoping Approach B = 30% displacement and 3% displacement mortality throughout year and maximum monthly density for CRM.

550. For kittiwake, the PVA predicted that the regional SPA end population would be lower than the start population for both the with and without Project scenarios over the 35-year period. For the Developer Approach, the end population size with Project scenario was lower than the without Project scenario. There was a very slight predicted decrease in the counterfactual of the population growth rate, and the counterfactual of the population size was also very close to 1.000, while the 50th Centile value was close to 50. These values indicate that the PVA did not predict a significant negative effect from the project alone effects of displacement and collision mortality from the Developer Approach on the kittiwake regional SPA population after 35 years.

551. For Scoping Approach A, the end population size with Project scenario was lower than the without Project scenario. There was a very slight predicted decrease in the counterfactual of the population growth rate, and the counterfactual of the population size was also close to 1.000, while the 50th Centile value was close to 50. These values indicate that the PVA did not predict a significant negative effect from the project alone effects of displacement and collision mortality from Scoping Approach A on the kittiwake regional SPA population after 35 years.

552. For Scoping Approach B, the end population size with Project scenario was lower than the without Project scenario. There was a very slight predicted decrease in the counterfactual of the population growth rate, and the counterfactual of the population size was also close to 1.000, while the 50th Centile value was also close to 50. These values indicate that the PVA did not predict a significant negative effect from the project alone effects of displacement and collision mortality from Scoping Approach B on the kittiwake regional SPA population after 35 years.

553. Based on the results from the displacement and collision assessments, and the combined PVA on displacement and collision effects on the regional SPA populations for the Developer Approach, the magnitude of impact on the regional kittiwake population is low.

554. Based on the results from the displacement and collision assessments, and the combined PVA on displacement and collision effects on the regional SPA populations for Scoping Approach A, the magnitude of impact on the regional kittiwake population is low.

555. Based on the results from the displacement and collision assessments, and the combined PVA on displacement and collision effects on the regional SPA populations for Scoping Approach B, the magnitude of impact on the regional kittiwake population is low.

Sensitivity of the Receptor

556. A review of post-construction studies of seabirds at offshore wind farms in European waters concluded that kittiwake was one of the species that was hardly affected by offshore wind farms or with attraction and avoidance approximately equal over all studies (Dierschke et al., 2016). A review of vulnerability of Scottish seabirds to offshore wind turbines ranked kittiwake with the seventh highest score in the context of collision impacts, based on flight activity at blade height, manoeuvrability, time spent in flight, nocturnal flight activity and conservation importance (Furness and Wade, 2012). Similarly, Furness et al., (2013) scored kittiwake as the seventh-highest species of concern in the context of collision impacts, while Bradbury et al., (2014), classified the kittiwake population vulnerability to collision mortality as high.

557. On this basis, kittiwake sensitivity to collision from operational offshore wind farms is considered to be high (Table 11.16).

558. Kittiwake sensitivity to displacement effects are discussed in Paragraph 248 onwards. In conclusion, for kittiwake, there is evidence from other operating offshore wind farm projects that displacement is not likely to occur to any significant level. A review of post-construction studies of seabirds at offshore wind farms in European waters concluded that kittiwake was one of the species which were hardly affected by offshore wind farms or with attraction and avoidance approximately equal over all studies (Dierschke et al., 2016). Two reviews of vulnerability of Scottish seabirds to offshore wind turbines in the context of disturbance and displacement ranked kittiwake with a score of two, where five was the most vulnerable score and one was the least vulnerable (Furness and Wade, 2012, Furness et al., 2013). Similarly, Bradbury et al., (2014), classified the kittiwake population vulnerability to displacement as very low.

559. On this basis, kittiwake sensitivity to displacement effects from operational offshore wind farms is considered to be low (Table 11.16). Therefore, kittiwake sensitivity to collision impacts has been used to determine the sensitivity of this species.

560. In addition, estimated numbers of kittiwakes recorded within the Proposed Development were considered as nationally important in the breeding season (See volume 3, appendix 11.1, annex G), with individuals likely originating from a number of SPAs and non-SPAs in the region. On this basis the conservation importance for kittiwake was considered to be medium.

Significance of the Effect

561. For combined displacement and collision effects on kittiwake from the Project alone, for the Developer Approach, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor to moderate adverse** significance, which is significant in EIA terms.

562. For Scoping Approach A, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor to moderate adverse** significance, which is significant in EIA terms.

563. For Scoping Approach B, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor to moderate adverse** significance, which is significant in EIA terms.

564. As outlined in Section 11.9.2, in cases where the range for the significance of effect spans the significance threshold (minor to moderate), the final significance is based upon the expert's professional judgement as to which outcome delineates the most likely effect, with an explanation as to why this is the case.

565. As highlighted by NS in the NnG Scoping Opinion (Marine Scotland, 2017a), collision risk and displacement are considered to be mutually exclusive impacts, and therefore combining mortality estimates for displacement and collision as has been done for this PVA should be considered extremely precautionary. On this basis, it is considered that for all three approaches, the effect will be of **minor adverse** significance, which is not significant in EIA terms. For further discussion on levels of precaution in the Scoping Approach, see volume 3, appendix 11.3 and appendix 11.4.

Secondary and Tertiary Mitigation and Residual Effect

566. No offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **minor adverse** significance, which is not significant in EIA terms.

Little Gull

567. For the Developer Approach, annual estimated little gull mortality from collision impacts in the Proposed Development was based on mean densities of flying birds recorded on baseline digital aerial surveys. For the Scoping Approach, this was based on maximum densities of flying birds recorded on baseline digital aerial surveys. Figures are presented for the breeding and non-breeding seasons, based on the worst-case design scenario (307x14 MW wind turbines).

Table 11.68: Estimated number of collisions for little gull by bio-season in the Proposed Development for the worst-case scenario (SNCBs avoidance rates, wind turbine 14 MW, Option 2). Estimates are rounded to nearest whole bird.

	Breeding Season	Non-breeding Season	Annual
Developer Approach	0	2	2
Scoping Approach	0	4	4

Magnitude of Impact

568. The estimated number of collisions per bio-season for little gull based on the Developer Approach and the Scoping Approach are presented in Table 11.68. Estimated numbers of collisions for little gull were zero

in the breeding season. For the Developer Approach, two birds were predicted to collide with wind turbines in the non-breeding season. For the Scoping Approach, four little gull collisions were predicted over this period.

569. A complete range of collision numbers for the Proposed Development, and the different design scenarios for both the Developer Approach and the Scoping Approach are presented in volume 3, appendix 11.3.

Breeding Season

570. As little gulls do not breed in the UK, it is considered that the birds recorded in July on the digital aerial baseline surveys were non-breeding birds.

571. When CRM estimates were rounded to the nearest whole bird, there were zero little gull collisions predicted for the breeding season for both the Developer Approach and the Scoping Approach (Table 11.69 and Table 11.70). There were therefore no collision impacts predicted for the breeding season for little gull.

Table 11.69: Estimated Numbers of Collisions for Little Gull in the Proposed Development array area by bio-season in Relation to Baseline Mortality for the Developer Approach

Bio-season	Estimated Seasonal Collision Mortality	Regional Baseline Population (Adults)	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Mid Apr-Aug)	0	n/a	n/a	0
Non-breeding season (Sep-Dec)	2	3,000	600	0.033
Total	2	-	-	0.033

Figures in brackets represent collision estimates based on Scoping Approach (see text for details).

Table 11.70: Estimated Numbers of Collisions for Little Gull in the Proposed Development array area by bio-season in Relation to Baseline Mortality, for the Scoping Approach

Bio-season	Estimated Seasonal Collision Mortality	Regional Baseline Population (Adults)	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Mid Apr-Aug)	0	n/a	n/a	0
Non-breeding season (Sep-Dec)	4	3,000	600	0.67
Total	4	-	-	0.67

Figures in brackets represent collision estimates based on Scoping Approach (see text for details).

Non-breeding Season

572. For the Developer Approach in the non-breeding season, the total estimated number of little gull collisions was two birds, based on the worst-case design scenario (Table 11.69).

573. Little gull is not considered in the BDMPS report (Furness, 2015), therefore there is no BDMPS regional population available for the non-breeding season. Analysis of ESAS data by Skov *et al*. (1995) identified a geographically discrete autumn passage concentration of little gulls 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 in the non-breeding season (Forrester *et al.,* 2007). Furthermore, survey work commissioned in recent years to inform the Forth and Tay offshore wind farm projects has shown that this species is more common than previously appreciated (or numbers have increased), with for example a peak estimated population for the NnG study area of up to 3,841 birds in September 2012 (NnG, 2018).

574. The upper limit of 3,000 birds from an estimate of 1,500 to 3,000 individuals present between June and November in the Forth and Tay area (Forrester et al., 2007) has been used in this assessment as the best available regional reference population estimate during the non-breeding season, although this is considered likely to be an under-estimate.

575. The baseline mortality rate for little gull was based on an estimate of adult little gull survival of 0.8 published by Garthe and Hüppop (2004). The corresponding average baseline mortality rate of 0.2 was applied to the best available regional reference population estimate during the non-breeding season (3,000 birds) to give a predicted baseline mortality of little gulls of 600 birds per non-breeding season. Based on the Developer Approach, the additional predicted mortality of two little gulls would increase the baseline mortality rate by 0.033%.

576. For the Scoping Approach in the non-breeding season, the total estimated number of little gull collisions was four birds, based on the worst-case design scenario (Table 11.70). This additional predicted mortality would increase the baseline mortality rate by 0.67%.

Assessment of Collision Mortality throughout the Year

577. There were no collision impacts predicted for little gull in the breeding season, therefore annual collision mortality will be the same as for the non-breeding season.

578. The estimated increase in the annual baseline mortality rate for little gull as a result of collision is predicted to be 0.033% for the Developer Approach and 0.67% for the Scoping Approach (Table 11.69). The magnitude of this impact is therefore considered to be negligible.

Sensitivity of the Receptor

579. A review of post-construction studies of seabirds at offshore wind farms in European waters concluded that little gull was one of the species that weakly avoided offshore wind farms (Dierschke et al., 2016). Little gull was not included in vulnerability reviews by Furness and Wade (2012) or Furness et al., (2013) but Bradbury et al., (2014), classified the little gull population vulnerability to collision mortality as moderate.

580. On this basis, little gull sensitivity to collision from operational offshore wind farms is considered to be medium (Table 11.16).

581. In addition, estimated numbers of little gulls recorded within the Proposed Development were considered as regionally important in the non-breeding season (volume 3, appendix 11.1, annex G). On this basis the conservation importance for little gull was considered to be low.

Significance of the Effect

582. For collision effects on little gull from the Project alone, for the Developer Approach and the Scoping Approach, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

583. No offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **negligible to minor** adverse significance, which is not significant in EIA terms.

Common Tern

584. For the Developer Approach, estimated common tern mortality from collision impacts in the Proposed Development array area was based on mean densities of flying birds recorded on baseline digital aerial surveys. For the Scoping Approach, this was based on maximum densities of flying birds recorded on baseline digital aerial surveys.

585. The estimated number of collisions per month for common tern based on the Developer Approach and the Scoping Approach are presented in Table 11.71. Figures are presented for the breeding and non-breeding seasons, based on the worst-case design scenario (307x14 MW wind turbines). Numbers are presented by month rather than seasonally, in order to demonstrate the typically low estimated numbers of collisions per month. For both the Developer Approach and the Scoping Approach, collision numbers were less than one bird per month in all months except for August.

586. For assessment purposes, the breeding season for common tern has been defined as May to mid-September (NatureScot, 2020). There are two BDMPS periods in the non-breeding season as defined by Furness (2015). The autumn migration period covers late July to early September, and the spring migration period covers April and May. As a precautionary assessment, all estimated collisions were assessed as being from the breeding season, as well as being part of the autumn migration period. Estimated collision numbers for the spring migration period of the non-breeding season were considerably less than one whole bird, therefore no assessment was carried out for this period of the non-breeding season.

587. A complete range of collision numbers for the Proposed Development array area, and the different design scenarios for both the Developer Approach and the Scoping Approach are presented in volume 3, appendix 11.3.

Table 11.71: Monthly Estimated Collisions for Common Tern in the Proposed Development array area for the Worst-Case Scenario (SNCBs avoidance rates, wind turbine 14 MW, Option 2), based on the Developer and Scoping Approaches. Estimates are presented using the mean avoidance rate (0.980)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Developer Approach													
	0.00	0.00	0.00	0.10	0.06	0.00	0.75	4.85	0.30	0.00	0.00	0.00	6.05
Scoping Approach													
	0.00	0.00	0.00	0.21	0.11	0.00	0.81	7.43	0.59	0.00	0.00	0.00	9.15

Magnitude of Impact

588. The overall baseline mortality rates were based on age-specific demographic rates and age class proportions as presented in Table 11.21. The potential magnitude of impact was estimated by calculating the increase in baseline mortality for the relevant bio-seasons with respect to the regional populations.

Table 11.72: Estimated Numbers of Collisions for Common Tern in the Proposed Development array area by bio-season in Relation to Baseline Mortality, for the Developer Approach

Bio-season	Estimated Seasonal Collision Mortality	Regional Baseline Population (Adults)	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (May-mid Sep)	6	n/a	n/a	0
Autumn Migration[1] (late Jul-early Sep)	6[2]	144,911	26,084	0.023
Spring Migration[1] (Apr-May)	0	144,911	26,084	0

Figures in brackets represent collision estimates based on Scoping Approach (see text for details).

1 There is an overlap in the months across the three seasons as the breeding season follows the NatureScot (2020) approach, while the Autumn and Spring Migration periods follow BDMPS (Furness 2015).

2 These collision estimates have been assessed for both the breeding season and the autumn migration period, and therefore have not been summed.

Table 11.73: Estimated Numbers of Collisions for Common Tern in the Proposed Development array area by bio-season in Relation to Baseline Mortality, for the Scoping Approach

Bio-season	Estimated Seasonal Collision Mortality	Regional Baseline Population (Adults)	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (May-mid Sep)	9	n/a	n/a	0
Autumn Migration[1] (late Jul-early Sep)	9[2]	144,911	26,084	0.035
Spring Migration[1] (Apr-May)	0	144,911	26,084	0

Figures in brackets represent collision estimates based on Scoping Approach (see text for details).

1 There is an overlap in the months across the three seasons as the breeding season follows the NatureScot (2020) approach, while the Autumn and Spring Migration periods follow BDMPS (Furness 2015).

2 These collision estimates have been assessed for both the breeding season and the autumn migration period, and therefore have not been summed.

Breeding Season

589. Common tern collisions were predicted to occur between April and September, based on densities recorded in the Proposed Development array area on baseline digital aerial surveys. For the Developer Approach in the breeding season, the total estimated number of common tern collisions was six birds (Table 11.72). However, this includes non-breeding adults and immature birds, as well as breeding adults. The age breakdown of common terns recorded on baseline digital aerial surveys by bio-season is presented in Table 11.74. Based on the proportion of immature common terns recorded on digital aerial baseline surveys in the breeding season, 12% of the population present in the breeding season are immature birds, then this would mean that five adult common terns and one immature bird are predicted to collide with wind turbines in the breeding season, based on the worst-case design scenario.

Table 11.74: Proportions of juvenile, immature and adult Common Tern recorded on Digital Aerial Surveys

Season	Juvenile	Immature	Adult
Breeding (May-mid Sep)	0.1	0.02	0.88
Non-breeding (mid-Sep-Apr)	0	0	1

590. There are no common tern breeding colonies within mean maximum foraging range (plus 1S.D.) of the Proposed Development, based on the published range of 18.0±8.9 km (Woodward et al., 2019). On this basis, it was concluded that none of the predicted common tern collisions for the Developer Approach or the Scoping Approach during the breeding season were from the regional breeding population. Therefore, there will be no impact from collision on the common tern regional breeding population in the breeding season.

Non-breeding Season – Autumn Migration Period

591. According to NatureScot (2020) the non-breeding season is defined as mid-September to April, consequently for both the Developer and Scoping Approach, less than one common tern collision is predicted over this period (Table 11.71).

592. However, according to the BDMPS review, the autumn migration period of the non-breeding season in UK waters is defined as late July to early September (Furness, 2015). Therefore, the predicted common tern collisions between July and August could be considered to be from the regional BDMPS population for the autumn migration period. As a precautionary approach, collision impacts for the Developer Approach and the Scoping Approach have been assessed on this basis.

593. For the Developer Approach in the autumn migration period, the total estimated number of common tern collisions (rounded up) was six birds (Table 11.72). Based on Furness (2015), the total common tern BDMPS regional baseline population for the autumn migration period is estimated to be 144,911 individuals (Table 11.9). Using the average baseline mortality rate of 0.180 (Table 11.21), the estimated baseline mortality of common tern is 26,084 birds in the autumn migration period. The additional predicted mortality of six common terns would increase the baseline mortality rate by 0.023% (Table 11.72).

594. For the Scoping Approach in the autumn migration period, the total estimated number of common tern collisions (rounded up) was nine birds. The additional predicted mortality of nine common terns would increase the baseline mortality rate by 0.035% (Table 11.73).

Assessment of Collision Mortality throughout the Year

595. As there are no common tern colonies within mean maximum foraging range (plus 1S.D.) of the Proposed Development array area, there will be no impact from collision on the common tern regional breeding population in the breeding season.

596. As there were very low numbers of predicted common tern collisions for the spring period of the non-breeding season, the totals for the autumn period of the non-breeding season therefore represent the annual collision totals for this species.

597. Using the Developer Approach, the predicted theoretical additional annual mortality due to collision was an estimated six common terns. This corresponds to an increase in the baseline mortality rate of 0.023% (Table 11.72).

598. Using the Scoping Approach, the predicted theoretical additional annual mortality due to collision was an estimated nine common terns. This corresponds to an increase in the baseline mortality rate of 0.035% (Table 11.73).

599. The estimated increase in the annual baseline mortality for common tern as a result of collision would result in a very slight decrease in the size of the regional BDMPS population of common tern in the autumn migration period of the non-breeding season, for both the Developer Approach and the Scoping Approach. The magnitude of this impact is therefore considered to be negligible.

Sensitivity of the Receptor

600. A review of post-construction studies of seabirds at offshore wind farms in European waters concluded that common tern was one of the species that was hardly affected by offshore wind farms or with attraction and avoidance approximately equal over all studies (Dierschke et al., 2016). A review of vulnerability of

Scottish seabirds to offshore wind turbines ranked common tern with the 15th highest score in the context of collision impacts, based on flight activity at blade height, manoeuvrability, time spent in flight, nocturnal flight activity and conservation importance (Furness and Wade, 2012). Similarly, Furness et al., (2013) scored common tern as the 14th highest ranked species of concern in the context of collision impacts, while Bradbury et al., (2014), classified the common tern population vulnerability to collision mortality as moderate.

601. On this basis, common tern sensitivity to collision from operational offshore wind farms is considered to be medium (Table 11.16).

602. In addition, estimated numbers of common terns recorded within the Proposed Development were considered as regionally important in the breeding season (see appendix 11.1, annex G), with individuals likely originating from a number of SPAs and non-SPAs within and outside the region. On this basis the conservation importance for common tern was considered to be low.

Significance of the Effect

603. For collision effects on common tern from the Project alone, for the Developer Approach and the Scoping Approach, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

604. No offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **negligible to minor** adverse significance, which is not significant in EIA terms.

Arctic Tern

605. For the Developer Approach, estimated Arctic tern mortality from collision impacts in the Proposed Development array area was based on mean densities of flying birds recorded on baseline digital aerial surveys. For the Scoping Approach, this was based on maximum densities of flying birds recorded on baseline digital aerial surveys.

606. The estimated number of collisions per month for Arctic tern based on the Developer Approach and the Scoping Approach are presented in Table 11.75. Figures are presented for the breeding and non-breeding seasons, based on the worst-case design scenario (307x14 MW wind turbines). Numbers are presented by month rather than seasonally, in order to demonstrate the typically low estimated numbers of collisions per month. For both the Developer Approach and the Scoping Approach, collision numbers were less than one bird per month in all months except for August.

607. For assessment purposes, the breeding season for Arctic tern has been defined as May to August, with the non-breeding season defined as September to April (NatureScot, 2020). However, there are two BDMPS periods in the non-breeding season as defined by Furness (2015). The autumn migration period covers July to early September, and the spring migration period covers late April and May. As a precautionary assessment, all estimated collisions were assessed as being from the breeding season, as well as being part of the autumn migration period. Estimated collision numbers for the spring migration period of the non-breeding season were considerably less than one whole bird, therefore no assessment was carried out for this period of the non-breeding season.

Table 11.75: Monthly estimated collisions for Arctic tern in the Proposed Development array area for the worst-case scenario (SNCBs avoidance rates, wind turbine 14 MW, Option 2), based on the Developer and Scoping Approaches. Estimates are presented using the mean avoidance rate (0.980)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Developer Approach													
	0.00	0.00	0.00	0.03	0.21	0.12	2.14	5.57	0.03	0.00	0.00	0.00	8.10
Scoping Approach													
	0.00	0.00	0.00	0.07	0.26	0.15	4.17	9.25	0.07	0.00	0.00	0.00	13.97

608. Arctic tern collisions were predicted to occur between April and September, based on densities recorded in the Proposed Development on baseline digital aerial surveys. For both the Developer Approach and the Scoping Approach, collision numbers were less than one bird per month in all months except for July and August.

609. A complete range of collision numbers for the Proposed Development, and the different design scenarios for both the Developer Approach and the Scoping Approach are presented in volume 3, appendix 11.3.

Magnitude of Impact

610. The overall baseline mortality rates were based on age-specific demographic rates and age class proportions as presented in Table 11.21. The potential magnitude of impact was estimated by calculating the increase in baseline mortality for the relevant bio-seasons with respect to the regional populations.

Table 11.76: Estimated Numbers of Collisions for Arctic Tern in the Proposed Development array area by bio-season in Relation to Baseline Mortality, for the Developer Approach

Bio-season	Estimated Seasonal Collision Mortality	Regional Baseline Population (Adults)	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (May-Aug)	8	n/a	n/a	0
Autumn Migration[1] (Jul-early Sep)	8[2]	163,930	40,327	0.02
Spring Migration[1] (Late Apr-May)	0	163,930	40,327	0

Figures in brackets represent collision estimates based on Scoping Approach (see text for details).

1 There is an overlap in the months across the three seasons as the breeding season follows the NatureScot (2020) approach, while the Autumn and Spring Migration periods follow BDMPS (Furness 2015).

2 These collision estimates have been assessed for both the breeding season and the autumn migration period, and therefore have not been summed.

Table 11.77: Estimated Numbers of Collisions for Arctic Tern in the Proposed Development array area by bio-season in Relation to Baseline Mortality, for the Scoping Approach

Bio-season	Estimated Seasonal Collision Mortality	Regional Baseline Population (Adults)	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (May-Aug)	14	n/a	n/a	0
Autumn Migration[1] (Jul-early Sep)	14[2]	163,930	40,327	0.035
Spring Migration[1] (Late Apr-May)	0	163,930	40,327	0

Figures in brackets represent collision estimates based on Scoping Approach (see text for details).

1 There is an overlap in the months across the three seasons as the breeding season follows the NatureScot (2020) approach, while the Autumn and Spring Migration periods follow BDMPS (Furness 2015).

2 These collision estimates have been assessed for both the breeding season and the autumn migration period, and therefore have not been summed.

Breeding Season

611. For the Developer Approach in the breeding season, the total estimated number of Arctic tern collisions was eight birds (Table 11.76). However, this includes non-breeding adults and immature birds, as well as breeding adults. The age breakdown of Arctic terns recorded on baseline digital aerial surveys by bio-season is presented in Table 11.78. Based on the proportion of immature Arctic terns recorded on digital aerial baseline surveys in the breeding season, 8% of the population present in the breeding season are immature birds. This would mean that seven adult Arctic terns and one immature bird are predicted to collide with wind turbines in the breeding season, based on the worst-case design scenario.

612. For the Scoping Approach in the breeding season, the total estimated number of Arctic tern collisions was 14 birds (Table 11.77), however, this includes non-breeding adults and immature birds, as well as breeding adults. Based on the proportion of immature Arctic terns recorded on digital aerial baseline surveys in the breeding season (Table 11.78), 8% of the population present in the breeding season are immature birds. This would mean that 13 adult Arctic terns and one immature bird are predicted to collide with wind turbines in the breeding season, based on the worst-case design scenario.

Table 11.78: Proportions of juvenile, immature and adult Arctic Tern recorded on Digital Aerial Surveys

Season	Juvenile	Immature	Adult
Breeding (May-Aug)	0.08	0	0.92
Non-breeding (Sep-Apr)	0.08	0	0.92

613. There are no Arctic tern breeding colonies within mean maximum foraging range (plus 1S.D.) of the Proposed Development array area, based on the published range of 25.7±14.8 km (Woodward et al., 2019). In addition, numbers of Arctic terns recorded in the Proposed Development array area were very low in the early part of the breeding season, between April and June (Table 11.75). Numbers increased slightly in July and August, by which time failed breeding birds or early fledged juveniles will have left breeding colonies elsewhere. Large flocks of Arctic terns on passage are regularly recorded on the east coast of Scotland in July and August, for example 1,000 at Tenstsmuir (Fife) on 9th August 1986, 1,500 there 26th July 1991 and 1,600 at Goosepools (Fife) on 7th August 2000. These birds are known to remain in Scottish coastal waters such as the Forth of Forth to feed for one to two weeks before migrating south for the winter (Forrester et al., 2007). For these reasons, it was concluded that none of the predicted Arctic tern collisions for the Developer Approach or the Scoping Approach during the breeding season were from the regional breeding population. Therefore, there will be no impact from collision on the Arctic tern regional breeding population in the breeding season.

Non-breeding Season – Autumn Migration Period

614. According to the BDMPS review, the autumn migration period of the non-breeding season in UK waters for Arctic tern is defined as July to early September (Furness, 2015). Therefore the predicted Arctic tern collisions between July and August could be considered to be from the regional BDMPS population for the autumn migration period, rather than from the regional breeding population, as outlined above. Collision impacts for the Developer Approach and the Scoping Approach have therefore also been assessed on this basis.

615. For the Developer Approach in the autumn migration period, the total estimated number of Arctic tern collisions (rounded up) was eight birds (Table 11.76). Based on Furness (2015), the total Arctic tern BDMPS regional baseline population for the autumn migration period is estimated to be 163,930 individuals (Table 11.9). Using the average baseline mortality rate of 0.246 (Table 11.21), the estimated baseline mortality of Arctic tern is 40,327 birds in the autumn migration period. The additional predicted mortality of eight Arctic terns would increase the baseline mortality rate by 0.02% (Table 11.76).

616. For the Scoping Approach in the autumn migration period, the total estimated number of Arctic tern collisions (rounded up) was 14 birds. The additional predicted mortality of 14 Arctic terns would increase the baseline mortality rate by 0.035% (Table 11.77)).

617. For both approaches, this level of potential impact is considered to be of negligible magnitude during the autumn migration period of the non-breeding season, as it represents no discernible increase to baseline mortality levels as a result of collision.

Assessment of Collision Mortality throughout the Year

618. As there are no Arctic tern colonies within mean maximum foraging range (plus 1S.D.) of the Proposed Development array area, there will be no impact from collision on the Arctic tern regional breeding population in the breeding season.

619. As there were very low numbers of predicted Arctic tern collisions for the spring period of the non-breeding season, the totals for the autumn period of the non-breeding season therefore represent the annual collision totals for this species.

620. Using the Developer Approach, the predicted theoretical additional annual mortality due to collision was an estimated eight Arctic terns. This corresponds to an increase in the baseline mortality rate of 0.02% (Table 11.76).

621. Using the Scoping Approach, the predicted theoretical additional annual mortality due to collision was an estimated 14 Arctic terns. This corresponds to an increase in the baseline mortality rate of 0.035% (Table 11.77).

622. The estimated increase in the annual baseline mortality for Arctic tern as a result of collision would result in a very slight decrease in the size of the regional BDMPS population of Arctic tern, in the autumn migration period of the non-breeding season, for both the Developer Approach and the Scoping Approach. The magnitude of this impact is therefore considered to be negligible.

Sensitivity of the Receptor

623. A review of post-construction studies of seabirds at offshore wind farms in European waters concluded that Arctic tern was one of the species that was hardly affected by offshore wind farms or with attraction and avoidance approximately equal over all studies (Dierschke et al., 2016). A review of vulnerability of Scottish seabirds to offshore wind turbines ranked Arctic tern with the 18th highest score in the context of collision impacts, based on flight activity at blade height, manoeuvrability, time spent in flight, nocturnal flight activity and conservation importance (Furness and Wade, 2012). Similarly, Furness et al., (2013) scored Arctic tern as the 17th highest ranked species of concern in the context of collision impacts, while Bradbury et al., (2014), classified the Arctic tern population vulnerability to collision mortality as low.

624. On this basis, Arctic tern sensitivity to collision from operational offshore wind farms is considered to be medium (Table 11.16).

625. In addition, estimated numbers of Arctic terns recorded within the Proposed Development were considered as regionally important in the breeding season (See volume 3, appendix 11.1, annex G), prior to the August influx of birds from SPA and non-SPA breeding colonies from within and outside the region. On this basis the conservation importance for Arctic tern was considered to be low.

Significance of the Effect

626. For collision effects on Arctic tern from the Project alone, for the Developer Approach and the Scoping Approach, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

627. No offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **negligible to minor** adverse significance, which is not significant in EIA terms.

Great Skua

628. For the Developer Approach, estimated great skua mortality from collision impacts in the Proposed Development array area was based on mean densities of flying birds recorded on baseline digital aerial surveys. For the Scoping Approach, this was based on maximum densities of flying birds recorded on baseline digital aerial surveys.

629. When rounded to the nearest whole bird, the estimated annual number of collisions for great skua were zero for both the Developer Approach and the Scoping Approach (Table 11.46). Total annual estimates for both approaches were very low, at 0.17 birds per year for the Developer Approach, and 0.35 birds per year for the Scoping Approach (volume 3, appendix 11.3. These estimates were made based on the very precautionary avoidance rate of 0.98, therefore actual numbers of collisions are considered to be even lower than these estimates.

Magnitude of Impact

630. The estimated increase in the annual baseline mortality for great skua as a result of collision would result in a very slight decrease in the size of the regional great skua population, for both the Developer Approach and the Scoping Approach. The magnitude of this impact is therefore considered to be negligible.

Assessment of Collision Mortality throughout the Year

631. This level of potential impact is considered to be of negligible magnitude throughout the year, as it represents no discernible increase to baseline mortality levels as a result of collision.

Sensitivity of the Receptor

632. Great skua was not included in a review of post-construction studies of seabirds at offshore wind farms in European waters (Dierschke et al., 2016). However, a review of vulnerability of Scottish seabirds to offshore wind turbines ranked great skua as the ninth highest score in the context of collision impacts, based on flight activity at blade height, manoeuvrability, time spent in flight, nocturnal flight activity and conservation importance (Furness and Wade, 2012), as did a similar review by Furness et al., (2013). Bradbury et al., (2014), classified the great skua population vulnerability to collision mortality as moderate.

633. On this basis, great skua sensitivity to collision from operational offshore wind farms is considered to be medium (Table 11.16).

634. In addition, estimated numbers of great skuas recorded within the Proposed Development were considered to be regionally important in the autumn migration period of the non-breeding season (See volume 3, appendix 11.1, annex G), with individuals likely originating from a number of SPAs and non-SPAs within and outside the region. On this basis the conservation importance for great skua was considered to be low.

Significance of the Effect

635. For collision effects on great skua from the Project alone, for the Developer Approach and the Scoping Approach, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

636. No offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **negligible to minor** adverse significance, which is not significant in EIA terms.

Collision assessment for migratory species

637. This collision assessment covers migratory water birds and seabirds on passage that were recorded on site-specific baseline surveys. Firstly, a screening exercise was undertaken to review which species to include in the collision assessment (Table 11.79). Some seabird species were screened out on the basis of evidence from previous reviews as to their risk of collision impacts (e.g. Furness and Wade, 2012, Furness et al., 2013 and Bradbury et al., 2014). Other seabird species have already been assessed using CRM. The remaining species that require a collision assessment were assessed using results from the Strategic Assessment of Collision Risk of Scottish Offshore Wind Farms to Migrating Birds (WWT, 2014), as advised in the Scoping Opinion.

638. For the WWT (2014) study, UK seabird and non-seabird species populations potentially at risk from collision with wind turbines at Scottish offshore wind farm sites were shortlisted, proportions of the populations likely to pass the wind farm sites were estimated and CRM was performed. Modelling was carried out for 27 seabird species and 38 non-seabird species. For seabirds, modelling sensitivity analysis was conducted by assuming different migratory corridors and distributions within those corridors and species-specific flying height distributions.

639. It was not possible to use the same approach for non-seabird species, as their migration routes are typically less well known. Instead, migration corridor widths for non-seabird species passing Scottish coastal waters were assumed to comprise the cross-sectional width of the Scottish coast perpendicular to the species flyway or flyways (superimposed as close to the coast as possible). During the CRM the number of individuals of each species estimated to be at risk of collision at each wind farm was calculated as the passage population multiplied by the proportional overlap of each wind farm and that species' migration corridor width.

640. A number of assumptions were made in the analyses, including on migratory routes and bird distributions within those routes, flight heights and wind turbine avoidance rates (98% was used for all species). In addition, where contemporary population estimates were not available the analyses made use of historic population counts. Collision mortality estimates were assessed in relation to an indicative threshold value of 1% of the passage population. Further details are provided within the Strategic Collision Assessment report (WWT, 2014).

Table 11.79: Type of Collision Assessment undertaken for Bird Species Recorded on Digital Aerial Baseline Surveys in the Offshore Ornithology study area between March 2019 and April 2021.

Species	Raw Total Number Recorded[1]	Sensitivity to Collision with Offshore Wind Farms[2]	Collision Assessment Required	Type of Collision Assessment Undertaken
Pink-footed goose	17		Y	WWT, 2014
Teal	2		Y	WWT, 2014
Tufted duck	2		Y	WWT, 2014
Common scoter	3	Low risk	Screened out	-
Goosander	2	Low risk	Screened out	-
Red-necked grebe[3]	1	Very low risk	Screened out	-
Oystercatcher	1		Y	WWT, 2014
Lapwing	1		Y	WWT, 2014
Golden plover	55		Y	WWT, 2014
Curlew	3		Y	WWT, 2014
Woodcock	2		Y	WWT, 2014
Kittiwake	R	High risk	Y	CRM
Black-headed gull	2	Moderate risk	Y	WWT, 2014
Little gull	73	Moderate risk	Y	CRM
Common gull	R	High risk	Y	WWT, 2014
Great black-backed gull	R	Very high risk	Y	WWT, 2014
Herring gull	R	Very high risk	Y	CRM
Lesser black-backed gull	R	Very high risk	Y	CRM
Sandwich tern	11	Moderate risk	Y	WWT, 2014
Common tern	R	Moderate risk	Y	CRM
Arctic tern	R	Moderate risk	Y	CRM
Great skua	29	Moderate risk	Y	CRM
Pomarine skua	1	Low risk	Screened out	-
Arctic skua	6	Moderate risk	Y	WWT, 2014
Little auk	R	Very low risk	Screened out	-
Guillemot	R	Very low risk	Screened out	-
Razorbill	R	Very low risk	Screened out	-
Puffin	R	Very low risk	Screened out	-
Red-throated diver	36	Moderate risk	Y	WWT, 2014
Great northern diver	1	Moderate risk	Y	WWT, 2014
European storm-petrel	6	Low risk	Screened out	-
Fulmar	R	Very low risk	Screened out	-
Sooty shearwater	2	Very low risk	Screened out	-
Manx shearwater	33	Very low risk	Screened out	-
Gannet	R	High risk	Y	CRM
Shag	4	Moderate risk	Y	WWT, 2014

1 Where the total raw number of a species exceeded 100, the species was considered to occur regularly, denoted by R in table.

2 Based on rankings presented in Furness and Wade (2012), Furness et al., (2013) and Bradbury et al., 2014).

3 Based on sensitivity ranking for similar species great crested grebe.

641. A total of 16 species of seabird and water bird were assessed for collision impacts using the Strategic Collision Assessment report (WWT, 2014) (Table 11.79). These species are discussed below.

Table 11.80: Passage Populations of Seabird Species Recorded in the Offshore Ornithology study area on Baseline Surveys, with Estimated Proportions Passing Along Scottish East Coast, Assigned Coastal Strip and Overall Percent of Species Estimated to fly at Rotor Height

Species	Passage Population Spring	Passage Population Autumn	East Coast Proportion	Coastal Strip (km)	% Estimated to Fly at Collision Height (Cook et al., 2012)
Black-headed gull	120,000	120,000	0.7	0-60	7.9%
Common gull	300,000	300,000	0.7	0-20	22.9%
Great black-backed gull	10,000	10,000	0.7	0-20	33.1%
Sandwich tern	3,000	5,000	0.8	0-10	3.6%
Arctic skua	5,000	10,000	0.5	0-20	3.8%
Red-throated diver	10,000	10,000	0.25	0-20	2.0%
Great northern diver	3,000	3,000	0.4	0-40	2.0%
Shag	70,000	70,000	0.6	0-10	12.4%

Table 11.81: Passage Populations of Water Bird Species Recorded in the Offshore Ornithology study area on Baseline Surveys, with Estimated Proportions Passing Along Scottish East Coast, Assigned Coastal Strip and Overall Percent of Species Estimated to fly at Rotor Height

Species	Passage Population Spring	Passage Population Autumn	East Coast Proportion	Coastal Strip (km)	% Estimated to Fly at Collision Height (Cook et al., 2012)
Pink-footed goose	360,000	360,000	0.7	620.6	30%
Teal	100,000	100,000	0.5	1,140	15%
Tufted duck	213,000	213,000	0.25	1,134.6	15%
Oystercatcher	80,000	80,000	0.5	1,138.6	25%
Golden plover	30,000	60,000	0.5	1,124.2	25%
Curlew (breeding)	116,000	116,000	0	380	25%
Curlew (wintering)	85,700	85,700	1	520	25%
Woodcock (breeding)	34,000	34,000	0	380	25%
Woodcock (wintering)	644,000	644,000	0	520	25%

642. The WWT (2014) assessment then used the migration extension of the Band (2012) offshore CRM to calculate spring and autumn mortality estimates of seabirds and water birds. For seabird species for which flight height data were available (Cook *et al*. 2012) all three model options were used. For seabird species lacking flight height data and for non-seabird species only Option 1 was used. An avoidance rate of 98% was assumed for all collision estimates generated during this assessment. Species biometrics used in the collision modelling are detailed in the Strategic Collision Assessment report (WWT, 2014).

643. For seabirds the passage population was adjusted to account for collisions at each wind farm, on the assumption that each wind farm modelled was encountered in order, from north to south in autumn and vice versa in spring. This removed the possibility of individuals being 'killed' multiple times. This adjustment used the 98% avoidance rate mortality. No such adjustment was made for non-seabird species, since these birds were modelled as crossing the offshore wind farms on broad fronts which encompassed all the wind farms within their migration corridor. Thus, non-seabird species' populations were modelled as if each individual was only at risk of encountering one Scottish wind farm.

644. The steps undertaken for estimating collision mortality are summarised below:

- The seasonal (spring/autumn) passage population was proportionately split into east and west components;
- Seabirds: the passage population was multiplied by the proportional overlap between each wind farm in turn and the species' migration corridor;
- Terrestrial: the passage population was multiplied by the average width of each wind farm divided by the species' migration front (i.e., to obtain the proportion of the population passing through each wind farm);
- Application of the Band (2012) migrant CRM to the population passing through the wind farm to estimate numbers in collision; and
- Individual wind farm collision estimates summed for each species.

645. For the seabird species listed in Table 11.80, a range of collision results are presented based on the different widths of coastal strip and the different flight distributions that were run through the collision model (Table 11.82). Six tables of estimated collision numbers were produced, based on corridor width, corridor distance from shore (near/mid/far) and also uniform or skewed flight distribution within the corridor. Each combination of coastal corridor distance from shore and flight distribution generated different collision estimates due to the variation in the extent of overlap between each corridor and the offshore wind farms. However, the WWT (2014) report concluded that it was not possible to determine which of the alternative scenarios provided the closest representation of migration activity for any given seabird species.

Table 11.82: Estimated Collisions based on Band Option 2, during Spring and Autumn Passage for Populations of Seabird Species Recorded in the Offshore Ornithology study area on Baseline Surveys

Species	Summed Spring and Autumn Passage Population	Minimum Annual Collision Estimates at 98% Avoidance (95% ci)	Maximum Annual Collision Estimates at 98% Avoidance (95% ci)	Collision Estimate as % of Passage Population
Black-headed gull	240,000	436 (19-2,818)	656 (29-4,230)	0.18-0.27%
Common gull	600,000	1,126 (406-2,332)	9,158 (3,332-18,894)	0.19-1.53%
Great black-backed gull	91,399[2]	66 (36-113)	513 (280-895)	0.07-0.56%
Sandwich tern	8,000	3 (0-16)	37 (8-343)	0.04-0.46%
Arctic skua	15,000	6 (0-29)	30 (0-136)	0.04-0.2%
Red-throated diver	20,000	7 (5-10)	17 (12-22)	0.04-0.09
Great northern diver[1]	6,000	4	5	0.07-0.08
Shag	140,000	105 (24-471)	1,209 (200-6,240)	0.08-0.86%

1 Based on Band Option 1 due to lack of flight height data.

2 for great black-backed gulls, as Scottish birds are largely sedentary with birds from Norway and further east adding to the non-breeding season population (Forrester et al., 2007), the BDMPS non-breeding season population Furness, 2015) was used, rather than the summed passage population.

646. For the non-seabird species listed in Table 11.81, the annual migration collision mortality estimates based on an avoidance rate of 98% for all species are presented in Table 11.83. Following publication of the WWT (2014) report, NatureScot amended the goose avoidance rate to 99.8%, which reduced the values for pink-footed goose by 1/10th. This has been amended in Table 11.83.

Table 11.83: **Estimated Collisions based on Band Option 2 during Spring and Autumn Passage for Populations of Seabird Species Recorded in the Offshore Ornithology study area on Baseline Surveys**

Species	Combined Spring and Autumn Passage Population	Annual Collision Estimates at 98% Avoidance	Collision Estimate as % of Passage Population
Pink-footed goose	720,000	80[1]	0.01%
Teal	200,000	39	0.02%
Tufted duck	426,000	70	0.02%
Oystercatcher	160,000	65	0.04%
Golden plover	90,000	33	0.04%
Curlew (breeding)	232,000	174	0.08%
Curlew (wintering)	171,400	207	0.12%
Woodcock (breeding)	68,000	55	0.08%
Woodcock (wintering)	1,288,000	767	0.06%

1 Based on NatureScot revised avoidance rate of 99.8%.

647. Assuming an indicative threshold value of 1% of the passage population, no non-seabird species had collision mortality estimates (at 98% avoidance) that were of concern (Table 11.83).

648. The only non-seabird species that was recorded in the Offshore Ornithology study area on baseline surveys but is not considered in the WWT (2014) report was lapwing. This species was not included for CRM in the WWT (2014) report due to a lack of data on numbers in Scotland during spring and autumn passage. However, as only one individual was recorded in February 2021, it is considered that numbers of lapwing passing through the Proposed Development array area on spring and autumn passage is likely to be low. Overall, it is considered likely that the population of lapwings which pass through Scottish waters do not appear to be at risk of significant levels of additional mortality due to collisions with Scottish offshore wind farms, for the same reasons as other wader species.

649. The report concluded that at a strategic level the populations of non-seabird species which pass through Scottish waters do not appear to be at risk of significant levels of additional mortality due to collisions with Scottish offshore wind farms. On this basis, it is concluded that there will not be a significant level of additional mortality due to collisions with the Proposed Development array area for the non-seabird species recorded on baseline surveys.

11.11.1. PROPOSED MONITORING

650. This section outlines the proposed monitoring proposed for offshore and intertidal ornithology. Proposed monitoring measures are outlined in Table 11.84 below.

Table 11.84: **Monitoring Commitments for Offshore and Intertidal Ornithology**

Potential Environmental Effect	Monitoring Commitment	Means of Implementation
Displacement effects	Post-construction monitoring of seabird distributions in relation to the Proposed Development	Digital aerial surveys
Displacement and barrier effects Population-level effects	Co-funder of long-term breeding season GPS tracking studies on key species from key SPAs	GPS tracking programme for kittiwake on Isle of May, Fowlsheugh and St Abb's Head, and guillemot, razorbill and puffin on Isle of May
Collision effects	Co-funder of post-construction Seabirds Interaction Study at NnG offshore wind farm	Use of wind turbine mounted cameras and radar to investigate seabird interactions with offshore wind turbines
Population-level effects	Co-funder of long-term colour-ringing adult gannet study	Colour-ringing programme for adult gannets as well as resighting programme on Bass Rock, with Grassholm as control site
Ecosystem-level effects	In-principal support to PrePARED and EcoWind programmes of work	Access to the Berwick Bank offshore wind farm for data collection purposes; Provision of data gathered on key seabird species; Support of staff time to engage with the research team

11.12. CUMULATIVE EFFECTS ASSESSMENT

11.12.1. METHODOLOGY

651. The Cumulative Effects Assessment (CEA) takes into account the impact associated with the Proposed Development together with other relevant plans, projects and activities. Cumulative effects are therefore the combined effect of the Proposed Development in combination with the effects from a number of different projects, on the same receptor or resource. Please see volume 1, chapter 6 for detail on CEA methodology.

652. The projects and plans selected as relevant to the CEA presented within this chapter are based upon the results of a screening exercise (see volume 3, appendix 6.3 of the Offshore EIA Report). Each project or plan has been considered on a case by case basis for screening in or out of this chapter's assessment based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved.

653. In undertaking the CEA for the Proposed Development, it is important to bear in mind that other projects and plans under consideration will have differing potential for proceeding to an operational stage and hence a differing potential to ultimately contribute to a cumulative impact alongside the Proposed Development. Therefore, a tiered approach has been adopted. This provides a framework for placing relative weight upon the potential for each project/plan to be included in the CEA to ultimately be realised, based upon the project/plan's current stage of maturity and certainty in the projects' parameters. The tiered approach which has been utilised within the Proposed Development CEA employs the following tiers:

- tier 1 assessment – Proposed Development (Berwick Bank Wind Farm offshore) with Berwick Bank Wind Farm onshore;
- tier 2 assessment – All plans/projects assessed under Tier 1, plus projects which are operational, under construction, those with consent, and those which have been submitted but are not yet determined;
- tier 3 assessment – All plans/projects assessed under Tier 2, plus those projects that have submitted Scoping Report but not a consent application; and

- tier 4 assessment – All plans/projects assessed under Tier 3, plus those projects likely to come forward where an Agreement for Lease (AfL) has been granted.

654. This tiered approach has been adopted to provide an explicit assessment of the Proposed Development as a whole.

655. The specific projects scoped into the CEA for offshore and intertidal ornithology, are outlined in Table 11.85.

656. The range of potential cumulative impacts is a subset of those considered for the Proposed Development alone assessment. This is because some of the potential impacts identified and assessed for the Proposed Development alone, are localised and temporary in nature. It is considered therefore, that these potential impacts have limited or no potential to interact with similar changes associated with other plans or projects. These have therefore been scoped out of the CEA.

657. Similarly, some of the potential impacts considered within the Proposed Development alone assessment are specific to a particular phase of development (e.g. construction, operation and maintenance or decommissioning). Where the potential for cumulative effects with other plans or projects only have potential to occur where there is spatial or temporal overlap with the Proposed Development during certain phases of development, impacts associated with a certain phase may be omitted from further consideration where no plans or projects have been identified that have the potential for cumulative effects during this period.

658. As described in volume 1, chapter 3, the Applicant is developing an additional export cable grid connection to Blyth, Northumberland (the Cambois connection). Therefore, applications for necessary consents (including marine licences) will be applied for separately. The CEA for the Cambois connection is based on information presented in the Cambois Connection Scoping Report (SSER, 2022e), submitted in October 2022. The Cambois connection was considered in the CEA for offshore and intertidal ornithology as the Cambois connection will overlap spatially and temporally with the Proposed Development and the project will engage in activities such as cable burial and installation of cable protection which could potentially impact offshore and intertidal ornithology IEFs. However, based on conclusions on the likely scale of impact from such operations on benthic and fish IEFs (see volume 2, chapters 8 and 9) and limited potential for indirect effects on birds as a result of temporary changes to prey distribution (see paragraph 106 onwards), the potential for cumulative impacts has been screened out (Table 11.86).

Table 11.85: List of Other Projects and Plans Considered Within the CEA for Offshore and Intertidal Ornithology

Project/Plan	Status [i.e. Application, Consented, Under Construction, Operational]	Description of Project/Plan	Overlap with the Proposed Development
Tier 1			
Offshore Wind Projects and Associated Cables			
No Tier 1 projects identified within the regional Offshore Ornithology study area			
Tier 2			
Offshore Wind Projects and Associated Cables			
Beatrice Offshore Wind Farm	Active/In Operation	84 wind turbines	Operation
Blyth Demo Phase 1	Active/In Operation	15 wind turbines	Operation
Blyth Demo Phase 2	Consented	Up to 5 floating wind turbines	Possible Construction and Operation
Dogger Bank (Creyke Beck) A	Under Construction	Up to 200 wind turbines	Operation
Dogger Bank (Creyke Beck) B	Under Construction	Up to 200 wind turbines.	Operation
Dogger Bank C (Teesside A)	Under Construction		Operation
Sofia Offshore Wind Farm (Teesside B)	Under Construction		Operation
Dudgeon	Active/In Operation	67 wind turbines	Operation
East Anglia One	Active/In Operation	Up to 325 wind turbines	Operation
East Anglia One North	Consented	Up to 67 wind turbines	Possible Construction and Operation
East Anglia Two	Consented	Up to 75 wind turbines	Possible Construction and Operation
East Anglia Three	Consented	Up to 172 wind turbines	Possible Construction and Operation
European Offshore Wind Deployment Centre (EOWDC)	Active/In Operation	Up to 11 wind turbines	Operation
Galloper	Active/In Operation	Up to 56 wind turbines	Operation
Greater Gabbard	Active/In Operation	140 wind turbines	Operation
Gunfleet Sands I and II	Active/In Operation	Up to 30 wind turbines	Operation
Hornsea One	Active/In Operation	Up to 120 wind turbines	Operation
Hornsea Project Two	Active/In operation	Up to 360 wind turbines	Operation
Hornsea Project Three (HOW03)	Consented	Up to 231 wind turbines	Possible Construction and Operation
Hornsea Project Four (HOW04)	Submitted	Up to 180 wind turbines	Possible Construction and Operation
Humber Gateway	Active/In Operation	Up to 83 wind turbines	Operation
Hywind	Active/In Operation	Up to 5 wind turbines	Operation
Inch Cape Offshore Wind Farm - 15680	Consented	Up to 72 wind turbines	Possible Construction and Operation
Kentish Flats	Active/In Operation	Up to 30 wind turbines	Operation
Kentish Flats Extension	Active/In Operation	Up to 17 wind turbines	Operation
Kincardine Offshore Windfarm	Active/In Operation	Up to 8 wind turbines	Operation
Levenmouth Demonstration Wind Turbine	Active/In Operation	1 wind turbine	Operation
Lincs	Active/In Operation	75 wind turbines	Operation
London Array	Active/In Operation	175 wind turbines	Operation

Project/Plan	Status [i.e. Application, Consented, Under Construction, Operational]	Description of Project/Plan	Overlap with the Proposed Development
Lynn and Inner Dowsing Wind Farms	Active/In Operation	54 wind turbines	Operation
Methil Offshore Wind Farm	Active/In Operation	1 wind turbine	Operation
Moray Offshore Windfarm (East)	Active/In Operation	100 wind turbines	Operation
Moray Offshore Windfarm (West)	Consented	Up to 85 wind turbines	Possible Construction and Operation
Neart Na Gaoithe Offshore Wind farm	Under Construction	Up to 75 wind turbines	Operation
Norfolk Boreas offshore wind farm	Consented	Up to 158 wind turbines	Operation
Norfolk Vanguard Offshore Windfarm	Consented	Up to 200 wind turbines	Possible Construction and Operation
Race Bank	Active/In Operation	91 wind turbines	Possible Construction and Operation
Scroby Sands	Active/In Operation	30 Wind turbines	Operation
Sheringham Shoal	Active/In Operation	88 wind turbines	Operation
Teesside	Active/In Operation	27 wind turbines	Operation
Triton Knoll	Active/In Operation	90 wind turbines	Operation
Westermost Rough	Active/In Operation	35 wind turbines	Operation
Wind T and D Site (Dounreay Tri Ltd)	Active/In Operation	2 wind turbines	Operation
Seagreen 1	Under Construction	114 wind turbines	Operation
Seagreen 1A Project	Consented	36 wind turbines	Possible Construction and Operation
Tier 3			
Offshore Wind Projects and Associated Cables			
Sheringham Shoal Extension	Scoping	Up to 27 wind turbines	Possible Construction and Operation
Dudgeon Extension Project	Scoping	Up to 34 wind turbines	Possible Construction and Operation
Forthwind Demonstration Project	Scoping	1 wind turbine	Possible Construction and Operation
Green Volt Floating Offshore Wind Farm	Scoping	Up to 30 wind turbines	Possible Construction and Operation
West of Orkney Wind Farm	Scoping	Up to 125 wind turbines	Possible Construction and Operation
Five Estuaries	Pre-planning Application	Up to 79 wind turbines	Possible Construction and Operation
North Falls	Pre-planning Application	Up to 71 wind turbines	Possible Construction and Operation
Dogger Bank South (East)	Scoping	Up to 150 wind turbines	Possible Construction and Operation
Dogger Bank South (West)	Scoping	Up to 150 wind turbines	Possible Construction and Operation
Outer Dowsing	Scoping	Up to 100 wind turbines	Possible Construction and Operation
Cambois connection	Pre-planning Application	NA	The construction and operation and maintenance phases of the Cambois connection overlap with the construction and operation and maintenance phases of the Proposed Development
Tier 4			
Offshore Wind Projects and Associated Cables			
ScotWind 1, Site 1: BP and EnBW: Morven	Lease - Marine	Up to 2,907 MW capacity.	
ScotWind 1, Site 2: SSE Renewables, CIP and Marubeni: Project name TBC	Lease - Marine	Up to 2,610 MW capacity.	
ScotWind 1, Site 3: Falck Renewables and BlueFloat Energy: Bellrock	Lease - Marine	Up to 1,200 MW capacity.	
ScotWind 1, Site 4: ScottishPower Renewables and Shell - CampionWind	Lease - Marine	Up to 2,000 MW capacity.	

Project/Plan	Status [i.e. Application, Consented, Under Construction, Operational]	Description of Project/Plan	Overlap with the Proposed Development
ScotWind 1, Site 5: Vattenfall and Fred Olsen Renewables: Cumhachd Ri Teachd	Lease - Marine	Up to 798 MW capacity.	
ScotWind 1, Site 6: Thistlewind Partners - Cluaran Deas Ear	Lease - Marine	Up to 1,008 MW capacity.	
NE1 - in clearing process	N/a	N/a	
ScotWind 1, Site 7: Thistlewind Partners: Cluaran Ear Thuath	Lease - Marine	Up to 1,008 MW capacity.	
ScotWind 1, Site 8: Flack Renewables, Orsted and Bluefloat Energy: Stromer	Lease - Marine	Up to 1,000 MW capacity.	
ScotWind 1, Site 9: Ocean Winds: Caledonia	Lease - Marine	Up to 1,000 MW capacity.	
NE5: Dropped since Draft	N/a	N/a	
ScotWind 1, Site 10: Flack Renewables, Orsted and Bluefloat Energy: BroadShore	Lease - Marine	Up to 500 MW capacity.	
ScotWind 1, Site 11: ScottishPower Renewables and Shell: MarramWind	Lease - Marine	Up to 3,000 MW capacity.	
ScotWind 1, Site 12: Floating Energy Allyance: Buchan	Lease - Marine	Up to 960 MW capacity.	
ScotWind 1, Site 13: RIDG, Corio Generation and TotalEngergies: West of Orkney	Lease - Marine	Up to 960 MW capacity.	
N3ScotWind 1, Site 14: Northland Power: Mhairi	Lease - Marine	Up to 1,500 MW capacity.	
ScotWind 1, Site 15: Magnora Offshore Wind: Project name TBC	Lease - Marine	Up to 496 MW capacity.	
ScotWind 1, Site 16: Northland Power: Sheena	Lease - Marine	Up to 840 MW capacity.	
ScotWind 1, Site 17: ScottishPower Renewables: Machairwind	Lease - Marine	Up to 840 MW capacity.	
ScotWind 1 Site 18: Ocean Winds: Project Name TBC	Lease - Marine	Up to 500 MW capacity.	
ScotWind 1 Site 19: Mainstream Renewables: Project Name TBC	Lease - Marine	Up to 1,500 MW capacity.	
ScotWind 1 Site 20: ESB Asset Development: Project Name TBC	Lease - Marine	Up to 500 MW capacity.	

11.12.2. CUMULATIVE EFFECTS ASSESSMENT

659. An assessment of the likely significance of the cumulative effects of the Proposed Development upon offshore and intertidal ornithology receptors arising from each identified impact is given below.

660. The approach to the CEA was discussed at Ornithology Road Map Meeting 5 (volume 3, appendix 11.8) and was also followed advice presented in the Scoping Opinion.

661. As for the project alone assessment, there were two approaches undertaken for the CEA; the Developer Approach and the Scoping Approach. The reasons for undertaking the Developer Approach in addition to the Scoping Approach are laid out in volume 3, appendix 11.3 and appendix 11.4.

Screening for Cumulative Effects

662. Potential effects arising from the Proposed Development alone have been screened for their potential to create a cumulative impact for ornithological receptors (Table 11.86).

Table 11.86: Potential cumulative effects for ornithological receptors

Impact	Potential for Cumulative Impact	Data Confidence	Rationale
Construction phase			
Disturbance and Displacement	No	High	There is a possibility that construction could overlap temporally with construction of Inch Cape and Seagreen 1a projects and the installation of the Cambois grid connection. However, the impact assessments for these projects have identified very small magnitudes of impact, and even if these occurred at the same time this would not constitute a significant effect.
Indirect impacts through effects on habitats and prey species	No	High	There is a possibility that construction would overlap temporally with construction of Inch Cape and Seagreen 1a projects, and the installation of the Cambois grid connection. However, the impact assessments for these projects have identified very small magnitudes of impact, and even if these occurred at the same time this would not constitute a significant effect.
Operation and Maintenance			
Disturbance and Displacement[1]	Yes	Medium-Low	There is potential for a cumulative effect, so a detailed, quantitative cumulative effect assessment is required. Note that data confidence is lower for older wind farms due to variations in the level of detail reported. There is greater confidence in assessments for more recent wind farms which have typically followed a standard approach to assessment and reporting.
Indirect impacts through effects on habitats and prey species	No	High	Low potential for cumulative effect because the contribution from the Proposed Development is small.
Collision risk	Yes	Medium	There is potential for a cumulative effect, so a detailed, quantitative cumulative effect assessment is required
Decommissioning			
Disturbance and Displacement	No	High	Low potential for cumulative effect because the contribution from the proposed project is small and it is dependent on a temporal and spatial co-incidence of disturbance/displacement from other plans or projects.
Indirect impacts through effects on habitats and prey species	No	High	Low potential for cumulative effect because the contribution from the proposed project is small and it is dependent on a temporal and spatial co-incidence of disturbance/displacement from other plans or projects.

1 Barrier effect is also included as CEA is based on SNCB Matrix approach (SNCBs, 2017).

Tier 1

663. For the cumulative displacement assessment, there are no cumulative displacement impacts for Tier 1.

Tier 2

Construction phase

664. Cumulative effects in the construction phase were scoped out in Table 11.86 and so are not considered further here.

Operation and maintenance phase

Gannet

665. There is potential for both cumulative collision impacts and cumulative displacement effects on gannet. Each of these potential impacts have been assessed separately and then combined to provide an overall cumulative impact. Cumulative collision impacts for gannets are presented in paragraph 870 onwards.

666. The estimated cumulative abundance of gannets from the relevant projects are presented in Table 11.87. There are a number of projects for which there are no, or limited, data on the number of gannets predicted to be displaced, in particular, for some of the earlier Round 1 and Round 2 developments.

667. The mean maximum foraging range +1 SD for gannet is 315.2±194.2 km. Projects within this foraging range during the breeding period are highlighted in bold in Table 11.87.

Table 11.87: Cumulative Abundance of Gannets for North Sea offshore wind farm Projects (Projects in bold are within 509.4 km of Proposed Development)

Project	Annual Cumulative Abundance	Breeding Season Cumulative Abundance	Autumn Migration Cumulative Abundance	Spring Migration Cumulative Abundance
Aberdeen	**40**	**35**	**5**	**0**
Beatrice	**151**	**151**	**0**	**0**
Blyth Demo			**0**	**0**
Dogger Bank A and B	**4,692**	**2,250**	**2,048**	**394**
Dogger C and Sofia	**2,506**	**1,155**	**887**	**464**
Dudgeon	**89**	**53**	**25**	**11**
Dudgeon Extension and Sheringham Shoal Extension (PEIR)	**1,086**	**401**	**638**	**47**
East Anglia 1 North	**661**	**149**	**468**	**44**
East Anglia 2	**1,275**	**192**	**891**	**192**
East Anglia 3	**2,205**	**412**	**1,269**	**524**
East Anglia One	**3,875**	**161**	**3,638**	**76**
Galloper	**1,543**	**360**	**907**	**276**
Greater Gabbard	**426**	**252**	**69**	**105**
Gunfleet Sands	**21**	**0**	**12**	**9**
Hornsea Project Four	**1,880**	**791**	**854**	**235**
Hornsea Project One	**1,615**	**671**	**694**	**250**
Hornsea Project Three	**2,844**	**1,333**	**984**	**527**
Hornsea Project Two	**1,721**	**457**	**1,140**	**124**
Humber Gateway			**0**	**0**
Hywind	**14**	**10**	**0**	**4**
Inch Cape	**3,313**	**2,398**	**703**	**212**
Kentish Flats + Extension	13	0	13	0
Kincardine	**120**	**120**	**0**	**0**
Lincs			**0**	**0**
London Array			0	0
Lynn and Inner Dowsing			**0**	**0**
Methil	**23**	**23**	**0**	**0**
Moray Firth East	**883**	**564**	**292**	**27**
Moray West	**3,410**	**2,827**	**439**	**144**
Neart na Gaoithe	**2,820**	**1,987**	**552**	**281**
Norfolk Boreas	**3,478**	**1,229**	**1,723**	**526**
Norfolk Vanguard	**3,161**	**271**	**2,453**	**437**
Race Bank	**153**	**92**	**32**	**29**
Rampion	590		590	0
Scroby Sands			0	0
Seagreen Alpha and Bravo	**3,952**	**2,956**	**664**	**332**
Sheringham Shoal	**80**	**47**	**31**	**2**
Teesside	**1**	**1**	**0**	**0**
Thanet			0	0
Triton Knoll	**250**	**211**	**15**	**24**
Westermost Rough			**0**	**0**
Total in Mean max +1SD foraging range (Breeding only)	**48,891**	**21,559**	**22,036**	**5,296**
		21,559		
Berwick Bank	6,504	4,735	1,500	269
Cumulative Total	**55,395**	**26,294**	**23,536**	**5,565**

668. The following displacement matrices provide, for the relevant bio-seasons, the estimated cumulative mortality of gannets predicted to occur due to displacement, as determined by the relevant specified rates of displacement and mortality. The approach used for the cumulative displacement assessment follows that of the project alone displacement assessment (see volume 3, appendix 11.4).

669. Each cell presents potential cumulative bird mortality following displacement from the Proposed Development and the other offshore wind farm projects during a bio-season. The outputs highlighted in colour are those based on the displacement and mortality rates used in the Developer Approach (highlighted in orange) and used in the Scoping Approach (highlighted in dark teal). Outputs highlighted in light teal reflect potential uncertainty associated with the selected figures. No adjustments for age classes of birds have been made. Further details are presented in volume 3, appendix 11.4).

670. For the Developer Approach cumulative displacement assessment, a displacement rate of 70% and a mortality rate of 1% was applied to each bio-season based on evaluation of the published literature and in line with values used by other offshore wind farm displacement assessments.

671. For the Scoping Approach cumulative displacement assessment, a displacement rate of 70% and mortality rates of 1% and 3% for the breeding and non-breeding seasons were applied.

672. A complete range of cumulative displacement matrices for the Proposed Development array area and 2 km buffer and other North Sea offshore wind farm projects for the different bio-seasons for both the Developer Approach and the Scoping Approach are presented in Table 11.88, Table 11.89 and Table 11.90.

Table 11.88: Potential Cumulative Gannet Mortality following Displacement from Offshore Wind Farms in the Breeding Season

Gannet (Breeding season)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	26	53	79	105	131	263	394	526	789	1,315	2,104	2,629
20%	0	53	105	158	210	263	526	789	1,052	1,578	2,629	4,207	5,259
30%	0	79	158	237	316	394	789	1,183	1,578	2,366	3,944	6,311	7,888
40%	0	105	210	316	421	526	1,052	1,578	2,104	3,155	5,259	8,414	10,518
50%	0	131	263	394	526	657	1,315	1,972	2,629	3,944	6,574	10,518	13,147
60%	0	158	316	473	631	789	1,578	2,366	3,155	4,733	7,888	12,621	15,776
70%	0	184	368	552	736	920	1,841	2,761	3,681	5,522	9,203	14,725	18,406
80%	0	210	421	631	841	1,052	2,104	3,155	4,207	6,311	10,518	16,828	21,035
90%	0	237	473	710	947	1,183	2,366	3,550	4,733	7,099	11,832	18,932	23,665
100%	0	263	526	789	1,052	1,315	2,629	3,944	5,259	7,888	13,147	21,035	26,294

Orange box - Based on 70% displacement rate and 1% mortality rate (Developer Approach and lower range of Scoping Approach).
Dark teal box - Based on 70% displacement rate and 3% mortality rate (upper range of Scoping Approach).

Table 11.89: Potential Cumulative Gannet Mortality following Displacement from Offshore Wind Farms in the Autumn Migration Period of the Non-Breeding Season

Gannet (Autumn Passage)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	24	47	71	94	118	235	353	471	706	1,177	1,883	2,354
20%	0	47	94	141	188	235	471	706	941	1,412	2,354	3,766	4,707
30%	0	71	141	212	282	353	706	1,059	1,412	2,118	3,530	5,649	7,061
40%	0	94	188	282	377	471	941	1,412	1,883	2,824	4,707	7,532	9,414
50%	0	118	235	353	471	588	1,177	1,765	2,354	3,530	5,884	9,414	11,768
60%	0	141	282	424	565	706	1,412	2,118	2,824	4,236	7,061	11,297	14,122
70%	0	165	330	494	659	824	1,648	2,471	3,295	4,943	8,238	13,180	16,475
80%	0	188	377	565	753	941	1,883	2,824	3,766	5,649	9,414	15,063	18,829
90%	0	212	424	635	847	1,059	2,118	3,177	4,236	6,355	10,591	16,946	21,182
100%	0	235	471	706	941	1,177	2,354	3,530	4,707	7,061	11,768	18,829	23,536

Orange box - Based on 70% displacement rate and 1% mortality rate (Developer Approach and lower range of Scoping Approach).
Dark teal box - Based on 70% displacement rate and 3% mortality rate (upper range of Scoping Approach).

Table 11.90: Potential Cumulative Gannet Mortality following Displacement from Offshore Wind Farms in the Spring Migration Period of the Non-Breeding Season

Gannet (Spring Passage)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	6	11	17	22	28	56	83	111	167	278	445	557
20%	0	11	22	33	45	56	111	167	223	334	557	890	1,113
30%	0	17	33	50	67	83	167	250	334	501	835	1,336	1,670
40%	0	22	45	67	89	111	223	334	445	668	1,113	1,781	2,226
50%	0	28	56	83	111	139	278	417	557	835	1,391	2,226	2,783
60%	0	33	67	100	134	167	334	501	668	1,002	1,670	2,671	3,339
70%	0	39	78	117	156	195	390	584	779	1,169	1,948	3,116	3,896
80%	0	45	89	134	178	223	445	668	890	1,336	2,226	3,562	4,452
90%	0	50	100	150	200	250	501	751	1,002	1,503	2,504	4,007	5,009
100%	0	56	111	167	223	278	557	835	1,113	1,670	2,783	4,452	5,565

Orange box - Based on 70% displacement rate and 1% mortality rate (Developer Approach and lower range of Scoping Approach).
Dark teal box - Based on 70% displacement rate and 3% mortality rate (upper range of Scoping Approach).

Magnitude of impact

673. For the Developer Approach, annual cumulative estimated gannet mortality from displacement by Tier 2 projects was based on 70% displacement and 1% mortality, which was further broken down into the relevant bio-seasons in Table 11.91. The overall baseline mortality rates were based on age-specific demographic rates and age class proportions as presented in Table 11.21. The potential magnitude of impact was estimated by calculating the increase in cumulative baseline mortality within each bio-season with respect to the regional populations.

Table 11.91: Cumulative Displacement Mortality Estimates for Gannet for Tier 2 projects by bio-season for Developer Approach

Bio-season	Peak Mean Seasonal Abundance	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Mid Mar-Sep)[1]	26,294	18,406 (9,866 adults)	184 (89 adults)	323,836	14,896 adults	0.60
Autumn migration (Oct-Nov)	23,536	16,475	165	456,298	68,901	0.24
Spring migration (Dec-mid Mar)	5,565	3,896	39	248,385	37,506	0.10
Total	-	30,237	293	-	-	0.94

1 Breeding season assessment is for breeding adults only.

2 Mortality is 1% in breeding and non-breeding season.

Breeding Season

674. During the breeding season, the cumulative abundance for gannet was estimated to be 26,294 individuals. When considering the Developer Approach and Scoping Approach displacement rate of 70% this would affect an estimated 18,406 birds. However, this estimate includes non-breeding adults and immature birds, as well as breeding adults.

675. 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, for the purposes of this assessment the estimated proportion of immature, non-breeding birds across all wind farms was based on age breakdown calculated for the Berwick Bank PVA study (see volume 3, appendix 11.6). Based on this breakdown, 46.4% of birds present are likely to be immature birds, with 53.6% of birds likely to be adult birds

676. If 53.6% of the population present are adults, then this would mean that an estimated 9,866 gannets displaced from offshore wind farms during the breeding period would be adult birds.

677. Applying the Developer Approach mortality rate of 1%, the predicted theoretical additional mortality due to displacement effects would be 184 gannets (99 adults) in the breeding season. However, a proportion of adult birds present at colonies in the breeding season will opt not to breed in a particular breeding season. It has been estimated that 10% of adult gannets may be “sabbatical” birds in any particular breeding season (volume 3, appendix 11.6), and this has been applied for this assessment. On this basis, ten adult gannets were considered to be not breeding and so 89 adult breeding gannets were taken forward for the breeding season assessment.

678. The total gannet regional baseline breeding population is estimated to be 323,836 individuals. Using the adult baseline mortality rate of 0.046 (Table 11.21), the predicted baseline mortality of gannets is 14,896 adult birds per breeding season. The additional predicted mortality of 89 adult gannets would increase the baseline mortality rate by 0.60% (Table 11.91).

679. For Scoping Approach A, annual cumulative estimated gannet mortality from displacement by Tier 2 projects was based on 70% displacement and 1% mortality in the breeding and non-breeding seasons, which was further broken down into the relevant bio-seasons in Table 11.92.

Table 11.92: Cumulative Displacement Mortality Estimates for Gannet for Tier 2 projects by bio-season for Scoping Approach A

Bio-season	Peak Mean Seasonal Abundance	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Mid Mar-Sep)[1]	26,294	18,406 (9,866 adults)	184 (89 adults)	323,836	14,896 adults	0.60
Autumn migration (Oct-Nov)	23,536	16,475	165	456,298	68,901	0.24
Spring migration (Dec-mid Mar)	5,565	3,896	39	248,385	37,506	0.10
Total	-	30,237	293	-	-	0.94

1 Breeding season assessment is for breeding adults only.

2 Mortality is 1% and 3% in breeding season and 1% and 3% in non-breeding season.

680. If 53.6% of the population present are adults, then this would mean that an estimated 9,866 gannets displaced from offshore wind farms during the breeding period would be adult birds.

681. Applying the Scoping Approach A mortality rate of 1%, the predicted theoretical additional mortality due to cumulative displacement effects would be 184 gannets (99 adults) in the breeding season. Applying the 10% rate for “sabbatical” non-breeding birds, resulted in 89 adult breeding gannets being taken forward for the breeding season assessment.

682. The total gannet regional baseline breeding population is estimated to be 323,836 individuals. Using the adult baseline mortality rate of 0.046 (Table 11.21), the predicted baseline mortality of gannets is 14,896 adult birds per breeding season. The additional predicted mortality of 89 adult gannets would increase the baseline mortality rate by 0.60% (Table 11.92).

683. For Scoping Approach B, annual cumulative estimated gannet mortality from displacement by Tier 2 projects was based on 70% displacement and 3% mortality in the breeding and non-breeding seasons, which was further broken down into the relevant bio-seasons in Table 11.93.

Table 11.93: Cumulative Displacement Mortality Estimates for Gannet for Tier 2 projects by bio-season for Scoping Approach B

Bio-season	Peak Mean Seasonal Abundance	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Mid Mar-Sep)[1]	26,294	18,406 (9,866 adults)	552 (266 adults)	323,836	14,896 adults	1.79
Autumn migration (Oct-Nov)	23,536	16,475	494	456,298	68,901	0.72
Spring migration (Dec-mid Mar)	5,565	3,896	17	248,385	37,506	0.31
Total	-	30,237	777	-	-	2.82

1 Breeding season assessment is for breeding adults only.

2 Mortality is 1% and 3% in breeding season and 1% and 3% in non-breeding season.

684. If 53.6% of the population present are adults, then this would mean that an estimated 9,866 gannets displaced from offshore wind farms during the breeding period would be adult birds.

685. Applying the Scoping Approach B mortality rate of 3%, the predicted theoretical additional mortality due to displacement effects would be 552 gannets (296 adults) in the breeding season. Applying the 10% rate for “sabbatical” non-breeding birds, resulted in 30 birds being considered as non-breeding “sabbatical birds, with 266 adult breeding gannets being taken forward for the breeding season assessment.

686. The total gannet regional baseline breeding population is estimated to be 323,836 individuals. Using the adult baseline mortality rate of 0.046 (Table 11.21), the predicted baseline mortality of gannets is 14,896 adult birds per breeding season. The additional predicted mortality of 266 adult gannets would increase the baseline mortality rate by 1.79% (Table 11.93).

Non-breeding season – Autumn Migration Period

687. For the autumn migration period of the non-breeding season, the cumulative abundance for gannet was 23,536 individuals. When considering the Developer Approach and Scoping Approach displacement rate of 70%, this would affect an estimated 16,475 birds.

688. Based on information presented in Furness (2015), in the non-breeding season 45% of the population present are immature birds and 55% of birds are adults. This would mean that an estimated 7,414 gannets displaced during the autumn migration period would be immature birds, with 9,061 adult birds also displaced.

689. Applying the Developer Approach mortality rate of 1%, the predicted theoretical additional mortality due to displacement effects was 165 gannets in the autumn migration period. Based on Furness (2015), the total gannet BDMPS regional baseline population for the autumn migration period is predicted to be 456,298 individuals. Using the average baseline mortality rate of 0.151 (Table 11.21), the predicted regional baseline mortality of gannets is 68,901 birds in the autumn migration period. The additional predicted mortality of 165 gannets would increase the baseline mortality rate by 0.24% (Table 11.91).

690. Applying the Scoping Approach A mortality rate of 1%, it was calculated that the predicted theoretical additional mortality due to displacement effects was 165 gannets. This additional predicted mortality would increase the baseline mortality rate by 0.24% (Table 11.92).

691. Applying the Scoping Approach B mortality rate of 3%, it was calculated that the predicted theoretical additional mortality due to displacement effects was 494 gannets. This additional predicted mortality would increase the baseline mortality rate by 0.72% (Table 11.93).

Non-breeding season – Spring Migration Period

692. For the spring migration period of the non-breeding season, the cumulative abundance for gannet was 5,565 individuals. When considering the Developer Approach and Scoping Approach displacement rate of 70%, this would affect an estimated 3,896 birds.

693. Based on information presented in Furness (2015), in the non-breeding season 45% of the population present are immature birds and 55% of birds are adults. This would mean that an estimated 1,753 gannets displaced during the spring migration period would be immature birds, with 2,143 adult birds also displaced.

694. Applying the Developer Approach mortality rate of 1%, the predicted theoretical additional mortality due to displacement effects was 39 gannets in the spring migration period. Based on Furness (2015), the total gannet BDMPS regional baseline population for the spring migration period is predicted to be 248,385 individuals (Table 11.9). Using the average baseline mortality rate of 0.151 (Table 11.21), the predicted regional baseline mortality of gannets is 37,506 birds in the spring migration period. The additional predicted mortality of 39 gannets would increase the baseline mortality rate by 0.10% (Table 11.91).

695. Applying the Scoping Approach A mortality rate of 1%, the predicted theoretical additional mortality due to displacement effects was 39 gannets in the spring migration period. This additional predicted mortality would increase the baseline mortality rate by 0.10% (Table 11.92).

696. Applying the Scoping Approach B mortality rate of 3%, the predicted theoretical additional mortality due to displacement effects was 117 gannets in the spring migration period. This additional predicted mortality would increase the baseline mortality rate by 0.31% (Table 11.93).

Assessment of Displacement Mortality throughout the Year

697. Predicted gannet mortality as a result of cumulative displacement for all seasons as calculated above, was summed for the whole year.

698. Based on an assumed displacement rate of 70% and the Developer Approach mortality rate of 1%, the predicted theoretical annual additional mortality due to cumulative displacement effects was an estimated 293 gannets. This corresponds to an increase in the baseline mortality rate of 0.94% (Table 11.91).

699. Applying the Scoping Approach A displacement rate of 70% and mortality rate of 1%, the predicted theoretical additional annual mortality due to cumulative displacement effects was an estimated 293 gannets. This corresponds to an increase in the baseline mortality rate of 0.94% (Table 11.92).

700. Applying the Scoping Approach B displacement rate of 70% and mortality rate of 3%, the predicted theoretical additional annual mortality due to cumulative displacement effects was an estimated 777 gannets. This corresponds to an increase in the baseline mortality rate of 2.82% (Table 11.93).

701. As these cumulative displacement mortality estimates suggested a potentially significant increase in the cumulative baseline mortality rate for gannet for both the Developer Approach and the Scoping Approaches, cumulative PVA analysis for combined displacement and collision effects was conducted on the gannet regional SPA population. The cumulative PVA assessment for gannet is presented following the cumulative collision impact section of this section, from paragraph 892 onwards.

Kittiwake

702. There is potential for both cumulative collision impacts and cumulative displacement effects on kittiwake. Each of these potential impacts have been assessed separately and then combined to provide an overall cumulative impact.

703. The estimated cumulative abundance of kittiwakes from the relevant projects are presented in Table 11.94. As displacement effects are not required to be assessed for English projects, there were no mean seasonal peak figures available for any projects outside Scottish waters, therefore the cumulative assessment for kittiwake was limited to Scottish offshore wind farm projects. In addition, complete figures were only available in the breeding season, therefore only cumulative breeding season effects are presented.

704. The mean maximum foraging range +1 SD for kittiwake is 156.1±144.5 km. Scottish projects within this foraging range during the breeding period are highlighted in bold in Table 11.94.

Table 11.94: Cumulative Abundance of Kittiwakes for North Sea Offshore Wind Farm Projects (Projects in bold are within 300.6 km of Proposed Development)

Project	Annual Cumulative Abundance	Breeding Season Cumulative Abundance	Autumn Migration Cumulative Abundance	Spring Migration Cumulative Abundance
Aberdeen	**700**	**663**	**14**	**23**
Beatrice	**3,653**	**1,430**	**1,112**	**1,112**
Blyth Demo[1]	**2,070**	**591**	**740**	**740**
Dogger Bank A and B (Creyke Beck)	**26,830**	**7,898**	**3,450**	**15,482**
Dogger Bank C and Sofia (Teesside)	**18,381**	**4,395**	**2,181**	**11,805**
Dudgeon	NA	NA	NA	NA
Dudgeon Expansion and Sheringham Shoal Extension (PEIR)	NA	NA	NA	NA
East Anglia ONE	2,087	171	1,158	758
East Anglia ONE North	825	231	159	435
East Anglia THREE	5,073	345	3,419	1,309
East Anglia TWO	675	241	127	301
Galloper	NA	NA	NA	NA
Greater Gabbard	NA	NA	NA	NA
Gunfleet Sands	NA	NA	NA	NA
Hornsea Project One[1]	19,591	2,946	31,481	767
Hornsea Project Two	**6,327**	**2,903**	**1,449**	**1,975**
Hornsea Project Three	11,665	5,320	2,550	3,795
Hornsea Project Four	**10,005**	**3,771**	**3,608**	**2,626**
Humber Gateway	**NA**	**NA**	**NA**	**NA**
Hywind[2]	**112**	**112**	**NA**	**NA**
Inch Cape	**6,003**	**3,866**	**1,069**	**1,069**
Kentish Flats	NA	NA	NA	NA
Kentish Flats extension	NA	NA	NA	NA
Kincardine	**-**	**229**	**NA**	**NA**
Lincs	NA	NA	NA	NA
London Array	NA	NA	NA	NA
Lynn and Inner Dowsing	NA	NA	NA	NA
Methil	**-**	**184**	**NA**	**NA**
Moray Firth (EDA)	**-**	**1,963**	**NA**	**NA**
Moray West	**9,446**	**6,902**	**1,470**	**1,074**
Neart na Gaoithe	**4,319**	**2,164**	**2,016**	**139**
Norfolk Boreas	4,100	575	2,576	949
Norfolk Vanguard	2,729	519	916	1,294
Race Bank	NA	NA	NA	NA
Rampion	NA	NA	NA	NA
Scroby Sands	NA	NA	NA	NA
Seagreen Alpha and Bravo	**7,806**	**3,235**	**2,286**	**2,286**
Sheringham Shoal	NA	NA	NA	NA
Teesside	**NA**	**NA**	**NA**	**NA**
Thanet	NA	NA	NA	NA
Triton Knoll[2]	848	290	332	226
Westermost Rough	**NA**	**NA**	**NA**	**NA**
Total	**-**	**50,944**	**62,113**	**48,165**
Total in Mean max +1SD foraging range (Breeding only)	**-**	**40,306**		
Berwick Bank	46,097	21,141	11,190	13,766
Cumulative Total	**196,681**	**61,447**	**73,303**	**61,931**

1 = Development site only (no buffer).

2= Development site plus 1km buffer.

NA = Not available.

705. The following displacement matrices provide the estimated cumulative mortality of kittiwakes predicted to occur due to displacement, as determined by the relevant specified rates of displacement and mortality. The approach used for the cumulative displacement assessment follows that of the project alone displacement assessment (see volume 3, appendix 11.4).

706. Each cell presents potential cumulative bird mortality following displacement from the Proposed Development and the other offshore wind farm projects in the breeding season. The outputs highlighted in colour are those based on the displacement and mortality rates used in the Developer Approach

(highlighted in orange) and used in the Scoping Approach (highlighted in dark teal). Outputs highlighted in light teal reflect potential uncertainty associated with the selected figures. No adjustments for age classes of birds have been made in the matrices. Further details are presented in volume 3, appendix 11.4).

707. For the Developer Approach cumulative displacement assessment, a displacement rate of 30% and a mortality rate of 2% was applied to the breeding season based on evaluation of the published literature and in line with values used by other offshore wind farm displacement assessments. No cumulative displacement assessment was undertaken for the non-breeding season.

708. For the cumulative displacement assessment for Scoping Approach A, a displacement rate of 30% and a mortality rate of 1% for the breeding and non-breeding seasons was applied. However, cumulative abundance figures for the non-breeding season for kittiwakes were not available for some of the older projects.

709. For the cumulative displacement assessment for Scoping Approach B, a displacement rate of 30% and a mortality rate of 3% for the breeding and non-breeding seasons was applied.

710. A complete range of cumulative displacement matrices for the Proposed Development array area and 2 km buffer and other North Sea offshore wind farm projects for the different bio-seasons for both the Developer Approach and Scoping Approaches A and B are presented in Table 11.95, Table 11.96 and Table 11.97.

Table 11.95: Potential Cumulative Kittiwake Mortality following Displacement from Offshore Wind Farms in the Breeding Season

Kittiwake (Breeding season)	Mortality Level (% of displaced birds at risk of mortality)													
Displacement Level (% of all birds on site)		0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
	0%	0	0	0	0	0	0	0	0	0	0	0	0	0
	10%	0	61	123	184	246	307	614	922	1,229	1,843	3,072	4,916	6,145
	20%	0	123	246	369	492	614	1,229	1,843	2,458	3,687	6,145	9,832	12,289
	30%	0	184	369	553	737	922	1,843	2,765	3,687	5,530	9,217	14,747	18,434
	40%	0	246	492	737	983	1,229	2,458	3,687	4,916	7,374	12,289	19,663	24,579
	50%	0	307	614	922	1,229	1,536	3,072	4,609	6,145	9,217	15,362	24,579	30,724
	60%	0	369	737	1,106	1,475	1,843	3,687	5,530	7,374	11,060	18,434	29,495	36,868
	70%	0	430	860	1,290	1,721	2,151	4,301	6,452	8,603	12,904	21,506	34,410	43,013
	80%	0	492	983	1,475	1,966	2,458	4,916	7,374	9,832	14,747	24,579	39,326	49,158
	90%	0	553	1,106	1,659	2,212	2,765	5,530	8,295	11,060	16,591	27,651	44,242	55,302
	100%	0	614	1,229	1,843	2,458	3,072	6,145	9,217	12,289	18,434	30,724	49,158	61,447

Orange box - Based on 30% displacement rate and 2% mortality rate (Developer Approach).
Dark teal box - Based on 30% displacement rate and 1% mortality rates (Scoping Approach A).
Dark teal box - Based on 30% displacement rate and 3% mortality rates (Scoping Approach B).

Table 11.96: Potential Cumulative Kittiwake Mortality following Displacement from Offshore Wind Farms in the Autumn Period of the Non-breeding Season (Scoping Approach A & B only)

Kittiwake (Autumn period)	Mortality Level (% of displaced birds at risk of mortality)													
Displacement Level (% of all birds on site)		0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
	0%	0	0	0	0	0	0	0	0	0	0	0	0	0
	10%	0	73	147	220	293	367	733	1,100	1,466	2,199	3,665	5,864	7,330
	20%	0	147	293	440	586	733	1,466	2,199	2,932	4,398	7,330	11,728	14,661
	30%	0	220	440	660	880	1,100	2,199	3,299	4,398	6,597	10,995	17,593	21,991
	40%	0	293	586	880	1,173	1,466	2,932	4,398	5,864	8,796	14,661	23,457	29,321
	50%	0	367	733	1,100	1,466	1,833	3,665	5,498	7,330	10,995	18,326	29,321	36,652
	60%	0	440	880	1,319	1,759	2,199	4,398	6,597	8,796	13,195	21,991	35,185	43,982
	70%	0	513	1,026	1,539	2,052	2,566	5,131	7,697	10,262	15,394	25,656	41,050	51,312
	80%	0	586	1,173	1,759	2,346	2,932	5,864	8,796	11,728	17,593	29,321	46,914	58,642
	90%	0	660	1,319	1,979	2,639	3,299	6,597	9,896	13,195	19,792	32,986	52,778	65,973
	100%	0	733	1,466	2,199	2,932	3,665	7,330	10,995	14,661	21,991	36,652	58,642	73,303

Dark teal box - Based on 30% displacement rate and 1% mortality rates (Scoping Approach A).
Dark teal box - Based on 30% displacement rate and 3% mortality rates (Scoping Approach B).

Table 11.97: Potential Cumulative Kittiwake Mortality following Displacement from Offshore Wind Farms in the Spring Period of the Non-breeding Season (Scoping Approach A & B only)

Kittiwake (Spring period)	Mortality Level (% of displaced birds at risk of mortality)													
Displacement Level (% of all birds on site)		0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
	0%	0	0	0	0	0	0	0	0	0	0	0	0	0
	10%	0	62	124	186	248	310	619	929	1,239	1,858	3,097	4,954	6,193
	20%	0	124	248	372	495	619	1,239	1,858	2,477	3,716	6,193	9,909	12,386
	30%	0	186	372	557	743	929	1,858	2,787	3,716	5,574	9,290	14,863	18,579
	40%	0	248	495	743	991	1,239	2,477	3,716	4,954	7,432	12,386	19,818	24,772
	50%	0	310	619	929	1,239	1,548	3,097	4,645	6,193	9,290	15,483	24,772	30,966
	60%	0	372	743	1,115	1,486	1,858	3,716	5,574	7,432	11,148	18,579	29,727	37,159
	70%	0	434	867	1,301	1,734	2,168	4,335	6,503	8,670	13,006	21,676	34,681	43,352
	80%	0	495	991	1,486	1,982	2,477	4,954	7,432	9,909	14,863	24,772	39,636	49,545
	90%	0	557	1,115	1,672	2,230	2,787	5,574	8,361	11,148	16,721	27,869	44,590	55,738
	100%	0	619	1,239	1,858	2,477	3,097	6,193	9,290	12,386	18,579	30,966	49,545	61,931

Dark teal box - Based on 30% displacement rate and 1% mortality rates (Scoping Approach A).
Dark teal box - Based on 30% displacement rate and 3% mortality rates (Scoping Approach B).

Magnitude of impact

711. For the Developer Approach, annual cumulative estimated kittiwake mortality from displacement by Tier 2 projects was based on 30% displacement and 2% mortality, for the breeding season only (Table 11.98). The overall baseline mortality rates were based on age-specific demographic rates and age class proportions as presented in Table 11.21. The potential magnitude of impact was estimated by calculating the increase in cumulative baseline mortality within each bio-season with respect to the regional populations.

Table 11.98: Cumulative Displacement Mortality Estimates for Kittiwake for Tier 2 projects in Breeding Season, for Developer Approach

Breeding season	Peak Mean Seasonal Abundance	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Mid Apr-Aug)[1]	61,447	9,954 adults	179 adults	319,126	46,273 adults	0.39

1 Breeding season assessment is for breeding adults only.

2 Mortality is 2% in breeding season only.

Breeding Season

712. During the breeding season, the cumulative abundance for kittiwake was estimated to be 61,447 individuals (Table 11.94). When considering the Developer Approach and Scoping Approach displacement rate of 30% this would affect an estimated 18,434 birds. However, this estimate includes non-breeding adults and immature birds, as well as breeding adults.

713. 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, for the purposes of this assessment the estimated proportion of immature, non-breeding birds across all wind farms was based on age breakdown calculated for the Berwick Bank PVA study (see volume 3, appendix 11.6). Based on this breakdown, 46% of birds present are likely to be immature birds, with 54% of birds likely to be adult birds

714. If 54% of the population present are adults, then this would mean that an estimated 9,954 kittiwakes displaced from offshore wind farms during the breeding period would be adult birds.

715. Applying the Developer Approach mortality rate of 2%, the predicted theoretical additional mortality due to displacement effects would be 369 kittiwakes (199 adults) in the breeding season. However, a proportion of adult birds present at colonies in the breeding season will opt not to breed in a particular breeding season. It has been estimated that 10% of adult kittiwakes may be “sabbatical” birds in any particular breeding season (volume 3, appendix 11.6), and this has been applied for this assessment. On this basis, 20 adult kittiwakes were considered to be not breeding and so 179 adult breeding kittiwakes were taken forward for the breeding season assessment.

716. The total kittiwake regional baseline breeding population is estimated to be 319,126 individuals (Table 11.9). Using the adult baseline mortality rate of 0.145 (Table 11.21), the predicted baseline mortality of kittiwakes is 46,273 adult birds per breeding season. The additional predicted mortality of 179 adult kittiwakes would increase the baseline mortality rate by 0.39% (Table 11.98).

717. For Scoping Approach A, annual cumulative estimated kittiwake mortality from displacement by Tier 2 projects was based on 30% displacement and 1% mortality in the breeding season, (Table 11.99).

Table 11.99: Cumulative Displacement Mortality Estimates for Kittiwake for Tier 2 projects in Breeding Season for Scoping Approach A

Bio-season	Peak Mean Seasonal Abundance	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Mid Apr-Aug)[1]	61,447	9,954 adults	90 adults	319,126	46,273 adults	0.19
Autumn migration (Sep-Dec)	73,303	21,991	220	829,937	132,790	0.17
Spring migration (Jan to mid-April)	61,931	18,579	186	627,816	100,451	0.19
Total	-	50,524	496	-	-	0.55

1 Breeding season assessment is for breeding adults only.

2 Mortality is 1% in the breeding and non-breeding seasons.

718. If 54% of the population present are adults, then this would mean that an estimated 9,954 kittiwakes displaced from offshore wind farms during the breeding period would be adult birds.

719. Applying the Scoping Approach A mortality rate of 1%, the predicted theoretical additional mortality due to cumulative displacement effects would be 184 kittiwakes (100 adults) in the breeding season. Applying the 10% rate for “sabbatical” non-breeding birds, resulted in 10 birds being considered as non-breeding “sabbatical birds, with 90 adult breeding kittiwakes being taken forward for the breeding season assessment.

720. The total kittiwake regional baseline breeding population is estimated to be 319,126 individuals. Using the adult baseline mortality rate of 0.145 (Table 11.21), the predicted baseline mortality of kittiwakes is 46,273 adult birds per breeding season. The additional predicted mortality of 90 adult kittiwakes would increase the baseline mortality rate by 0.19% (Table 11.99).

721. For Scoping Approach B, annual cumulative estimated kittiwake mortality from displacement by Tier 2 projects was based on 30% displacement and 3% mortality in the breeding season (Table 11.100).

Table 11.100: **Cumulative Displacement Mortality Estimates for Kittiwake for Tier 1 and 2 projects in Breeding Season for Scoping Approach B**

Bio-season	Peak Mean Seasonal Abundance	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Mid Apr-Aug)[1]	61,477	9,954 adults	269 adults	319,126	46,273 adults	0.58
Autumn migration (Sep-Dec)	73,303	21,991	660	829,937	132,790	0.50
Spring migration (Jan to mid-April)	61,931	18,579	557	627,816	100,451	0.55
Total	-	50,254	1,486	-	-	1.63

1 Breeding season assessment is for breeding adults only.

2 Mortality is 3% in the breeding and non-breeding seasons.

722. If 54% of the population present are adults, then this would mean that an estimated 9,954 kittiwakes displaced from offshore wind farms during the breeding period would be adult birds.

723. Applying the Scoping Approach B mortality rate of 3%, the predicted theoretical additional mortality due to cumulative displacement effects would be 553 kittiwakes (299 adults) in the breeding season. Applying the 10% rate for "sabbatical" non-breeding birds, resulted in 30 birds being considered as non-breeding "sabbatical birds, with 269 adult breeding kittiwakes being taken forward for the breeding season assessment.

724. The total kittiwake regional baseline breeding population is estimated to be 319,126 individuals. Using the adult baseline mortality rate of 0.145 (Table 11.21), the predicted baseline mortality of kittiwakes is 46,273 adult birds per breeding season. The additional predicted mortality of 269 adult kittiwakes would increase the baseline mortality rate by 0.58% (Table 11.100).

Non-breeding Season – Autumn Migration Period

725. For the Developer Approach, kittiwake cumulative displacement was not considered for the autumn migration period of the non-breeding season, for the reasons outlined in Paragraph 11.11.215.

726. For the autumn migration period of the non-breeding season, the cumulative abundance for kittiwake was 73,303 individuals (Table 11.94). When considering the Scoping Approach displacement rate of 30%, this would affect an estimated 21,991 birds.

727. Based on information presented in Furness (2015), in the non-breeding season 47% of the population present in the autumn migration period are immature birds and 53% of birds are adults. This would mean that an estimated 10,336 kittiwakes displaced from offshore wind farms during the autumn migration period would be immature birds, with 11,655 adult birds also displaced.

728. Applying the Scoping Approach A mortality rate of 1%, it was calculated that the predicted theoretical additional mortality due to cumulative displacement effects was 220 kittiwakes (117 adults and 103 immature birds) in the autumn migration period. Based on Furness (2015), the total kittiwake BDMPS regional baseline population for the autumn migration period is estimated to be 829,937 individuals (Table 11.9). Using the average baseline mortality rate of 0.160 (Table 11.21), the estimated regional baseline mortality of kittiwakes is 132,790 birds in the autumn migration period of the non-breeding season. The additional predicted mortality of 220 kittiwakes for Scoping Approach A would increase the baseline mortality rate by 0.17% (Table 11.99).

729. Applying the Scoping Approach B mortality rate of 3%, it was calculated that the predicted theoretical additional mortality due to cumulative displacement effects was 660 kittiwakes (350 adults and 310 immature birds) in the autumn migration period. Based on Furness (2015), the total kittiwake BDMPS regional baseline population for the autumn migration period is estimated to be 829,937 individuals (Table 11.9). Using the average baseline mortality rate of 0.160 (Table 11.21), the estimated regional baseline mortality of kittiwakes is 132,790 birds in the autumn migration period of the non-breeding season. The additional predicted mortality of 660 kittiwakes for Scoping Approach B would increase the baseline mortality rate by 0.50% (Table 11.100).

Non-breeding Season – Spring Migration Period

730. For the Developer Approach, kittiwake displacement was not considered for the spring migration period of the non-breeding season, for the reasons outlined in Paragraph 11.11.215.

731. For the spring migration period of the non-breeding season, the cumulative abundance for kittiwake was 61,931 individuals (Table 11.94). When considering the Scoping Approach displacement rate of 30%, this would affect an estimated 18,579 birds.

732. Based on information presented in Furness (2015), in the non-breeding season, 47% of the population present in the spring migration period are immature birds, and 53% of birds are adults. This would mean that an estimated 8,732 kittiwakes displaced from offshore wind farms during the spring migration period would be immature birds, with 9,847 adult birds also displaced.

733. Applying the Scoping Approach A mortality rate of 1%, it was calculated that the predicted theoretical additional mortality due to cumulative displacement effects was 186 kittiwakes (99 adults and 87 immature birds) in the spring migration period. Based on Furness (2015), the total kittiwake BDMPS regional baseline population for the spring migration period is estimated to be 627,816 individuals (Table 11.9). Using the average baseline mortality rate of 0.160 (Table 11.21), the estimated regional baseline mortality of kittiwakes is 100,451 birds in the spring migration period. The additional predicted mortality of 186 kittiwakes for Scoping Approach A would increase the baseline mortality rate by 0.19% (Table 11.99).

734. Applying the Scoping Approach B mortality rate of 3%, it was calculated that the predicted theoretical additional mortality due to displacement effects was 557 kittiwakes (295 adults and 262 immature birds) in the spring migration period. Based on Furness (2015), the total kittiwake BDMPS regional baseline population for the spring migration period is estimated to be 627,816 individuals (Table 11.9). Using the average baseline mortality rate of 0.160 (Table 11.21), the estimated regional baseline mortality of kittiwakes is 100,451 birds in the spring migration period. The additional predicted mortality of 557 kittiwakes for Scoping Approach B would increase the baseline mortality rate by 0.55% (Table 11.100).

Assessment of Displacement Mortality throughout the Year

735. Predicted kittiwake mortality as a result of cumulative displacement for all seasons as calculated above, was summed for the whole year.

736. Based on an assumed displacement rate of 30% and the Developer Approach mortality rate of 2%, the predicted theoretical additional mortality due to cumulative displacement effects was an estimated 179 breeding adult kittiwakes in the breeding season only. This corresponds to an increase in the baseline mortality rate of 0.39% (Table 11.98).

737. Applying the Scoping Approach A displacement rate of 30% and mortality rate of 1% in the breeding and non-breeding seasons, the predicted theoretical additional annual mortality due to cumulative displacement effects was an estimated 496 kittiwakes. This corresponds to an increase in the baseline mortality rate of 0.55% (Table 11.99).

738. Applying the Scoping Approach B displacement rate of 30% and mortality rate of 3% in the breeding and non-breeding seasons, the predicted theoretical additional annual mortality due to displacement effects was an estimated 1,486 kittiwakes. This corresponds to an increase in the baseline mortality rate of 1.63% (Table 11.100).

739. These cumulative displacement mortality estimates did not suggest a potentially significant increase in the cumulative baseline mortality rate for kittiwake for the Developer Approach or the Scoping Approaches. However, cumulative PVA analysis for combined displacement and collision effects was conducted on the kittiwake regional SPA population. The cumulative PVA assessment for kittiwake is presented following the cumulative collision impact section of this section, from paragraph 933 onwards.

Guillemot

740. There is potential for cumulative displacement effects on guillemot. The estimated cumulative abundance of guillemots from the relevant projects are presented in Table 11.101. There are a number of projects for which there are no, or limited, data on the number of guillemots predicted to be displaced, in particular, for some of the earlier Round 1 and Round 2 developments.

741. The mean maximum foraging range +1 SD for guillemot is 73.2±80.5 km. Projects within this foraging range during the breeding period are highlighted in bold in Table 11.101.

Table 11.101: Cumulative Abundance of Guillemots for North Sea Offshore Wind Farm Projects (Projects in bold are within 153.7 km of Proposed Development)

Project	Annual Cumulative Abundance	Breeding Season Cumulative Abundance	Non-breeding Season Cumulative Abundance
Aberdeen	**772**	**547**	**225**
Beatrice	16,365	13,610	2,755
Blyth Demo	**2,541**	**1,220**	**1,321**
Dogger Bank A and B	31,649	14,886	16,763
Dogger C and Sofia	14,463	8,494	5,969
Dudgeon	876	334	542
Dudgeon Extension and Sheringham Shoal/Extension (PEIR)	12,247	3,576	8,671
East Anglia 1 North	6,071	4,183	1,888
East Anglia 2	3,752	2,077	1,675
East Anglia 3	4,603	1,744	2,859
East Anglia One	914	274	640
Galloper	898	305	593
Greater Gabbard	893	345	548
Gunfleet Sands	363	0	363
Hornsea Project Four	84,800	15,245	69,555
Hornsea Project One	17,933	9,836	8,097
Hornsea Project Three	31,146	13,374	17,772
Hornsea Project Two	20,899	7,735	13,164
Humber Gateway	237	99	138
Hywind	**2,385**	**249**	**2,136**
Inch Cape	**7,548**	**4,371**	**3,177**
Kentish Flats + Extension	7	0	7
Kincardine	**632**	**632**	**0**
Lincs	1,396	582	814
London Array	569	192	377
Lynn and Inner Dowsing	0		
Methil	**25**	**25**	**0**
Moray Firth East	10,367	9,820	547
Moray West	62,600	24,426	38,174
Neart na Gaoithe	**5,516**	**1,755**	**3,761**
Norfolk Boreas	21,541	7,764	13,777
Norfolk Vanguard	9,096	4,320	4,776
Race Bank	1,069	361	708
Rampion	26,423	10,887	15,536
Scroby Sands	0		
Seagreen Alpha and Bravo	**33,524**	**24,724**	**8,800**
Sheringham Shoal	1,105	390	715
Teesside	1,168	267	901
Thanet	142	18	124
Triton Knoll	1,171	425	746
Westermost Rough	833	347	486
Total	**438,539**	**189,439**	**249,100**
Total in range of impact		**31,768**	**15,659**
Berwick Bank	118,325	74,154	44,171
Cumulative total	**165,752**	**105,922**	**59,830**

742. The following displacement matrices provide, for the relevant bio-seasons, the estimated cumulative mortality of guillemots predicted to occur due to displacement, as determined by the relevant specified rates of displacement and mortality. The approach used for the cumulative displacement assessment follows that of the project alone displacement assessment (see volume 3, appendix 11.4).

743. Each cell presents potential cumulative bird mortality following displacement from the Proposed Development and the other offshore wind farm projects during a bio-season. The outputs highlighted in colour are those based on the displacement and mortality rates used in the Developer Approach (highlighted in orange) and used in the Scoping Approach (highlighted in dark teal). Outputs highlighted in light teal reflect potential uncertainty associated with the selected figures. No adjustments for age classes of birds have been made. Further details are presented in volume 3, appendix 11.4).

744. For the Developer Approach cumulative displacement assessment, a displacement rate of 50% and a mortality rate of 1% was applied to each bio-season based on evaluation of the published literature and in line with values used by other offshore wind farm displacement assessments.

745. There were two parts to the Scoping Approach displacement assessment and these are outlined below. For Scoping Approach A, a displacement rate of 60% and mortality rates of 3% for the breeding season and 1% for the non-breeding season were applied. For Scoping Approach B, a displacement rate of 60% and mortality rates of 5% for the breeding season and 3% for the non-breeding season were applied.

746. A complete range of cumulative displacement matrices for the Proposed Development array area and 2 km buffer and other North Sea offshore wind farm projects for the different bio-seasons for both the Developer Approach and the Scoping Approach A and B are presented in Table 11.102 and Table 11.103.

Table 11.102: Potential Cumulative Guillemot Mortality following Displacement from Offshore Wind Farms in the Breeding Season

Guillemot (Breeding season)	Displacement Level (% of all birds on site)	Mortality Level (% of displaced birds at risk of mortality)												
		0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
	0%	0	0	0	0	0	0	0	0	0	0	0	0	0
	10%	0	106	212	318	424	530	1,059	1,589	2,118	3,178	5,296	8,474	10,592
	20%	0	212	424	636	847	1,059	2,118	3,178	4,237	6,355	10,592	16,948	21,184
	30%	0	318	636	953	1,271	1,589	3,178	4,766	6,355	9,533	15,888	25,421	31,777
	40%	0	424	847	1,271	1,695	2,118	4,237	6,355	8,474	12,711	21,184	33,895	42,369
	50%	0	530	1,059	1,589	2,118	2,648	5,296	7,944	10,592	15,888	26,481	42,369	52,961
	60%	0	636	1,271	1,907	2,542	3,178	6,355	9,533	12,711	19,066	31,777	50,843	63,553
	70%	0	741	1,483	2,224	2,966	3,707	7,415	11,122	14,829	22,244	37,073	59,316	74,145
	80%	0	847	1,695	2,542	3,390	4,237	8,474	12,711	16,948	25,421	42,369	67,790	84,738
	90%	0	953	1,907	2,860	3,813	4,766	9,533	14,299	19,066	28,599	47,665	76,264	95,330
	100%	0	1,059	2,118	3,178	4,237	5,296	10,592	15,888	21,184	31,777	52,961	84,738	105,922

Orange box - Based on 50% displacement rate and 1% mortality rate (Developer Approach).

Dark teal boxes - Based on 60% displacement rate and 3% and 5% mortality rate (Scoping Approach A and B).

Table 11.103: Potential Cumulative Guillemot Mortality following Displacement from Offshore Wind Farms in the Non-Breeding Season

Guillemot (Non-breeding season)	Displacement Level (% of all birds on site)	Mortality Level (% of displaced birds at risk of mortality)												
		0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
	0%	0	0	0	0	0	0	0	0	0	0	0	0	0
	10%	0	60	120	179	239	299	598	897	1,197	1,795	2,992	4,786	5,983
	20%	0	120	239	359	479	598	1,197	1,795	2,393	3,590	5,983	9,573	11,966
	30%	0	179	359	538	718	897	1,795	2,692	3,590	5,385	8,975	14,359	17,949
	40%	0	239	479	718	957	1,197	2,393	3,590	4,786	7,180	11,966	19,146	23,932
	50%	0	299	598	897	1,197	1,496	2,992	4,487	5,983	8,975	14,958	23,932	29,915
	60%	0	359	718	1,077	1,436	1,795	3,590	5,385	7,180	10,769	17,949	28,718	35,898
	70%	0	419	838	1,256	1,675	2,094	4,188	6,282	8,376	12,564	20,941	33,505	41,881
	80%	0	479	957	1,436	1,915	2,393	4,786	7,180	9,573	14,359	23,932	38,291	47,864
	90%	0	538	1,077	1,615	2,154	2,692	5,385	8,077	10,769	16,154	26,924	43,078	53,847
	100%	0	598	1,197	1,795	2,393	2,992	5,983	8,975	11,966	17,949	29,915	47,864	59,830

Orange box - Based on 50% displacement rate and 1% mortality rate (Developer Approach).

Dark teal boxes - Based on 60% displacement rate and 1% and 3% mortality rate (Scoping Approach A and B).

Magnitude of impact

747. For the Developer Approach, annual cumulative estimated guillemot mortality from displacement by Tier 2 projects was based on 50% displacement and 1% mortality, which was further broken down into the relevant bio-seasons in Table 11.104. For the Scoping Approach, annual cumulative estimated guillemot mortality from displacement by Tier 2 projects was based on 60% displacement and 3% and 5% mortality in the breeding season and 1% and 3% mortality in the non-breeding season (Table 11.105).

748. The overall baseline mortality rates were based on age-specific demographic rates and age class proportions as presented in Table 11.21. The potential magnitude of impact was estimated by calculating the increase in cumulative baseline mortality within each bio-season with respect to the regional populations.

Breeding Season

749. During the breeding season, the cumulative abundance for guillemot was estimated to be 105,922 individuals (Table 11.101). When considering the Developer Approach displacement rate of 50% this would affect an estimated 52,961 birds. However, this estimate includes non-breeding adults and immature birds, as well as breeding adults.

Table 11.104: Cumulative Displacement Mortality Estimates for Guillemot for Tier 2 projects by bio-season for Developer Approach

Bio-season	Peak Mean Seasonal Abundance	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Apr-mid Aug)[1]	105,922	52,961 (27,116 adults)	530 (252 adults)	353,971	25,840 adults	0.98
Non-breeding (mid Aug- Mar)	59,830	29,915	299	353,971	52,388	0.57
Total	-	57,031	551	-	-	1.55

1 Breeding season assessment is for breeding adults only.

2 Mortality is 1% in breeding and non-breeding season.

750. 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, using proportions from the stable age structure calculated from the population models from which PVAs were produced (Table 11.33) (volume 3, appendix 11.6). the estimated proportion of immature, non-breeding birds across all wind farms was estimated. Based on the proportion of immature guillemots from the stable age structure (Table 11.33), 48.8% of birds present are likely to be immature birds, with 51.2% of birds likely to be adult birds. This would mean that an estimated 27,116 guillemots displaced from offshore wind farms during the breeding period would be adult birds.

751. Applying the Developer Approach mortality rate of 1%, the predicted theoretical additional mortality due to displacement effects would be 530 guillemots (271 adults) in the breeding season. However, a proportion of adult birds present at colonies in the breeding season will opt not to breed in a particular breeding season. It has been estimated that 7% of adult guillemots may be “sabbatical” birds in any particular breeding season (volume 3, appendix 11.6), and this has been applied for this assessment. On this basis, 19 adult guillemots were considered to be not breeding and so 252 adult breeding guillemots were taken forward for the breeding season assessment.

752. The total guillemot regional baseline breeding population is estimated to be 353,971 individuals. Using the adult baseline mortality rate of 0.073 (Table 11.21), the predicted baseline mortality of guillemots is 25,840 adult birds per breeding season. The additional predicted mortality of 252 adult guillemots would increase the baseline mortality rate by 0.98% (Table 11.104).

753. When considering the Scoping Approach A displacement rate of 60%, this would affect an estimated 63,553 birds (Table 11.105 and Table 11.106). Assuming that 51.2% of the population present are adult birds, then this would mean that an estimated 32,539 guillemots displaced would be adult birds.

754. Applying the Scoping Approach A mortality rate of 3%, the predicted theoretical additional mortality due to cumulative displacement effects was 1,907 guillemots (976 adults) in the breeding season. Applying the 7% rate for “sabbatical” non-breeding birds, resulted in 68 birds being considered as non-breeding “sabbatical birds, with 908 adult breeding guillemots being taken forward for the breeding season assessment.

755. Using the adult baseline mortality rate of 0.073 (Table 11.21), the predicted baseline mortality of guillemots is 25,840 adult birds per breeding season. The additional predicted mortality of 908 adult guillemots would increase the baseline mortality rate by 3.51% (Table 11.105).

Table 11.105: Cumulative Displacement Mortality Estimates for Guillemot for Tier 2 projects by bio-season for Scoping Approach A

Bio-season	Peak Mean Seasonal Abundance	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Apr-mid Aug)[1]	105,922	63,553 (32,539 adults)	1,907 (908 adults)	353,971	25,840 adults	3.51
Non-breeding (mid Aug- Mar)	59,830	35,898	359	353,971	52,388	0.69
Total	-	68,437	1,267	-	-	4.2

1 Breeding season assessment is for breeding adults only.

2 Mortality is 3% in breeding season and 1% in non-breeding season.

756. Applying the Scoping Approach B mortality rate of 5%, the predicted theoretical additional mortality due to displacement effects was 3,178 guillemots (1,627 adults) in the breeding season. Applying the 7% rate for “sabbatical” non-breeding birds, resulted in 114 birds being considered as non-breeding “sabbatical birds, with 1,513 adult breeding guillemots being taken forward for the breeding season assessment.

757. Using the adult baseline mortality rate of 0.073 (Table 11.21), the predicted baseline mortality of guillemots is 25,840 adult birds per breeding season. The additional predicted mortality of 1,513 adult guillemots would increase the baseline mortality rate by 5.86% (Table 11.106).

Table 11.106: Cumulative Displacement Mortality Estimates for Guillemot for Tier 2 projects by bio-season for Scoping Approach B

Bio-season	Peak mean seasonal abundance	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Apr-mid Aug)[1]	105,922	63,553 (32,539 adults)	3,178 (1,513 adults)	353,971	25,840 adults	5.86
Non-breeding (mid Aug- Mar)	59,830	35,898	1,077	353,971	52,388	2.06
Total	-	68,437	2,590	-	-	7.92

1 Breeding season assessment is for breeding adults only.

2 Mortality is 5% in breeding season and 3% in non-breeding season.

Non-breeding season

758. During the non-breeding season, the cumulative abundance for guillemot is 59,830 individuals (Table 11.101). When considering the Developer Approach displacement rate of 50%, this would affect an estimated 29,915 birds (Table 11.104). However, this estimate includes non-breeding adults and immature birds, as well as breeding adults. Based on information presented in Furness (2015), in the non-breeding season 43% of the population present are immature birds and 57% of birds are adults. This would mean that an estimated 12,863 guillemots displaced during the non-breeding season would be immature birds, with 17,052 adult birds also displaced.

759. Applying the Developer Approach mortality rate of 1%, the predicted theoretical additional mortality due to cumulative displacement effects was 299 guillemots in the non-breeding season. Scoping Opinion advice for guillemots was to use the regional breeding population within mean maximum foraging range +1S.D. as the reference population for the guillemot non-breeding season, on the basis that birds do not travel far from their breeding colonies in the non-breeding season (Buckingham *et al*. 2022). Therefore, the total guillemot regional baseline population in the non-breeding season, including adults and immature birds, is predicted to be 353,971 individuals.

760. Using the average baseline mortality rate of 0.148 (Table 11.21), the predicted regional baseline mortality of guillemots is 52,388 birds in the non-breeding season. The additional predicted mortality of 299 guillemots would increase the baseline mortality rate by 0.57% (Table 11.104).

761. When considering the Scoping Approach displacement rate of 60%, this would affect an estimated 35,898 birds (Table 11.105 and Table 11.106). Based on information presented in Furness (2015), in the non-breeding season 43% of the population present are immature birds and 57% of birds are adults. This would mean that an estimated 15,436 guillemots displaced during the non-breeding season would be immature birds, with 20,462 adult birds also displaced.

762. Applying the Scoping Approach A mortality rate of 1%, it was calculated that the predicted theoretical additional mortality due to cumulative displacement effects was 359 guillemots. This additional predicted mortality would increase the baseline mortality rate by 0.69% (Table 11.105).

763. Applying the Scoping Approach B mortality rate of 3%, it was calculated that the predicted theoretical additional mortality due to cumulative displacement effects was 1,077 guillemots. This additional predicted mortality would increase the baseline mortality rate by 2.06% (Table 11.106).

Assessment of Displacement Mortality throughout the Year

764. Predicted guillemot mortality as a result of cumulative displacement for all seasons as calculated above, was summed for the whole year.

765. Based on the Developer Approach displacement rate of 50% and a mortality rate of 1%, the predicted theoretical cumulative annual mortality due to displacement effects was an estimated 551 guillemots. This corresponds to an increase in the baseline mortality rate of 1.55% (Table 11.104).

766. Applying the Scoping Approach A displacement rate of 60% and mortality rate of 3% in the breeding season and 1% in the non-breeding season, the predicted theoretical cumulative mortality due to displacement effects was an estimated 1,267 guillemots. This corresponds to an increase in the baseline mortality rate of 4.2% (Table 11.105).

767. Applying the Scoping Approach B displacement rate of 60% and mortality rate of 5% in the breeding season and 3% in the non-breeding season, the predicted theoretical cumulative mortality due to displacement effects was an estimated 2,590 guillemots. This corresponds to an increase in the baseline mortality rate of 7.92% (Table 11.106).

Summary of PVA Assessment

768. As these cumulative displacement mortality estimates suggested a potentially significant increase in the cumulative baseline mortality rate for guillemot for North Sea offshore wind farms and both the Developer Approach and the Scoping Approach, cumulative PVA analysis was conducted on the guillemot regional SPA population. The cumulative PVA analysis was carried out considering a range of cumulative displacement and mortality rates as well as a range of scenarios.

769. The results of the PVA for predicted cumulative displacement impacts for the Developer Approach and Scoping Approach with both other Forth and Tay consented projects and other North Sea consented projects during the operation phase for the guillemot regional SPA population for the 35-year projection is summarised in Table 11.107. Further details of the PVA methodology, input parameters and an explanation of how to interpret the PVA results can be found in volume 3, appendix 11.6.

Table 11.107: Summary of PVA Cumulative Displacement Outputs for Guillemot for the Proposed Development array area and a 2 km buffer after 35 years

Scenario and Start population 344,608 adults[1]	Unimpacted Median Population Size	Impacted Median Population Size	Counterfactual of Population Growth Rate - Median	Counterfactual Population Size - Median	Unimpacted Centile at Impacted 50th Centile - Median
Forth and Tay Consented + Developer Approach	1,177,118	1,142,467	0.999	0.971	39.6
Forth and Tay Consented + Scoping Approach A	1,177,118	1,081,981	0.998	0.918	23.2
Forth and Tay Consented + Scoping Approach B	1,177,118	1,007,158	0.996	0.856	8.6
North Sea Consented + Developer Approach	1,177,118	1,131,946	0.999	0.962	36.6
North Sea Consented + Scoping Approach A	1,177,118	1,060,139	0.997	0.902	18.1
North Sea Consented + Scoping Approach B	1,177,118	973,219	0.995	0.830	4.5

1 Starting population taken from volume 3, appendix 11.6.

Developer Approach = 50% displacement rate and 1% mortality rate in breeding season and non-breeding season.

Scoping Approach A = 60% displacement rate and 3% mortality rate in breeding season and 1% mortality rate in non-breeding season.

Scoping Approach B = 60% displacement rate and 5% mortality rate in breeding season and 3% mortality rate in non-breeding season.

770. For both the with and without Project scenarios, the guillemot regional SPA population is predicted to increase over the 35-year period. For the Developer Approach with other Forth and Tay consented projects, the end population size with Project scenario was predicted to be slightly lower than the without Project scenario. There was a very slight predicted decrease in the counterfactual of the population growth

rate, and the counterfactual of the population size was also very close to 1.000, while the 50th Centile value was relatively close to 50. These values indicate that the PVA did not predict a significant negative effect from the cumulative effects of displacement mortality from the Developer Approach and other Forth and Tay consented projects on the guillemot regional SPA population after 35 years.

771. For Scoping Approach A with other Forth and Tay consented projects, the end population size with Project scenario was lower than the without Project scenario. There was a slight predicted decrease in the counterfactual of the population growth rate, and the counterfactual of the population size was also close to 1.000, while the 50th Centile value was 23.2. These values indicate that the PVA did not predict a significant negative effect from the cumulative effects of displacement mortality from Scoping Approach A and other Forth and Tay consented projects on the guillemot regional SPA population after 35 years.

772. For Scoping Approach B with other Forth and Tay consented projects, the end population size with Project scenario was lower than the without Project scenario. There was a slight predicted decrease in the counterfactual of the population growth rate, and the counterfactual of the population size was below 0.9, while the 50th Centile value was 8.6. These values indicate that the PVA did predict a negative effect from the cumulative effects of displacement mortality from Scoping Approach B and other Forth and Tay consented projects on the guillemot regional SPA population after 35 years.

773. For the Developer Approach with other North Sea consented projects, the end population size with Project scenario was lower than the without Project scenario. There was very little predicted difference in the counterfactual of the population growth rate, and the counterfactual of the population size was also close to 1.000, while the 50th Centile value was 36.6. These values indicate that the PVA did not predict a significant negative effect from the cumulative effects of displacement mortality from the Developer Approach and other North Sea consented projects on the guillemot regional SPA population after 35 years.

774. For Scoping Approach A with other North Sea consented projects, the end population size with Project scenario was lower than the without Project scenario. There was a slight predicted decrease in the counterfactual of the population growth rate, and the counterfactual of the population size was also close to 1.000, while the 50th Centile value was 18.1, These values indicate that the PVA did not predict a significant negative effect from the cumulative effects of displacement mortality from the Scoping Approach and other North Sea consented projects on the guillemot regional SPA population after 35 years.

775. For Scoping Approach B with other North Sea consented projects, the end population size with Project scenario was lower than the without Project scenario. There was a larger predicted difference in the counterfactual of the population growth rate, and the counterfactual of the population size was also lower, while the 50th Centile value was 4.5. These values indicate that the PVA predicted a larger negative effect from the cumulative effects of displacement mortality from Scoping Approach B and other North Sea consented projects on the guillemot regional SPA guillemot population after 35 years.

776. Based on the results from the cumulative displacement assessment and the cumulative PVA for the Developer Approach, the magnitude of impact on the guillemot regional SPA population is low.

777. Based on the results from the cumulative displacement assessment and the cumulative PVA for Scoping Approach A, the magnitude of impact on the guillemot regional SPA population is low.

778. Based on the results from the cumulative displacement assessment and the cumulative PVA for Scoping Approach B, the magnitude of impact on the guillemot regional SPA population is medium.

Sensitivity of the receptor

779. Evidence of guillemot sensitivity to displacement from offshore wind farms is summarised in paragraph 296 onwards. Overall, on the basis of evidence from post-construction studies and reviews, guillemot sensitivity to operational offshore wind farms is considered to be medium (Table 11.16).

Significance of the effect

780. For cumulative displacement effects for guillemot, for the Developer Approach, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

781. For Scoping Approach A, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

782. For Scoping Approach B, the magnitude of the impact is deemed to be medium, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **moderate** adverse significance, which is significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

783. For the Developer Approach and Scoping Approach A, no offshore and intertidal ornithology mitigation is considered necessary because the likely cumulative effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual cumulative impact is considered to be of **minor** adverse significance, which is not significant in EIA terms.

784. For Scoping Approach B, the residual cumulative impact is considered to be of **moderate** adverse significance, which is significant in EIA terms. However, it is considered that the displacement mortality rates used in Scoping Approach B are likely to be highly precautionary, for the reasons outlined in volume 3, appendix 11.4. Consequently, no additional mitigation is proposed.

Razorbill

785. There is potential for cumulative displacement effects on razorbills. The estimated cumulative abundance of razorbills from the relevant projects are presented in Table 11.108. There are a number of projects for which there are no, or limited, data on the number of razorbills predicted to be displaced, in particular, for some of the earlier Round 1 and Round 2 developments.

786. The mean maximum foraging range +1 SD for razorbill is 88.7±75.9 km. Projects within this foraging range during the breeding period are highlighted in bold in Table 11.108.

Table 11.108: Cumulative Abundance of Razorbills for North Sea Offshore Wind Farm Projects (Projects in bold are within 164.6 km of Proposed Development)

Project	Annual Cumulative Abundance	Breeding Season Cumulative Abundance	Autumn Migration Cumulative Abundance	Winter Period Cumulative Abundance	Spring Migration Cumulative Abundance
Aberdeen	**258**	**161**	**64**	**7**	**26**
Beatrice	3,094	873	833	555	833
Blyth Demonstration Project	**364**	**121**	**91**	**61**	**91**
Dudgeon Extension P and Sheringham Shoal Extension (PEIR)	7,089	1,064	4,295	1,310	420
Dogger Bank (Creyke Beck) A	8,703	1,250	1,576	1,728	4,149
Dogger Bank (Creyke Beck) B	10,897	1,538	2,097	2,143	5,119
Dogger Bank C (Teesside A)	4,022	834	310	959	1,919
Dogger Bank Sofia (Teesside B)	6,124	1,153	592	1,426	2,953
Dudgeon	1,693	256	346	745	346
East Anglia ONE	533	16	26	155	336
East Anglia ONE North	749	403	85	54	207
East Anglia THREE	5,952	1,807	1,122	1,499	1,524
East Anglia TWO	692	281	44	136	230
Galloper	587	44	43	106	394
Greater Gabbard	471	0	0	387	84
Gunfleet Sands	30	0	0	30	0
Hornsea Project Four	4,711	276	3,590	474	371
Hornsea Project One	9,242	1,109	4,812	1,518	1,803
Hornsea Project Three	8,404	630	2,020	3,649	2,105
Hornsea Project Two	9,120	2,511	4,221	720	1,668
Humber Gateway	80	27	20	13	20
Hywind	**759**	**30**	**719**	**10**	
Inch Cape	**4,957**	**1,436**	**2,870**	**651**	
Kentish Flats and Extension	0	0	0	0	0
Kincardine	**22**	**22**			
Lincs and LID	135	45	34	22	34
London Array	69	14	20	14	21
Methil	**4**	**4**	**0**	**0**	**0**
Moray Firth (EDA)	3,724	2,423	1,103	30	168
Moray West	10,121	2,808	3,544	184	3,585
Neart na Gaoithe	**6,331**	**331**	**5,492**	**508**	
Norfolk Boreas	2,303	630	263	1,065	345
Norfolk Vanguard	3,508	879	866	839	924
Race Bank	140	28	42	28	42
Rampion	5,267	630	66	1,244	3,327
Scroby Sands	0				
Seagreen Alpha and Bravo	**11,949**	**9,574**	**0**	**2,375**	**0**
Sheringham Shoal	1,690	106	1,343	211	30
Teesside	**99**	**16**	**61**	**2**	**20**
Thanet	38	3	0	14	21
Triton Knoll	1,266	40	254	855	117
Westermost Rough	455	91	121	152	91
Total (all projects above)	135,652	**33,464**	**42,985**	**25,879**	**33,323**
Total in Mean max +1SD foraging range (Breeding only)		**11,695**			
Berwick Bank	21,768	4,040	8,849	1,399	7,480
Cumulative Total	**135,651**	**15,735**	**51,834**	**27,278**	**40,803**

787. The following displacement matrices provide, for the relevant bio-seasons, the estimated cumulative mortality of razorbills predicted to occur due to displacement, as determined by the relevant specified rates of displacement and mortality. The approach used for the cumulative displacement assessment follows that of the project alone displacement assessment (see volume 3, appendix 11.4).

788. Each cell presents potential cumulative bird mortality following displacement from the Proposed Development and the other offshore wind farm projects during a bio-season. The outputs highlighted in colour are those based on the displacement and mortality rates used in the Developer Approach (highlighted in orange) and used in the Scoping Approach (highlighted in dark teal). Outputs highlighted in light teal reflect potential uncertainty associated with the selected figures. No adjustments for age classes of birds have been made. Further details are presented in volume 3, appendix 11.4).

789. For the Developer Approach cumulative displacement assessment, a displacement rate of 50% and a mortality rate of 1% was applied to each bio-season based on evaluation of the published literature and in line with values used by other offshore wind farm displacement assessments.

790. There were two parts to the Scoping Approach displacement assessment and these are outlined below. For Scoping Approach A, a displacement rate of 60% and mortality rates of 3% for the breeding season and 1% for the non-breeding season were applied. For Scoping Approach B, a displacement rate of 60% and mortality rates of 5% for the breeding season and 3% for the non-breeding season were applied.

791. A complete range of cumulative displacement matrices for the Proposed Development array area and 2 km buffer and other North Sea offshore wind farm projects for the different bio-seasons for both the Developer Approach and Scoping Approach A and B are presented in Table 11.109 to Table 11.112.

Table 11.109: Potential Cumulative Razorbill Mortality following Displacement from Offshore Wind Farms in the Breeding Season

Razorbill (Breeding season)	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	16	31	47	63	79	157	236	315	472	787	1,259	1,574
20%	0	31	63	94	126	157	315	472	629	944	1,574	2,518	3,147
30%	0	47	94	142	189	236	472	708	944	1,416	2,360	3,776	4,721
40%	0	63	126	189	252	315	629	944	1,259	1,888	3,147	5,035	6,294
50%	0	79	157	236	315	393	787	1,180	1,574	2,360	3,934	6,294	7,868
60%	0	94	189	283	378	472	944	1,416	1,888	2,832	4,721	7,553	9,441
70%	0	110	220	330	441	551	1,101	1,652	2,203	3,304	5,507	8,812	11,015
80%	0	126	252	378	504	629	1,259	1,888	2,518	3,776	6,294	10,070	12,588
90%	0	142	283	425	566	708	1,416	2,124	2,832	4,248	7,081	11,329	14,162
100%	0	157	315	472	629	787	1,574	2,360	3,147	4,721	7,868	12,588	15,735

Orange box - Based on 50% displacement rate and 1% mortality rate (Developer Approach).

Dark teal box - Based on 60% displacement rate and 3% and 5% mortality rate (Scoping Approach A and B).

Table 11.110: Potential Cumulative Razorbill Mortality following Displacement from Offshore Wind Farms in the Autumn Migration Period of the Non-Breeding Season

Razorbill Autumn Passage	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	52	104	156	207	259	518	778	1,037	1,555	2,592	4,147	5,183
20%	0	104	207	311	415	518	1,037	1,555	2,073	3,110	5,183	8,293	10,367
30%	0	156	311	467	622	778	1,555	2,333	3,110	4,665	7,775	12,440	15,550
40%	0	207	415	622	829	1,037	2,073	3,110	4,147	6,220	10,367	16,587	20,734
50%	0	259	518	778	1,037	1,296	2,592	3,888	5,183	7,775	12,959	20,734	25,917
60%	0	311	622	933	1,244	1,555	3,110	4,665	6,220	9,330	15,550	24,880	31,100
70%	0	363	726	1,089	1,451	1,814	3,628	5,443	7,257	10,885	18,142	29,027	36,284
80%	0	415	829	1,244	1,659	2,073	4,147	6,220	8,293	12,440	20,734	33,174	41,467
90%	0	467	933	1,400	1,866	2,333	4,665	6,998	9,330	13,995	23,325	37,321	46,651
100%	0	518	1,037	1,555	2,073	2,592	5,183	7,775	10,367	15,550	25,917	41,467	51,834

Orange box - Based on 50% displacement rate and 1% mortality rate (Developer Approach).

Dark teal box - Based on 60% displacement rate and 1% and 3% mortality rate (Scoping Approach A and B).

Table 11.111: Potential Cumulative Razorbill Mortality following Displacement from Offshore Wind Farms in the Winter Period of the Non-Breeding Season

Razorbill Winter	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds on site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	27	55	82	109	136	273	409	546	818	1,364	2,182	2,728
20%	0	55	109	164	218	273	546	818	1,091	1,637	2,728	4,365	5,456
30%	0	82	164	246	327	409	818	1,228	1,637	2,455	4,092	6,547	8,184
40%	0	109	218	327	436	546	1,091	1,637	2,182	3,273	5,456	8,729	10,911
50%	0	136	273	409	546	682	1,364	2,046	2,728	4,092	6,820	10,911	13,639
60%	0	164	327	491	655	818	1,637	2,455	3,273	4,910	8,184	13,094	16,367
70%	0	191	382	573	764	955	1,909	2,864	3,819	5,728	9,547	15,276	19,095
80%	0	218	436	655	873	1,091	2,182	3,273	4,365	6,547	10,911	17,458	21,823
90%	0	246	491	737	982	1,228	2,455	3,683	4,910	7,365	12,275	19,640	24,551
100%	0	273	546	818	1,091	1,364	2,728	4,092	5,456	8,184	13,639	21,823	27,278

Orange box - Based on 50% displacement rate and 1% mortality rate (Developer Approach).

Dark teal box - Based on 60% displacement rate and 1% and 3% mortality rate (Scoping Approach A and B).

Table 11.112: Potential Cumulative Razorbill Mortality following Displacement from Offshore Wind Farms in the Spring Migration Period of the Non-Breeding Season

Razorbill Spring	Mortality Level (% of displaced birds at risk of mortality)												
Displacement Level (% of all birds in site)	0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
0%	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	0	41	82	122	163	204	408	612	816	1,224	2,040	3,264	4,080
20%	0	82	163	245	326	408	816	1,224	1,632	2,448	4,080	6,528	8,161
30%	0	122	245	367	490	612	1,224	1,836	2,448	3,672	6,120	9,793	12,241
40%	0	163	326	490	653	816	1,632	2,448	3,264	4,896	8,161	13,057	16,321
50%	0	204	408	612	816	1,020	2,040	3,060	4,080	6,120	10,201	16,321	20,402
60%	0	245	490	734	979	1,224	2,448	3,672	4,896	7,345	12,241	19,585	24,482
70%	0	286	571	857	1,142	1,428	2,856	4,284	5,712	8,569	14,281	22,850	28,562
80%	0	326	653	979	1,306	1,632	3,264	4,896	6,528	9,793	16,321	26,114	32,642
90%	0	367	734	1,102	1,469	1,836	3,672	5,508	7,345	11,017	18,361	29,378	36,723
100%	0	408	816	1,224	1,632	2,040	4,080	6,120	8,161	12,241	20,402	32,642	40,803

Orange box - Based on 50% displacement rate and 1% mortality rate (Developer Approach).

Dark teal box - Based on 60% displacement rate and 1% and 3% mortality rate (Scoping Approach A and B).

Magnitude of impact

792. For the Developer Approach, annual cumulative estimated razorbill mortality from displacement by Tier 2 projects was based on 50% displacement and 1% mortality, which was further broken down into the relevant bio-seasons in Table 11.113. For the Scoping Approach, annual cumulative estimated razorbill mortality from displacement by Tier 2 projects was based on 60% displacement and 3% and 5% mortality in the breeding season and 1% and 3% mortality in the non-breeding season (Table 11.114).

793. The overall baseline mortality rates were based on age-specific demographic rates and age class proportions as presented in Table 11.21. The potential magnitude of impact was estimated by calculating the increase in cumulative baseline mortality within each bio-season with respect to the regional populations.

Breeding Season

794. During the breeding season, the cumulative abundance for razorbill was estimated to be 15,735 individuals (Table 11.108). When considering the Developer Approach displacement rate of 50% this would affect an estimated 7,868 birds. However, this estimate includes non-breeding adults and immature birds, as well as breeding adults.

Table 11.113: Cumulative Displacement Mortality Estimates for Razorbill for Tier 2 projects by bio-season for Developer Approach

Bio-season	Peak mean Seasonal Abundance	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Apr-mid Aug)[1]	15,735	7,868 (4,202 adults)	79 (39 adults)	84,501	7,605 adults	0.51
Autumn migration (mid-Aug-Oct)	51,834	25,917	259	591,874	71,025	0.36
Winter (Nov-Dec)	27,278	13,639	136	218,622	26,235	0.52
Spring migration (Jan-Mar)	40,803	20,402	204	591,874	71,025	0.29
Total	-	64,160	638	-	-	1.68

1 Breeding season assessment is for breeding adults only.

2 Mortality is 1% in breeding and non-breeding season.

795. 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, using proportions from the stable age structure calculated from the population models from which PVAs were produced (Table 11.38) (volume 3, appendix 11.6). the estimated proportion of immature, non-breeding birds across all wind farms was estimated. Based on the proportion of immature razorbills from the stable age structure (Table 11.38), 46.6% of birds present are likely to be immature birds, with 53.4% of birds likely to be adult birds. This would mean that an estimated 4,202 razorbills displaced from offshore wind farms during the breeding period would be adult birds.

796. Applying the Developer Approach mortality rate of 1%, the predicted theoretical additional mortality due to displacement effects would be 79 razorbills (42 adults) in the breeding season. However, a proportion of adult birds present at colonies in the breeding season will opt not to breed in a particular breeding season. It has been estimated that 7% of adult razorbills may be "sabbatical" birds in any particular breeding season (volume 3, appendix 11.6), and this has been applied for this assessment. On this basis, three adult razorbills were considered to be not breeding and so 39 adult breeding razorbills were taken forward for the breeding season assessment.

797. The total razorbill regional baseline breeding population is estimated to be 84,501 individuals. Using the adult baseline mortality rate of 0.09 (Table 11.21), the predicted baseline mortality of razorbills is 7,605 adult birds per breeding season. The additional predicted mortality of 39 adult razorbills would increase the baseline mortality rate by 0.51% (Table 11.113).

798. When considering the Scoping Approach displacement rate of 60%, this would affect an estimated 9,441 birds (Table 11.114 and Table 11.115). Assuming that 53.4% of the population present are adult birds, then this would mean that an estimated 5,041 razorbills displaced would be adult birds.

799. Applying the Scoping Approach A mortality rate of 3%, the predicted theoretical additional mortality due to cumulative displacement effects was 283 razorbills (151 adults) in the breeding season. Applying the 7% rate for "sabbatical" non-breeding birds, resulted in 11 birds being considered as non-breeding "sabbatical birds, with 140 adult breeding razorbills being taken forward for the breeding season assessment.

800. Using the adult baseline mortality rate of 0.09 (Table 11.21), the predicted baseline mortality of razorbills is 7,605 adult birds per breeding season. The additional predicted mortality of 140 adult razorbills would increase the baseline mortality rate by 1.84% (Table 11.114).

Table 11.114: Cumulative Displacement Mortality Estimates for Razorbill for Tier 2 projects by bio-season for Scoping Approach A

Bio-season	Peak Mean Seasonal Abundance	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Apr-mid Aug)[1]	15,735	9,441 (5,041 adults)	283 (140 adults)	84,501	7,605 adults	1.84
Autumn migration (mid-Aug-Oct)	51,834	31,100	311	591,874	71,025	0.44
Winter (Nov-Dec)	27,278	16,367	164	218,622	26,235	0.63
Spring migration (Jan-Mar)	40,803	24,482	245	591,874	71,025	0.34
Total	-	76,990	860	-	-	3.25

1 Breeding season assessment is for breeding adults only.

2 Mortality is 3% in breeding season and 1% in non-breeding season.

801. Applying the Scoping Approach B mortality rate of 5%, the predicted theoretical additional mortality due to displacement effects was 472 razorbills (252 adults) in the breeding season. Applying the 7% rate for "sabbatical" non-breeding birds, resulted in 18 birds being considered as non-breeding "sabbatical birds, with 234 adult breeding razorbills being taken forward for the breeding season assessment.

802. Using the adult baseline mortality rate of 0.09 (Table 11.21), the predicted baseline mortality of razorbills is 7,605 adult birds per breeding season. The additional predicted mortality of 234 adult razorbills would increase the baseline mortality rate by 3.08% (Table 11.115).

Table 11.115: Cumulative Displacement Mortality Estimates for Razorbill for Tier 2 projects by bio-season for Scoping Approach B

Bio-season	Peak mean seasonal abundance	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Apr-mid Aug)[1]	15,735	9,441 (5,041 adults)	472 (234 adults)	84,501	7,605 adults	3.08
Autumn migration (mid-Aug-Oct)	51,834	31,100	933	591,874	71,025	1.31
Winter (Nov-Dec)	27,278	16,367	491	218,622	26,235	1.87
Spring migration (Jan-Mar)	40,803	24,482	734	591,874	71,025	1.03
Total	-	76,990	2,392	-	-	7.29

1 Breeding season assessment is for breeding adults only.

2 Mortality is 5% in breeding season and 3% in non-breeding season.

Autumn Migration Period of Non-breeding Season

803. For the autumn migration period of the non-breeding season, the cumulative mean peak abundance of razorbills was 51,834 individuals (Table 11.108). When considering the Developer Approach displacement rate of 50%, this would affect an estimated 25,917 birds (Table 11.113).

804. Applying the Developer Approach mortality rate of 1%, the predicted theoretical additional mortality due to displacement effects was 259 razorbills in the autumn migration period. Based on Furness (2015), the total razorbill BDMPS regional baseline population for the autumn migration period is predicted to be 591,874 individuals (Table 11.9). Using the average baseline mortality rate of 0.120 (Table 11.21), the predicted regional baseline mortality of razorbills is 71,025 birds in the autumn migration period of the non-breeding season. The additional predicted mortality of 259 razorbills would increase the baseline mortality rate by 0.36% (Table 11.113).

805. When considering the Scoping Approach displacement rate of 60% this would affect an estimated 31,100 birds (Table 11.114 and Table 11.115). Applying the Scoping Approach A mortality rate of 1%, the predicted theoretical additional mortality due to cumulative displacement effects was 311 razorbills in the autumn migration period. Using the average baseline mortality rate of 0.120 (Table 11.21), the predicted regional baseline mortality of razorbills is 71,025 birds in the autumn migration period of the non-breeding season. The additional predicted mortality of 311 razorbills would increase the baseline mortality rate by 0.44% (Table 11.114).

806. Applying the Scoping Approach B mortality rate of 3%, the predicted theoretical additional mortality due to cumulative displacement effects was 933 razorbills in the autumn migration period. Using the average baseline mortality rate of 0.120 (Table 11.21), the predicted regional baseline mortality of razorbills is 71,025 birds in the autumn migration period of the non-breeding season. The additional predicted mortality of 933 razorbills would increase the baseline mortality rate by 1.31% (Table 11.115).

Winter Period of Non-breeding Season

807. For the winter period of the non-breeding season, the cumulative mean peak abundance of razorbills was 27,278 individuals (Table 11.108). When considering the Developer Approach displacement rate of 50%, this would affect an estimated 13,639 birds (Table 11.113).

808. Applying the Developer Approach mortality rate of 1%, the predicted theoretical additional mortality due to displacement effects was 136 razorbills in the winter period. Based on Furness (2015), the total razorbill BDMPS regional baseline population for the winter period is predicted to be 218,622 individuals (Table 11.9). Using the average baseline mortality rate of 0.120 (Table 11.21), the predicted regional baseline mortality of razorbills is 26,235 birds in the winter period of the non-breeding season. The additional predicted mortality of 136 razorbills would increase the baseline mortality rate by 0.52% (Table 11.113).

809. When considering the Scoping Approach displacement rate of 60% this would affect an estimated 16,367 birds (Table 11.114 and Table 11.115). Applying the Scoping Approach A mortality rate of 1%, the predicted theoretical additional mortality due to cumulative displacement effects was 164 razorbills in the winter period. Using the average baseline mortality rate of 0.120 (Table 11.21), the predicted regional baseline mortality of razorbills is 26,235 birds in the winter period of the non-breeding season. The additional predicted mortality of 164 razorbills would increase the baseline mortality rate by 0.63% (Table 11.114).

810. Applying the Scoping Approach B mortality rate of 3%, the predicted theoretical additional mortality due to cumulative displacement effects was 491 razorbills in the winter period. Using the average baseline mortality rate of 0.120 (Table 11.21), the predicted regional baseline mortality of razorbills is 26,235 birds in the winter period of the non-breeding season. The additional predicted mortality of 491 razorbills would increase the baseline mortality rate by 1.87% (Table 11.115).

Spring Migration Period of Non-breeding Season

811. For the spring migration period of the non-breeding season, the cumulative mean peak abundance of razorbills was 40,803 individuals (Table 11.108). When considering the Developer Approach displacement rate of 50%, this would affect an estimated 20,402 birds (Table 11.113).

812. Applying the Developer Approach mortality rate of 1%, the predicted theoretical additional mortality due to displacement effects was 204 razorbills in the spring migration period. Based on Furness (2015), the total razorbill BDMPS regional baseline population for the spring migration period is predicted to be 591,874 individuals (Table 11.9). Using the average baseline mortality rate of 0.120 (Table 11.21), the predicted regional baseline mortality of razorbills is 71,025 birds in the spring migration period of the non-breeding

season. The additional predicted mortality of 204 razorbills would increase the baseline mortality rate by 0.29% (Table 11.113).

813. When considering the Scoping Approach displacement rate of 60% this would affect an estimated 24,482 birds (Table 11.114 and Table 11.115). Applying the Scoping Approach A mortality rate of 1%, the predicted theoretical additional mortality due to cumulative displacement effects was 245 razorbills in the spring period. Using the average baseline mortality rate of 0.120 (Table 11.21), the predicted regional baseline mortality of razorbills is 71,025 birds in the spring migration period of the non-breeding season. The additional predicted mortality of 245 razorbills would increase the baseline mortality rate by 0.34% (Table 11.114).

814. Applying the Scoping Approach B mortality rate of 3%, the predicted theoretical additional mortality due to displacement effects was 734 razorbills in the spring period. Using the average baseline mortality rate of 0.120 (Table 11.21), the predicted regional baseline mortality of razorbills is 71,025 birds in the spring migration period of the non-breeding season. The additional predicted mortality of 734 razorbills would increase the baseline mortality rate by 1.03% (Table 11.115).

Assessment of Displacement Mortality throughout the Year

815. Predicted razorbill mortality as a result of cumulative displacement for all seasons as calculated above, was summed for the whole year.

816. Based on the Developer Approach displacement rate of 50% and a mortality rate of 1%, the predicted theoretical cumulative annual mortality due to displacement effects was an estimated 638 razorbills. This corresponds to an increase in the baseline mortality rate of 1.68% (Table 11.113).

817. Applying the Scoping Approach A displacement rate of 60% and mortality rate of 3% in the breeding season and 1% in the non-breeding season, the predicted theoretical cumulative mortality due to displacement effects was an estimated 860 razorbills. This corresponds to an increase in the baseline mortality rate of 3.25% (Table 11.114).

818. Applying the Scoping Approach B displacement rate of 60% and mortality rate of 5% in the breeding season and 3% in the non-breeding season, the predicted theoretical cumulative mortality due to displacement effects was an estimated 2,392 razorbills. This corresponds to an increase in the baseline mortality rate of 7.29% (Table 11.115).

Summary of PVA Assessment

819. As these cumulative displacement mortality estimates suggested a potentially significant increase in the cumulative baseline mortality rate for razorbill for North Sea offshore wind farms and both the Developer Approach and the Scoping Approach, cumulative PVA analysis was conducted on the razorbill regional SPA population. The cumulative PVA analysis was carried out considering a range of cumulative displacement and mortality rates as well as a range of scenarios.

820. The results of the cumulative PVA for predicted displacement impacts for the Developer Approach and Scoping Approach with both other Forth and Tay consented projects and other North Sea consented projects during the operation phase for the razorbill regional SPA population for the 35-year projection is summarised in Table 11.116. Further details of the PVA methodology, input parameters and an explanation of how to interpret the PVA results can be found in volume 3, appendix 11.6.

Table 11.116: Summary of PVA Cumulative Displacement Outputs for Razorbill for the Proposed Development array area and a 2 km buffer after 35 years

Scenario and Start population 113,842 adults[1]	Unimpacted Median Population Size	Impacted Median Population Size	Counterfactual of Population Growth Rate - Median	Counterfactual Population Size - Median	Unimpacted Centile at Impacted 50th Centile - Median
Forth and Tay Consented + Developer Approach	366241	362407	1.000	0.989	47.8
Forth and Tay Consented + Scoping Approach A	366241	349935	0.999	0.956	40.4
Forth and Tay Consented + Scoping Approach B	366241	341267	0.998	0.930	35.1
North Sea Consented + Developer Approach	366241	350751	0.999	0.959	40.9
North Sea Consented + Scoping Approach A	366241	330434	0.997	0.903	28.7
North Sea Consented + Scoping Approach B	366241	300038	0.994	0.820	14.0

1 Starting population taken from volume 3, appendix 11.6.

Developer Approach = 50% displacement rate and 1% mortality rate in breeding season and non-breeding season.

Scoping Approach A = 60% displacement rate and 3% mortality rate in breeding season and 1% mortality rate in non-breeding season.

Scoping Approach B = 60% displacement rate and 5% mortality rate in breeding season and 3% mortality rate in non-breeding season.

821. For both the with and without Project scenarios, the razorbill regional SPA population is predicted to increase over the 35-year period. For the Developer Approach with other Forth and Tay consented projects, the end population size with Project scenario was slightly lower than the without Project scenario. There was no predicted difference in the counterfactual of the population growth rate, and the counterfactual of the population size was also very close to 1.000, while the 50th Centile value was close to 50. These values indicate that the PVA did not predict a significant negative effect from the cumulative effects of displacement mortality from the Developer Approach and other Forth and Tay consented projects on the razorbill regional SPA population after 35 years.

822. For Scoping Approach A with other Forth and Tay consented projects, the end population size with Project scenario was lower than the without Project scenario. There was a very slight predicted decrease in the counterfactual of the population growth rate, and the counterfactual of the population size was also close to 1.000, while the 50th Centile value was close to 50. These values indicate that the PVA did not predict a significant negative effect from the cumulative effects of displacement mortality from Scoping Approach A and other Forth and Tay consented projects on the razorbill regional SPA population after 35 years.

823. For Scoping Approach B with other Forth and Tay consented projects, the end population size with Project scenario was lower than the without Project scenario. There was a slight predicted decrease in the counterfactual of the population growth rate, and the counterfactual of the population size was also close to 1.000, while the 50th Centile value was 35.1, These values indicate that the PVA did predict a slight negative effect from the cumulative effects of displacement mortality from Scoping Approach B and other Forth and Tay consented projects on the razorbill regional SPA population after 35 years.

824. For the Developer Approach with other North Sea consented projects, the end population size with Project scenario was lower than the without Project scenario. There was a slight predicted decrease in the counterfactual of the population growth rate, and the counterfactual of the population size was also close to 1.000, while the 50th Centile value was relatively close to 50. These values indicate that the PVA did not predict a significant negative effect from the cumulative effects of displacement mortality from the Developer Approach and other North Sea consented projects on the razorbill regional SPA population after 35 years.

825. For Scoping Approach A with other North Sea consented projects, the end population size with Project scenario was lower than the without Project scenario. There was a slight predicted decrease in the counterfactual of the population growth rate, and the counterfactual of the population size was also close to 1.000, while the 50th Centile value was 28.7. These values indicate that the PVA did predict a slight negative effect from the cumulative effects of displacement mortality from Scoping Approach A and other North Sea consented projects on the razorbill regional SPA population after 35 years.

826. For Scoping Approach B with other North Sea consented projects, there was a larger difference between the end population size with Project scenario compared to the without Project scenario. There was a slight predicted decrease in the counterfactual of the population growth rate, and the counterfactual of the population size was below 0.900, while the 50th Centile value was 14.0. These values indicate that the PVA did predict a negative effect from the cumulative effects of displacement mortality from Scoping Approach B and other North Sea consented projects on the razorbill regional SPA population after 35 years.

827. Based on the results from the cumulative displacement assessment and the cumulative PVA for the Developer Approach, the magnitude of impact on the razorbill regional SPA population is low.

828. Based on the results from the cumulative displacement assessment and the cumulative PVA for Scoping Approach A, the magnitude of impact on the razorbill regional SPA population is low.

829. Based on the results from the cumulative displacement assessment and the cumulative PVA for Scoping Approach B, the magnitude of impact on the razorbill regional SPA population is medium.

Sensitivity of the receptor

830. Evidence of razorbill sensitivity to displacement from offshore wind farms is summarised in paragraph 352 onwards. Overall, on the basis of evidence from post-construction studies and reviews, razorbill sensitivity to operational offshore wind farms is considered to be medium (Table 11.16).

Significance of the effect

831. For cumulative displacement effects for razorbill, for the Developer Approach, for the Developer Approach, the magnitude of the cumulative impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

832. For Scoping Approach A, the magnitude of the cumulative impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

833. For Scoping Approach B, the magnitude of the cumulative impact is deemed to be medium, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **moderate** adverse significance, which is significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

834. For the Developer Approach and Scoping Approach A, no offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **minor** adverse significance, which is not significant in EIA terms.

835. For Scoping Approach B, the residual cumulative impact is considered to be of **moderate** adverse significance, which is significant in EIA terms. However, it is considered that the displacement mortality rates used in Scoping Approach B are likely to be highly precautionary, for the reasons outlined in volume 3, appendix 11.4. Consequently, no additional mitigation is proposed.

Puffin

836. There is potential for cumulative displacement effects on puffins. The estimated cumulative abundance of puffins from the relevant projects are presented in Table 11.117. There are a number of projects for which there are no, or limited, data on the number of razorbills predicted to be displaced, in particular, for some of the earlier Round 1 and Round 2 developments.

837. The mean maximum foraging range +1 SD for puffin is 137.1±128.3 km. Projects within this foraging range during the breeding period are highlighted in bold in Table 11.117.

Table 11.117: Cumulative Abundance of Puffins for North Sea offshore wind farm Projects (Projects in bold are within 265.4 km of Proposed Development)

Project	Breeding Season Cumulative Abundance
Aberdeen	**42**
Beatrice	**2,858**
Blyth Demonstration Project	**235**
Dogger Bank (Creyke Beck) A	**37**
Dogger Bank (Creyke Beck) B	**102**
Dogger Bank C (Teesside A)	**34**
Dogger Bank Sofia (Teesside B)	**35**
Dudgeon	1
Dudgeon Extension and Sheringham Shoal Extension (PEIR)	14
East Anglia ONE	16
East Anglia ONE North	0
East Anglia THREE	181
East Anglia TWO	14
Galloper	0
Greater Gabbard	0
Gunfleet Sands	
Hornsea Project One	1,070
Hornsea Project Two	468

Project	Breeding Season Cumulative Abundance
Hornsea Project Three	*253*
Hornsea Project Four	153
Humber Gateway	15
Hywind	119
Inch Cape	2,956
Kentish Flats and Extension	3
Kincardine	**19**
Lincs and LID	3
London Array	0
Methil	**8**
Moray Firth (EDA)	**2,795**
Moray West	**1,115**
Neart na Gaoithe	**2,562**
Norfolk Boreas	0
Norfolk Vanguard	0
Race Bank	1
Rampion	7
Scroby Sands	
Seagreen Alpha and Bravo	**6,154**
Sheringham Shoal	4
Teesside	**35**
Thanet	0
Triton Knoll	23
Westermost Rough	61
Total (all projects above)	**21,393**
Total in Mean max +1SD foraging range (Breeding only)	**19,243**
Berwick Bank	4,513
Cumulative Total	**23,756**

838. The following displacement matrix (Table 11.118) provides, for the breeding season only, the estimated cumulative mortality of puffins predicted to occur due to displacement, as determined by the relevant specified rates of displacement and mortality. The approach used for the cumulative displacement assessment follows that of the project alone displacement assessment (see volume 3, appendix 11.4).

839. Each cell presents potential cumulative bird mortality following displacement from the Proposed Development and the other offshore wind farm projects in the breeding season. The outputs highlighted in colour are those based on the displacement and mortality rates used in the Developer Approach (highlighted in orange) and used in the Scoping Approach (highlighted in dark teal). Outputs highlighted in light teal reflect potential uncertainty associated with the selected figures. No adjustments for age classes of birds have been made. Further details are presented in volume 3, appendix 11.4).

840. For the Developer Approach cumulative displacement assessment, a displacement rate of 50% and a mortality rate of 1% were applied for the breeding season only, based on evaluation of the published literature and in line with values used by other offshore wind farm displacement assessments.

841. There were two parts to the Scoping Approach cumulative displacement assessment and these are outlined below. For Scoping Approach A, a displacement rate of 60% and a mortality rate of 3% were applied for the breeding season only. For Scoping Approach B, a displacement rate of 60% and a mortality rate of 5% were applied for the breeding season only.

Table 11.118: Potential Cumulative Puffin Mortality following Displacement from Offshore Wind Farms in the Breeding Season

Puffin (Breeding season)	Mortality Level (% of displaced birds at risk of mortality)													
Displacement Level (% of all birds in site)		0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
	0%	0	0	0	0	0	0	0	0	0	0	0	0	0
	10%	0	24	48	71	95	119	238	356	475	713	1,188	1,900	2,376
	20%	0	48	95	143	190	238	475	713	950	1,425	2,376	3,801	4,751
	30%	0	71	143	214	285	356	713	1,069	1,425	2,138	3,563	5,701	7,127
	40%	0	95	190	285	380	475	950	1,425	1,900	2,851	4,751	7,602	9,502
	50%	0	119	238	356	475	594	1,188	1,782	2,376	3,563	5,939	9,502	11,878
	60%	0	143	285	428	570	713	1,425	2,138	2,851	4,276	7,127	11,403	14,254
	70%	0	166	333	499	665	831	1,663	2,494	3,326	4,989	8,315	13,303	16,629
	80%	0	190	380	570	760	950	1,900	2,851	3,801	5,701	9,502	15,204	19,005
	90%	0	214	428	641	855	1,069	2,138	3,207	4,276	6,414	10,690	17,104	21,380
	100%	0	238	475	713	950	1,188	2,376	3,563	4,751	7,127	11,878	19,005	23,756

Orange box - Based on 50% displacement rate and 1% mortality rate (Developer Approach).

Dark teal box - Based on 60% displacement rate and 1% and 3% mortality rate (Scoping Approach A and B).

Magnitude of impact

842. For the Developer Approach, cumulative estimated puffin mortality from displacement by Tier 2 projects was based on 50% displacement and 1% mortality, for the breeding season only (Table 11.119). For the Scoping Approach, cumulative estimated puffin mortality from displacement by Tier 2 projects was based on 60% displacement and 1% and 3% mortality in the breeding season only (Table 11.120).

843. The overall baseline mortality rates were based on age-specific demographic rates and age class proportions as presented in Table 11.21. The potential magnitude of impact was estimated by calculating the increase in cumulative baseline mortality for the breeding season with respect to the regional populations.

Breeding Season

844. During the breeding season, the cumulative abundance for puffin was estimated to be 23,756 individuals (Table 11.117). When considering the Developer Approach displacement rate of 50% this would affect an estimated 11,878 birds. However, this estimate includes non-breeding adults and immature birds, as well as breeding adults.

Table 11.119: Cumulative Displacement Mortality Estimates for Puffin for Tier 2 projects by bio-season for Developer Approach

Bio-season	Peak Mean Seasonal Abundance	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Apr-mid Aug)[1]	23,756	11,878 (5,903 adults)	119 (55 adults)	233,550	23,121 adults	0.24

1 Breeding season assessment is for breeding adults only.

2 Mortality is 1% in breeding season.

845. 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, using proportions from the stable age structure calculated from the population models from which PVAs were produced (Table 11.43) (volume 3, appendix 11.6). the estimated proportion of immature, non-breeding birds across all wind farms was estimated. Based on the proportion of immature puffins, 50.3% of birds present are likely to be immature birds, with 49.7% of birds likely to be adult birds. This would mean that an estimated 5,903 puffins displaced from offshore wind farms during the breeding period would be adult birds.

846. Applying the Developer Approach mortality rate of 1%, the predicted cumulative theoretical additional mortality due to displacement effects would be 119 puffins (59 adults) in the breeding season. However, a proportion of adult birds present at colonies in the breeding season will opt not to breed in a particular breeding season. It has been estimated that 7% of adult puffins may be "sabbatical" birds in any particular breeding season (volume 3, appendix 11.6), and this has been applied for this assessment. On this basis, four adult puffins were considered to be not breeding and so 55 adult breeding puffins were taken forward for the breeding season assessment.

847. The total puffin regional baseline breeding population is estimated to be 233,550 individuals. Using the adult baseline mortality rate of 0.099 (Table 11.21), the predicted baseline mortality of puffins is 23,121 adult birds per breeding season. The additional predicted mortality of 55 adult puffins would increase the baseline mortality rate by 0.24% (Table 11.119).

848. When considering the Scoping Approach displacement rate of 60%, this would affect an estimated 14,254 birds (Table 11.120 and Table 11.121). Assuming that 49.7% of the population present are adult birds, then this would mean that an estimated 7,084 puffins displaced would be adult birds.

849. Applying the Scoping Approach A mortality rate of 3%, the predicted theoretical additional mortality due to cumulative displacement effects was 428 puffins (213 adults) in the breeding season. Applying the 7% rate for "sabbatical" non-breeding birds, resulted in 15 birds being considered as non-breeding "sabbatical birds, with 198 adult breeding puffins being taken forward for the breeding season assessment.

850. Using the adult baseline mortality rate of 0.099 (Table 11.21), the predicted baseline mortality of puffins is 23,121 adult birds per breeding season. The additional predicted mortality of 198 adult puffins would increase the baseline mortality rate by 0.86% (Table 11.120).

Table 11.120: Cumulative Displacement Mortality Estimates for Puffin for Tier 2 projects by bio-season for Scoping Approach A

Bio-season	Peak Mean Seasonal Abundance	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Apr-mid Aug)[1]	23,756	14,254 (7,084 adults)	428 (198 adults)	233,550	23,121 adults	0.86

1 Breeding season assessment is for breeding adults only.

2 Mortality is 3% in breeding season.

851. Applying the Scoping Approach B mortality rate of 5%, the predicted theoretical additional mortality due to cumulative displacement effects was 713 puffins (354 adults) in the breeding season. Applying the 7% rate for "sabbatical" non-breeding birds, resulted in 25 birds being considered as non-breeding "sabbatical birds, with 329 adult breeding puffins being taken forward for the breeding season assessment.

852. Using the adult baseline mortality rate of 0.099 (Table 11.21), the predicted baseline mortality of puffins is 23,121 adult birds per breeding season. The additional predicted mortality of 329 adult puffins would increase the baseline mortality rate by 1.42% (Table 11.121).

Table 11.121: Cumulative Displacement Mortality Estimates for Puffin for Tier 2 projects by bio-season for Scoping Approach B

Bio-season	Peak mean seasonal abundance	Estimated Seasonal Displacement	Estimated Seasonal Displacement Mortality[2]	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Apr-mid Aug)[1]	23,756	14,254 (7,084 adults)	713 (329 adults)	233,550	23,121 adults	1.42

1 Breeding season assessment is for breeding adults only.

2 Mortality is 5% in breeding season.

853. For the Developer Approach and Scoping Approach A, the cumulative displacement mortality estimate did not indicate a potential significant increase in the baseline mortality rate for puffin. However, for Scoping Approach B, the cumulative displacement mortality estimate did suggest a potential significant increase in the baseline mortality rate for puffin therefore cumulative PVA analysis was conducted on the puffin regional SPA population.

Summary of PVA Assessment

854. As these cumulative displacement mortality estimates suggested a potentially significant increase in the cumulative baseline mortality rate for puffin for North Sea offshore wind farms and both the Developer Approach and the Scoping Approach, cumulative PVA analysis was conducted on the puffin regional SPA

population. The cumulative PVA analysis was carried out considering a range of cumulative displacement and mortality rates as well as a range of scenarios.

855. The results of the cumulative PVA for predicted displacement impacts for the Developer Approach and Scoping Approach with both other Forth and Tay consented projects and other North Sea consented projects during the operation phase for the puffin regional SPA population for the 35-year projection is summarised in Table 11.122. Further details of the PVA methodology, input parameters and an explanation of how to interpret the PVA results can be found in volume 3, appendix 11.6.

Table 11.122: Summary of PVA Cumulative Displacement Outputs for Puffin for the Proposed Development array area and a 2 km buffer after 35 years

Scenario and Start population 177,778 adults[1]	Unimpacted Median Population Size	Impacted Median Population Size	Counterfactual of Population Growth Rate - Median	Counterfactual Population Size - Median	Unimpacted Centile at Impacted 50th Centile - Median
North Sea Consented + Developer Approach	756984	749618	1.000	0.986	48.8
North Sea Consented + Scoping Approach A	756984	735327	0.999	0.968	46.1
North Sea Consented + Scoping Approach B	756984	717711	0.998	0.947	42.8

1 Starting population taken from volume 3, appendix 11.6.

Developer Approach = 50% displacement rate and 1% mortality rate in breeding season.

Scoping Approach A = 60% displacement rate and 3% mortality rate in breeding season.

Scoping Approach B = 60% displacement rate and 5% mortality rate in breeding season.

856. For both the with and without Project scenarios, the puffin regional SPA population is predicted to increase over the 35-year period. For the Developer Approach with other North Sea consented projects, the end population size with Project scenario was lower than the without Project scenario. There was no predicted difference in the counterfactual of the population growth rate, and the counterfactual of the population size was also close to 1.000, while the 50th Centile value was very close to 50. These values indicate that the PVA did not predict a significant negative effect from the cumulative effects of displacement mortality from the Developer Approach and other North Sea consented projects on the puffin regional SPA population after 35 years.

857. For Scoping Approach A with other North Sea consented projects, the end population size with Project scenario was lower than the without Project scenario. There was a very slight predicted decrease in the counterfactual of the population growth rate, and the counterfactual of the population size was also close to 1.000, while the 50th Centile value was close to 50. These values indicate that the PVA did not predict a significant negative effect from the cumulative effects of displacement mortality from Scoping Approach A and other North Sea consented projects on the puffin regional SPA population after 35 years.

858. For Scoping Approach B with other North Sea consented projects, the end population size with Project scenario was lower than the without Project scenario. There was a very slight predicted decrease in the counterfactual of the population growth rate, and the counterfactual of the population size was also close to 1.000, while the 50th Centile value was relatively close to 50. These values indicate that the PVA did not predict a significant negative effect from the cumulative effects of displacement mortality from Scoping Approach B and other North Sea consented projects on the puffin regional SPA population after 35 years.

859. Based on the results from the cumulative displacement assessment and the cumulative PVA for the Developer Approach and other North Sea projects, the magnitude of impact on the puffin regional SPA population is negligible.

860. Based on the results from the cumulative displacement assessment and the cumulative PVA for Scoping Approach A and other North Sea projects, the magnitude of impact on the puffin regional SPA population is negligible.

861. Based on the results from the cumulative displacement assessment and the cumulative PVA for Scoping Approach B and other North Sea projects, the magnitude of impact on the puffin regional SPA population is low.

Sensitivity of the receptor

862. Evidence of puffin sensitivity to displacement from offshore wind farms is summarised in paragraph 384 onwards. Overall, on the basis of evidence from post-construction studies and reviews, puffin sensitivity to operational offshore wind farms is considered to be medium (Table 11.16).

Significance of the effect

863. For cumulative displacement effects for puffin, for the Developer Approach, the magnitude of the cumulative impact is deemed to be negligible, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms.

864. For Scoping Approach A, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms.

865. For Scoping Approach B, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

866. No offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of not more than **minor** adverse significance, which is not significant in EIA terms.

Decommissioning phase

867. Cumulative effects in the decommissioning phase were scoped out in Table 11.86 and so are not considered further here.

Tier 1

868. For the cumulative displacement assessment, there are no cumulative displacement impacts for Tier 1 alone.

Tier 2

Construction phase

869. Cumulative effects in the construction phase were scoped out in Table 11.86 and so are not considered further here.

Operation and maintenance phase

Gannet

870. The cumulative estimated number of collisions per bio-season for gannet are presented in Table 11.123. For the Proposed Development, two sets of figures are presented: the Developer Approach (based on mean densities) and the Scoping Approach (based on maximum densities), for the breeding and non-breeding seasons, based on the maximum design scenario (307x14 MW wind turbines). Estimated collisions for gannet for other relevant North Sea offshore wind farm projects are also presented.

Magnitude of Impact

871. The overall baseline mortality rates were based on age-specific demographic rates and age class proportions as presented in Table 11.21. The potential magnitude of impact was estimated by calculating the increase in baseline mortality within each bio-season with respect to the regional populations.

Table 11.123: Estimated Cumulative Collisions for Gannet by bio-season for Tier 2 Projects based on Consented Scenarios. (Estimates are rounded to nearest whole bird).

Project	Annual Collisions	Breeding Season Collisions	Autumn Migration Collisions	Spring Migration Collisions
Aberdeen	9	4	5	0
Beatrice	96	37	49	10
Blyth Demo	8	4	2	3
Dudgeon Extension and Sheringham Shoal Extension	11	4	6	0
Dogger Bank A and B	219	81	84	54
Dogger C and Sofia	36	15	10	11
Dudgeon	80	22	39	19
East Anglia 1 North	25	12	11	1
East Anglia 2	40	13	23	4
East Anglia 3	42	5	29	8
East Anglia One	141	3	131	6
Galloper	62	18	31	13
Greater Gabbard	28	14	9	5
Gunfleet Sands	0	0	0	0
Hornsea Project One	15	3	7	5
Hornsea Project Two	27	7	14	6
Hornsea Project Three	19	10	5	5
Hornsea Project Four	26	19	5	2
Humber Gateway	5	2	1	2
Hywind	7	6	1	1
Inch Cape	117	108	5	4
Kentish Flats + Extension	3	1	1	1
Kincardine	3	3	0	0
Lincs	5	2	1	2
London Array	6	2	1	2
Lynn and Inner Dowsing	1	0	0	0
Methil	6	6	0	0
Moray Firth East	125	81	35	9
Moray West	12	10	2	1
Neart na Gaoithe	103	89	7	7
Norfolk Boreas	31	14	13	4
Norfolk Vanguard	32	8	19	5
Race Bank	50	34	12	4
Rampion	102	36	64	2
Scroby Sands	0	0	0	0
Seagreen Alpha and Bravo	175	159	8	9
Sheringham Shoal	18	14	4	0
Teesside	7	5	2	0
Thanet	1	1	0	0
Triton Knoll	121	27	64	30
Westermost Rough	1	0	0	0
Total	1,810	878	697	235
Total in Mean max +1SD foraging range (Breeding only)		873		
Berwick Bank Developer Approach	153	138	13	2
Berwick Bank Scoping Approach	191	170	18	3
Total Cumulative (Developer Approach)	1,959	1,011	710	237
Total Cumulative (Scoping Approach)	1,997	1,043	715	238

Table 11.124: Estimated Cumulative Numbers of Collisions for Gannet for Tier 2 projects by bio-season for Developer Approach

Bio-season	Estimated Seasonal Collision Mortality	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Mid Mar-Sep)[1]	1,011 (488 adults)	323,836	14,896 adults	3.28

Bio-season	Estimated Seasonal Collision Mortality	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Autumn migration (Oct-Nov)	710	456,298	68,901	1.03
Spring migration (Dec-mid Mar)	237	248,385	37,506	0.63
Total	1,435	-	-	4.94

1 Breeding season assessment is for breeding adults only.

Table 11.125: Estimated Cumulative Numbers of Collisions for Gannet for Tier 2 projects by bio-season for Scoping Approach

Bio-season	Estimated Seasonal Collision Mortality	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Mid Mar-Sep)[1]	1,043 (503 adults)	323,836	14,896 adults	3.38
Autumn migration (Oct-Nov)	715	456,298	68,901	1.04
Spring migration (Dec-mid Mar)	238	248,385	37,506	0.63
Total	1,456	-	-	5.05

1 Breeding season assessment is for breeding adults only.

Breeding Season

872. The total cumulative estimated number of gannet collisions based on North Sea offshore wind farm consented estimates and the Development Approach during the breeding season was 1,011 birds (Table 11.123). However, this includes non-breeding adults and immature birds, as well as breeding adults. For the purposes of this assessment, the estimated proportion of immature, non-breeding gannets across all wind farms was based on the age breakdown calculated for the Berwick Bank PVA study (see volume 3, appendix 11.6). Based on this breakdown, 46.4% of birds present are likely to be immature birds, with 53.6% of birds likely to be adult birds. This would mean that 542 collisions would involve adult gannets during the breeding period.

873. However, a proportion of adult birds present at colonies in the breeding season will opt not to breed in a particular breeding season. It has been estimated that 10% of adult gannets may be “sabbatical” birds in any particular breeding season (volume 3, appendix 11.6), and this has been applied for this assessment. On this basis, 54 adult gannets were considered to be not breeding and so 488 adult breeding gannets were taken forward for the breeding season assessment.

874. The total gannet regional baseline breeding population is estimated to be 323,836 individuals. Using the adult baseline mortality rate of 0.046 (Table 11.21), the predicted baseline mortality of gannets is 14,896 adult birds per breeding season. The additional predicted mortality of 488 adult gannets would increase the baseline mortality rate by 3.28% (Table 11.124).

875. The total cumulative estimated number of gannet collisions based on North Sea offshore wind farm consented estimates and the Scoping Approach during the breeding season was 1,043 birds (Table 11.123). For the purposes of this assessment, the estimated proportion of immature, non-breeding gannets across all wind farms was based on the age breakdown calculated for the Berwick Bank PVA study (see volume 3, appendix 11.6). Based on this breakdown, 46.4% of birds present are likely to be immature birds, with 53.6% of birds likely to be adult birds. This would mean that 559 collisions would involve adult gannets during the breeding period. Applying the 10% rate for “sabbatical” non-breeding birds, resulted in 56 birds being considered as non-breeding “sabbatical birds, with 503 adult breeding gannets being taken forward for the breeding season assessment.

876. Using the adult baseline mortality rate of 0.046 (Table 11.21), the predicted baseline mortality of gannets is 14,896 adult birds per breeding season. The additional predicted mortality of 503 adult gannets would increase the baseline mortality rate by 3.38% (Table 11.125).

Autumn Migration Period of Non-breeding Season

877. The total cumulative estimated number of gannet collisions based on North Sea offshore wind farm consented estimates and the Development Approach during the autumn migration period of the non-breeding season was 710 birds (Table 11.123). However, this includes non-breeding adults and immature birds, as well as breeding adults. Based on information presented in Furness (2015), in the non-breeding season 45% of the population present are immature birds and 55% of birds are adults. Based on this breakdown, 391 collisions would involve adult gannets, and 319 collisions would involve immature birds.

878. Based on Furness (2015), the total gannet BDMPS regional baseline population for the autumn migration period is predicted to be 456,298 individuals. Using the average baseline mortality rate of 0.151 (Table 11.21), the predicted regional baseline mortality of gannets is 68,901 birds in the autumn migration period. The additional predicted mortality of 710 gannets of all ages would increase the baseline mortality rate by 1.03% (Table 11.124).

879. The total cumulative estimated number of gannet collisions based on North Sea offshore wind farm consented estimates and the Scoping Approach during the autumn migration period of the non-breeding season was 715 birds (Table 11.123). However, this includes non-breeding adults and immature birds, as well as breeding adults. Based on information presented in Furness (2015), in the non-breeding season 45% of the population present are immature birds and 55% of birds are adults. Based on this breakdown, 393 collisions would involve adult gannets, and 322 collisions would involve immature birds.

880. Using the average baseline mortality rate of 0.151 (Table 11.21), the predicted regional baseline mortality of gannets is 68,901 birds in the autumn migration period. The additional predicted mortality of 715 gannets of all ages would increase the baseline mortality rate by 1.04% (Table 11.125).

Spring Migration Period of Non-breeding Season

881. The total cumulative estimated number of gannet collisions based on North Sea offshore wind farm consented estimates and the Development Approach during the spring migration period of the non-breeding season was 237 birds (Table 11.123). However, this includes non-breeding adults and immature birds, as well as breeding adults. Based on information presented in Furness (2015), in the non-breeding season 45% of the population present are immature birds and 55% of birds are adults. Based on this breakdown, 391 collisions would involve 130 adult gannets, and 107 collisions would involve immature birds.

882. Based on Furness (2015), the total gannet BDMPS regional baseline population for the spring migration period is predicted to be 248,835 individuals. Using the average baseline mortality rate of 0.151 (Table 11.21), the predicted regional baseline mortality of gannets is 37,506 birds in the spring migration period. The additional predicted mortality of 237 gannets of all ages would increase the baseline mortality rate by 0.63% (Table 11.124).

883. The total cumulative estimated number of gannet collisions based on North Sea offshore wind farm consented estimates and the Scoping Approach during the autumn migration period of the non-breeding season was 238 birds (Table 11.123). Based on information presented in Furness (2015), in the non-breeding season 45% of the population present are immature birds and 55% of birds are adults. Based on this breakdown, 131 collisions would involve adult gannets, and 107 collisions would involve immature birds.

884. Using the average baseline mortality rate of 0.151 (Table 11.21), the predicted regional baseline mortality of gannets is 37,506 birds in the spring migration period. The additional predicted mortality of 238 gannets of all ages would increase the baseline mortality rate by 0.63% (Table 11.125).

Assessment of Cumulative Collision Mortality throughout the Year

885. Predicted gannet mortality as a result of cumulative collisions for North Sea offshore wind farms and the Developer and Scoping approaches for the Proposed Development for all bio-seasons as calculated above, was summed for the whole year.

886. Based on cumulative collisions for North Sea offshore wind farms and the Developer Approach, the predicted theoretical additional annual cumulative mortality due to collision was an estimated 1,435 gannets. This corresponds to an increase in the baseline mortality rate of 4.94% (Table 11.124).

887. Based on cumulative collisions for North Sea offshore wind farms and the Scoping Approach, the predicted theoretical additional annual mortality due to collision was an estimated 1,456 gannets. This corresponds to an increase in the baseline mortality rate of 5.05% (Table 11.125).

Cumulative Collision and Displacement Impacts Combined

888. NS advice in the Scoping Opinion was that collision and displacement impacts should be considered as additive within the assessment for gannet. The totals from the collision and displacement cumulative assessments for gannet were therefore combined, using the annual predicted mortality totals for both the Developer Approach and the Scoping Approach.

Table 11.126: Combined Cumulative Annual Estimated Mortality from Collisions and Displacement for Gannet for North Sea offshore wind farms and the Proposed Development array area for the Developer Approach

Bio-season	Cumulative Estimated Mortality	Increase in Baseline Mortality (%)
Total Cumulative Collision Mortality	1,435	4.94
Total Cumulative Displacement Mortality	293	0.94
Combined Total	1,728	5.88

Table 11.127: Combined Cumulative Annual Estimated Mortality from Collisions and Displacement for Gannet for North Sea offshore wind farms and the Proposed Development array area for the Scoping Approach

Bio-season	Cumulative Estimated Mortality	Increase in Baseline Mortality (%)
Total Collisions	1,456	5.05
Total Displacement	293-777	0.94-2.82
Combined Total	1,749-2,233	5.99-7.87

889. Based on estimated combined cumulative collision and displacement mortality from North Sea offshore wind farms and the Developer Approach, the predicted theoretical additional annual mortality due to collision and displacement was a combined total of 1,728 gannets. This corresponds to an increase in the baseline mortality rate of 5.88% (Table 11.126).

890. Based on estimated combined cumulative collision and displacement mortality from North Sea offshore wind farms and the Scoping Approach, the predicted theoretical additional annual mortality due to collision and displacement was a combined total of between 1,749 and 2,233 gannets. This corresponds to an increase in the baseline mortality rate of between 5.99% and 7.87% (Table 11.127).

891. It should be noted that this approach is considered highly precautionary. As highlighted by NS in the NnG Scoping Opinion (Marine Scotland, 2017a), collision risk and displacement are considered to be mutually exclusive impacts, and therefore combining mortality estimates for displacement and collision should be considered extremely precautionary.

Summary of PVA Assessment

892. As these cumulative collision mortality estimates suggested a potentially significant increase in the cumulative baseline mortality rate for North Sea offshore wind farms and both the Developer Approach and the Scoping Approach, cumulative PVA analysis was conducted on the gannet regional SPA population. The cumulative PVA analysis was carried out considering a range of cumulative displacement and mortality rates as well as a range of cumulative collision scenarios.

893. The results of the cumulative PVA for predicted displacement and collision impacts for the Developer Approach and Scoping Approach with both other Forth and Tay consented projects and other North Sea consented projects during the operation phase for the gannet regional SPA population for the 35-year projection is summarised in Table 11.128. Further details of the PVA methodology, input parameters and an explanation of how to interpret the PVA results can be found in volume 3, appendix 11.6.

Table 11.128: Summary of PVA Cumulative Displacement and Collision Outputs for Gannet for the Proposed Development array area after 35 years

Scenario and Start population 288,394 adults[1]	Unimpacted Median Population Size	Impacted Median Population Size	Counterfactual of Population Growth Rate - Median	Counterfactual Population Size - Median	Unimpacted Centile at Impacted 50th Centile - Median
Forth and Tay Consented + Developer Approach	1,986,443	1,886,754	0.999	0.952	37.2

Scenario and Start population 288,394 adults[1]	Unimpacted Median Population Size	Impacted Median Population Size	Counterfactual of Population Growth Rate - Median	Counterfactual Population Size - Median	Unimpacted Centile at Impacted 50th Centile - Median
Forth and Tay Consented + Scoping Approach A	1,986,443	1,883,882	0.998	0.946	36.9
Forth and Tay Consented + Scoping Approach B	1,986,443	1,846,353	0.998	0.927	32.1
North Sea As-built + Developer Approach	1,986,443	1,920,713	0.999	0.967	41.6
North Sea As built + Scoping Approach A	1,986,443	1,919,283	0.999	0.968	41.3
North Sea As-built + Scoping Approach B	1,986,443	1,894,512	0.999	0.956	38.1

1 Starting population taken from volume 3, appendix 11.6.

Developer Approach = 70% displacement rate and 1% mortality rate throughout the year; CRM based on mean monthly density.

Scoping Approach A = 70% displacement rate and 1% mortality rate throughout the year; CRM based on maximum monthly density.

Scoping Approach B = 70% displacement rate and 3% mortality rate throughout the year; CRM based on maximum monthly density.

894. For both the with and without Project scenarios, the gannet regional SPA population is predicted to increase over the 35-year period. For the Developer Approach with other Forth and Tay consented projects, the end population size with Project scenario was lower than the without Project scenario. There was a slight predicted difference in the counterfactual of the population growth rate, and the counterfactual of the population size was close to 1.000, while the 50th Centile value was 37.2, These values indicate that the PVA did not predict a significant negative effect from the cumulative effects of displacement and collision mortality from the Developer Approach and other Forth and Tay consented projects on the gannet regional SPA population after 35 years.

895. For Scoping Approach A with other Forth and Tay consented projects, the end population size with Project scenario was lower than the without Project scenario. There was a slight predicted difference in the counterfactual of the population growth rate, and the counterfactual of the population size was close to 1.000, while the 50th Centile value was 36.9, These values indicate that the PVA did not predict a significant negative effect from the cumulative effects of displacement and collision mortality from Scoping Approach A and other Forth and Tay consented projects on the gannet regional SPA population after 35 years.

896. For Scoping Approach B with other Forth and Tay consented projects, the end population size with Project scenario was lower than the without Project scenario. There was a slight difference in the counterfactual of the population growth rate, and the counterfactual of the population size was below 0.900, while the 50th Centile value was 32.1, These values indicate that the PVA did predict a slight negative effect from the cumulative effects of displacement and collision mortality from Scoping Approach B and other Forth and Tay consented projects on the gannet regional SPA population after 35 years.

897. For the Developer Approach with other North Sea as-built projects, the end population size with Project scenario was lower than the without Project scenario. There was a slight predicted difference in the counterfactual of the population growth rate, and the counterfactual of the population size was close to 1.000, while the 50th Centile value was relatively close to 50, These values indicate that the PVA did not predict a significant negative effect from the cumulative effects of displacement and collision mortality from the Developer Approach and other North Sea as-built projects on the gannet regional SPA population after 35 years.

898. For Scoping Approach A with other North Sea as-built projects, the end population size with Project scenario was lower than the without Project scenario. There was a slight predicted difference in the counterfactual of the population growth rate, and the counterfactual of the population size was close to 1.000, while the 50th Centile value was relatively close to 50, These values indicate that the PVA did not predict a significant negative effect from the cumulative effects of displacement and collision mortality from Scoping Approach A and other North Sea as-built projects on the gannet regional SPA population after 35 years.

899. For Scoping Approach B with other North Sea as-built projects, the end population size with Project scenario was lower than the without Project scenario. There was a slight predicted difference in the counterfactual of the population growth rate, and the counterfactual of the population size was close to 1.000, while the 50th Centile value was relatively close to 50, These values indicate that the PVA did not predict a significant negative effect from the cumulative effects of displacement and collision mortality from Scoping Approach B and other North Sea as-built projects on the gannet regional SPA population after 35 years.

900. Based on the results from the cumulative displacement and collision assessment and the cumulative displacement and collision PVA for the Developer Approach, the magnitude of impact on the regional SPA gannet population is low.

901. Based on the results from the cumulative displacement and collision assessment and the cumulative displacement and collision PVA for Scoping Approach A, the magnitude of impact on the regional SPA gannet population is low.

902. Based on the results from the cumulative displacement and collision assessment and the cumulative displacement and collision PVA for Scoping Approach B, the magnitude of impact on the regional SPA gannet population is medium.

Sensitivity of the receptor

903. Gannet sensitivity to displacement is discussed in paragraph 209 onwards. Based on evidence from other operational offshore wind farms and a review of gannet GPS tracking data from the Bass Rock, it is considered that the majority of adult gannets passing through the Proposed Development are in transit rather than actively foraging. In addition, the home range of birds breeding on the Bass Rock is very large, in relation to the size of the Proposed Development, while gannets are also known to feed on a wide range of prey species.

904. Based on evidence from post-construction studies, it is considered that collision impacts as estimated for the CRM assessment for gannet are likely to be over-estimates, as it is highly likely that the majority of gannets will avoid the Proposed Development.

905. On the basis of these results, which highlight the high degree of avoidance of wind turbines, gannet sensitivity to collision and displacement impacts from operational offshore wind farms is considered to be medium (Table 11.16).

Significance of the effect

906. For cumulative displacement and collision effects for gannet, for the Developer Approach, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

907. For Scoping Approach A, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

908. For Scoping Approach B, the magnitude of the impact is deemed to be medium, and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **moderate** adverse significance, which is significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

909. For the Developer Approach and Scoping Approach A, no offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **minor** adverse significance, which is not significant in EIA terms.

910. For Scoping Approach B, the residual cumulative impact is considered to be of **moderate** adverse significance, which is significant in EIA terms. However, it is considered that the combined displacement and collision mortality estimates used in Scoping Approach B are highly precautionary, for the reasons outlined in paragraph 454 and also in volume 3, appendix 11.3. Consequently, no additional mitigation is proposed.

Kittiwake

911. The cumulative estimated number of collisions per bio-season for kittiwake are presented in Table 11.129. For the Proposed Development, two sets of figures are presented: the Developer Approach (based on mean densities) and the Scoping Approach (based on maximum densities), for the breeding and non-breeding seasons, based on the maximum design scenario (307x14 MW wind turbines). Estimated collisions for kittiwakes for other relevant North Sea offshore wind farm projects are also presented.

Magnitude of Impact

912. The overall baseline mortality rates were based on age-specific demographic rates and age class proportions as presented in Table 11.21. The potential magnitude of impact was estimated by calculating the increase in baseline mortality within each bio-season with respect to the regional populations.

Table 11.129: Estimated Cumulative Collisions for Kittiwake by bio-season for Tier 2 Projects based on Consented Scenarios. (Estimates are rounded to nearest whole bird).

Project	Annual Collisions	Breeding Season Collisions	Autumn Migration Collisions	Spring Migration Collisions
Aberdeen	**14**	**9**	**4**	**1**
Beatrice	**80**	**52**	**6**	**22**
Blyth Demo	**5**	**2**	**2**	**1**
Dogger Bank A and B (Creyke Beck)	**719**	**289**	**135**	**295**
Dogger Bank C and Sofia (Teesside)	**445**	**137**	**91**	**217**
Dudgeon	0	0	0	0
Dudgeon Expansion and Sheringham Shoal Extension (PEIR)	31	18	10	2
East Anglia ONE	141	1	108	32
East Anglia ONE North	52	40	8	4
East Anglia THREE	92	5	57	31
East Anglia TWO	42	30	5	7
Galloper	28	3	12	13
Greater Gabbard	27	1	15	11
Gunfleet Sands	0	0	0	0
Hornsea Project One	21	8	10	4
Hornsea Project Two	**28**	**16**	**9**	**3**
Hornsea Project Three	123	54	38	31
Hornsea Project Four	**107**	**76**	**14**	**16**
Humber Gateway	**3**	**1**	**1**	**1**
Hywind	**18**	**17**	**1**	**1**
Inch Cape	**72**	**40**	**26**	**6**
Kentish Flats	2	0	1	1
Kentish Flats extension	2	0	0	2
Kincardine	**32**	**22**	**9**	**1**
Lincs	3	1	1	1
London Array	2	0	1	1
Lynn and Inner Dowsing	0	0	0	0
Methil	**0**	**0**	**0**	**0**
Moray Firth (EDA)	**31**	**24**	**2**	**5**
Moray West	**107**	**77**	**23**	**7**
Neart na Gaoithe	**27**	**8**	**17**	**2**
Norfolk Boreas	58	13	32	12
Norfolk Vanguard	58	22	16	19
Race Bank	19	1	14	3
Rampion	83	37	26	20
Scroby Sands	0	0	0	0
Seagreen Alpha and Bravo	**170**	**62**	**70**	**38**
Sheringham Shoal	0	0	0	0
Teesside	55	32	20	2
Thanet	1	0	1	0
Triton Knoll	76	9	50	16
Westermost Rough	**0**	**0**	**0**	**0**
Total	**2,774**	**1,107**	**835**	**828**
Total in Mean max +1SD foraging range (Breeding only)		**832**		
Berwick Bank (Developers approach)	685	426	155	104
Berwick Bank (Scoping Approach)	986	617	190	179
Cumulative (Developers Approach)	**3,459**	**1,258**	**990**	**932**
Cumulative (Scoping Approach)	**3,760**	**1,449**	**1,025**	**1,007**

Table 11.130: Estimated Cumulative Numbers of Collisions for Kittiwake for Tier 2 projects by bio-season for Developer Approach

Bio-season	Estimated Seasonal Collision Mortality	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Mid Apr-Aug)[1]	1,258 (611 adults)	319,126	46,273 adults	1.32
Autumn migration (Sep-Dec)	990	829,937	132,790	0.75
Spring migration (Jan to mid-April)	932	627,816	100,451	0.93
Total	2,533	-	-	3.0

1 Breeding season assessment is for breeding adults only.

Table 11.131: Estimated Cumulative Numbers of Collisions for Kittiwake for Tier 2 projects by bio-season for Scoping Approach

Bio-season	Estimated Seasonal Collision Mortality	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Mid Apr-Aug)[1]	1,449 (704 adults)	319,126	46,273 adults	1.52
Autumn migration (Sep-Dec)	1,025	829,937	132,790	0.77
Spring migration (Jan to mid-April)	1,007	627,816	100,451	1.00
Total	2,736	-	-	3.29

1 Breeding season assessment is for breeding adults only.

Breeding Season

913. The total cumulative estimated number of kittiwake collisions based on North Sea offshore wind farm consented estimates and the Development Approach during the breeding season was 1,258 birds (Table 11.129). However, this includes non-breeding adults and immature birds, as well as breeding adults. For the purposes of this assessment, the estimated proportion of immature, non-breeding kittiwakes across all wind farms was based on the age breakdown calculated for the Berwick Bank PVA study (see volume 3, appendix 11.6). Based on this breakdown, 46% of birds present are likely to be immature birds, with 54% of birds likely to be adult birds. This would mean that 679 collisions would involve adult kittiwakes during the breeding period.

914. However, a proportion of adult birds present at colonies in the breeding season will opt not to breed in a particular breeding season. It has been estimated that 10% of adult kittiwakes may be "sabbatical" birds in any particular breeding season (volume 3, appendix 11.6), and this has been applied for this assessment. On this basis, 68 adult kittiwakes were considered to be not breeding and so 611 adult breeding kittiwakes were taken forward for the breeding season assessment.

915. The total kittiwake regional baseline breeding population is estimated to be 319,126 individuals. Using the adult baseline mortality rate of 0.145 (Table 11.21), the predicted baseline mortality of kittiwakes is 46,273 adult birds per breeding season. The additional predicted mortality of 611 adult kittiwakes would increase the baseline mortality rate by 1.32% (Table 11.130).

916. The total cumulative estimated number of kittiwake collisions based on North Sea offshore wind farm consented estimates and the Scoping Approach during the breeding season was 1,449 birds (Table 11.129). For the purposes of this assessment, the estimated proportion of immature, non-breeding kittiwakes across all wind farms was based on the age breakdown calculated for the Berwick Bank PVA study (see volume 3, appendix 11.6). Based on this breakdown, 46% of birds present are likely to be immature birds, with 54% of birds likely to be adult birds. This would mean that 782 collisions would involve adult kittiwakes during the breeding period.

917. Applying the 10% rate for "sabbatical" non-breeding birds, resulted in 78 birds being considered as non-breeding "sabbatical birds, with 704 adult breeding kittiwakes being taken forward for the breeding season assessment.

918. Using the adult baseline mortality rate of 0.145 (Table 11.21), the predicted baseline mortality of kittiwakes is 46,273 adult birds per breeding season. The additional predicted mortality of 704 adult kittiwakes would increase the baseline mortality rate by 1.52% (Table 11.131).

Autumn Migration Period of Non-breeding Season

919. The total cumulative estimated number of kittiwake collisions based on North Sea offshore wind farm consented estimates and the Development Approach during the autumn migration period of the non-breeding season was 990 birds (Table 11.129). However, this includes non-breeding adults and immature birds, as well as breeding adults. Based on information presented in Furness (2015), in the non-breeding season 47% of the population present are immature birds and 53% of birds are adults. Based on this breakdown, 525 collisions would involve adult kittiwakes, and 465 collisions would involve immature birds.

920. Based on Furness (2015), the total kittiwake BDMPS regional baseline population for the autumn migration period is predicted to be 829,937 individuals. Using the average baseline mortality rate of 0.160 (Table 11.21), the predicted regional baseline mortality of kittiwakes is 132,790 birds in the autumn migration period. The additional predicted mortality of 990 kittiwakes of all ages would increase the baseline mortality rate by 0.75% (Table 11.130).

921. The total cumulative estimated number of kittiwake collisions based on North Sea offshore wind farm consented estimates and the Scoping Approach during the autumn migration period of the non-breeding season was 1,025 birds (Table 11.129). However, this includes non-breeding adults and immature birds, as well as breeding adults. Based on information presented in Furness (2015), in the non-breeding season 47% of the population present are immature birds and 53% of birds are adults. Based on this breakdown, 543 collisions would involve adult kittiwakes, and 482 collisions would involve immature birds.

922. Using the average baseline mortality rate of 0.160 (Table 11.21), the predicted regional baseline mortality of kittiwakes is 132,790 birds in the autumn migration period. The additional predicted mortality of 1,025 kittiwakes of all ages would increase the baseline mortality rate by 0.77% (Table 11.131).

Spring Migration Period of Non-breeding Season

923. The total cumulative estimated number of kittiwake collisions based on North Sea offshore wind farm consented estimates and the Development Approach during the spring migration period of the non-breeding season was 932 birds (Table 11.129). However, this includes non-breeding adults and immature birds, as well as breeding adults. Based on information presented in Furness (2015), in the non-breeding season 47% of the population present are immature birds and 53% of birds are adults. Based on this breakdown, 494 collisions would involve adult kittiwakes, and 438 collisions would involve immature birds.

924. Based on Furness (2015), the total kittiwake BDMPS regional baseline population for the spring migration period is predicted to be 627,816 individuals. Using the average baseline mortality rate of 0.160 (Table 11.21), the predicted regional baseline mortality of kittiwakes is 100,451 birds in the spring migration period. The additional predicted mortality of 932 kittiwakes of all ages would increase the baseline mortality rate by 0.93% (Table 11.130).

925. The total cumulative estimated number of kittiwake collisions based on North Sea offshore wind farm consented estimates and the Scoping Approach during the spring migration period of the non-breeding season was 1,007 birds (Table 11.129). However, this includes non-breeding adults and immature birds, as well as breeding adults. Based on information presented in Furness (2015), in the non-breeding season 47% of the population present are immature birds and 53% of birds are adults. Based on this breakdown, 534 collisions would involve adult kittiwakes, and 473 collisions would involve immature birds.

926. Using the average baseline mortality rate of 0.160 (Table 11.21), the predicted regional baseline mortality of kittiwakes is 100,451 birds in the spring migration period. The additional predicted mortality of 1,007 kittiwakes of all ages would increase the baseline mortality rate by 1.00% (Table 11.131).

Assessment of Cumulative Collision Mortality throughout the Year

927. Predicted kittiwake mortality as a result of cumulative collisions for North Sea offshore wind farms and the Developer and Scoping approaches for the Proposed Development for all bio-seasons as calculated above, was summed for the whole year.

928. Based on cumulative collisions for North Sea offshore wind farms and the Developer Approach, the predicted theoretical additional annual cumulative mortality due to collision was an estimated 2,533 kittiwakes. This corresponds to an increase in the baseline mortality rate of 3.0% (Table 11.130).

929. Based on cumulative collisions for North Sea offshore wind farms and the Scoping Approach, the predicted theoretical additional annual mortality due to collision was an estimated 2,736 kittiwakes. This corresponds to an increase in the baseline mortality rate of 3.29% (Table 11.131).

930. These cumulative collision mortality estimates suggest a potential significant increase in the baseline mortality rate for kittiwakes resulting from cumulative collision impacts for North Sea offshore wind farms and both the Developer Approach and the Scoping Approach, therefore cumulative PVA analysis was conducted on the kittiwake regional SPA population.

Summary of PVA Assessment

931. As these cumulative collision mortality estimates suggested a potentially significant increase in the cumulative baseline mortality rate for North Sea offshore wind farms and both the Developer Approach and the Scoping Approach, cumulative PVA analysis was conducted on the kittiwake regional SPA population. The cumulative PVA analysis was carried out considering a range of cumulative displacement and mortality rates as well as a range of cumulative collision scenarios.

932. The results of the cumulative PVA for predicted displacement and collision impacts for the Developer Approach and Scoping Approach with both other Forth and Tay consented projects and other North Sea consented projects during the operation phase for the kittiwake regional SPA population for the 35-year projection is summarised in Table 11.132. Further details of the PVA methodology, input parameters and an explanation of how to interpret the PVA results can be found in volume 3, appendix 11.6.

Table 11.132: Summary of PVA Cumulative Displacement and Collision Outputs for Kittiwake for the Proposed Development array area after 35 years

Scenario and Start Population 247,678 Adults[1]	Unimpacted Median Population Size	Impacted Median Population Size	Counterfactual of Population Growth Rate - Median	Counterfactual Population Size - Median	Unimpacted Centile at Impacted 50th Centile - Median
Forth and Tay Consented + Developer Approach	216118	210200	0.999	0.970	45.3
Forth and Tay Consented + Scoping Approach A	216118	207876	0.999	0.963	43.4
Forth and Tay Consented + Scoping Approach B	216118	206352	0.999	0.960	42.2
North Sea As-built + Developer Approach	216118	193188	0.997	0.893	31.2
North Sea As built + Scoping Approach A	216118	191433	0.997	0.882	29.8
North Sea As-built + Scoping Approach B	216118	183277	0.995	0.846	22.7

1 Starting population taken from volume 3, appendix 11.6.
Developer Approach = 30% displacement and 2% mortality rate in breeding season; CRM based on mean monthly density.
Scoping Approach A = 30% displacement rate and 1% mortality rate throughout the year; CRM based on maximum monthly density.
Scoping Approach B = 30% displacement rate and 3% mortality rate throughout the year; CRM based on maximum monthly density.

933. For kittiwake, the cumulative PVA predicted that the regional SPA end population would be lower than the start population for both the with and without Project scenarios over the 35-year period. For the Developer Approach, the end population size with Project scenario was lower than the without Project scenario. There was a slight predicted decrease in the counterfactual of the population growth rate, and the counterfactual of the population size was close to 1.000, while the 50th Centile value was close to 50. These values indicate that the PVA did not predict a significant negative effect from the cumulative effects of displacement and collision mortality from the Developer Approach and other Forth and Tay consented projects on the kittiwake regional SPA population after 35 years.

934. For Scoping Approach A with other Forth and Tay consented projects, the end population size with Project scenario was lower than the without Project scenario. There was a slight predicted decrease in the counterfactual of the population growth rate, and the counterfactual of the population size was close to 1.000, while the 50th Centile value was close to 50. These values indicate that the PVA did not predict a

significant negative effect from the cumulative effects of displacement and collision mortality from Scoping Approach A and other Forth and Tay consented projects on the kittiwake regional SPA population after 35 years.

935. For Scoping Approach B with other Forth and Tay consented projects, the end population size with Project scenario was lower than the without Project scenario. There was a slight predicted decrease in the counterfactual of the population growth rate, and the counterfactual of the population size was close to 1.000, while the 50th Centile value was close to 50. These values indicate that the PVA did not predict a significant negative effect from the cumulative effects of displacement and collision mortality from Scoping Approach B and other Forth and Tay consented projects on the kittiwake regional SPA population after 35 years.

936. For the Developer Approach with other North Sea as-built projects, the end population size with Project scenario was lower than the without Project scenario. There was a slight predicted decrease in the counterfactual of the population growth rate, and the counterfactual of the population size was below 0.9.000, while the 50th Centile value was 31.2. These values indicate that the PVA did predict a slight negative effect from the cumulative effects of displacement and collision mortality from the Developer Approach and other North Sea as-built projects on the kittiwake regional SPA population after 35 years.

937. For Scoping Approach A with other North Sea as-built projects, the end population size with Project scenario was lower than the without Project scenario. There was a slight predicted difference in the counterfactual of the population growth rate, and the counterfactual of the population size was below 0.9.000, while the 50th Centile value was 29.8. These values indicate that the PVA did predict a negative effect from the cumulative effects of displacement and collision mortality from the Scoping Approach and other North Sea as-built projects on the kittiwake regional SPA population after 35 years.

938. For Scoping Approach B with other North Sea as-built projects, the end population size with Project scenario was lower than the without Project scenario. There was a larger predicted decrease in the counterfactual of the population growth rate, and the counterfactual of the population size was below 0.9.000, while the 50th Centile value was 22.7. These values indicate that the PVA did predict a negative effect from the cumulative effects of displacement and collision mortality from the Scoping Approach and other North Sea as-built projects on the kittiwake regional SPA population after 35 years.

939. Based on the results from the cumulative displacement and collision assessments and the cumulative PVA for the Developer Approach, the magnitude of impact on the kittiwake regional SPA population is low.

940. Based on the results from the cumulative displacement and collision assessments and the cumulative PVA for Scoping Approach A, the magnitude of impact on the kittiwake regional SPA population is low.

941. Based on the results from the cumulative displacement and collision assessments and the cumulative PVA for Scoping Approach B, the magnitude of impact on the kittiwake regional SPA population is medium.

Sensitivity of the receptor

942. Kittiwake sensitivity to collision is discussed in paragraph 556 onwards. Based on evidence and reviews from other operational offshore wind farms, kittiwake sensitivity to collision impacts from operational offshore wind farms is considered to be high (Table 11.16).

Significance of the effect

943. For cumulative displacement and collision effects for kittiwake, for the Developer Approach, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor to moderate** adverse significance, which is significant in EIA terms.

944. For Scoping Approach A, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor to moderate** adverse significance, which is significant in EIA terms.

945. For Scoping Approach B, the magnitude of the impact is deemed to be medium, and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **moderate to major** adverse significance, which is significant in EIA terms.

946. As outlined in Section 11.9.2, in cases where the range for the significance of effect spans the significance threshold (minor to moderate), the final significance is based upon the expert's professional judgement as to which outcome delineates the most likely effect, with an explanation as to why this is the case.

947. As highlighted by NS in the NnG Scoping Opinion (Marine Scotland, 2017a), collision risk and displacement are considered to be mutually exclusive impacts, and therefore combining mortality estimates for displacement and collision as was done for the PVA should be considered extremely precautionary.

948. On this basis, it is considered that for the Developer and Scoping Approach A, the effect will be of **minor** adverse significance, which is not significant in EIA terms. For Scoping Approach B, it is considered that the effect will be of **moderate** adverse significance, which is significant in EIA terms. For further discussion on levels of precaution in the Scoping Approach, see volume 3, appendix 11.3 and appendix 11.4.

Secondary and Tertiary Mitigation and Residual Effect

949. For the Developer Approach and Scoping Approach A, no offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **minor** adverse significance, which is not significant in EIA terms.

950. For Scoping Approach B, the residual cumulative impact is considered to be of **moderate** adverse significance, which is significant in EIA terms. However, it is considered that the combined displacement and collision mortality estimates used in the PVA for Scoping Approach B are highly precautionary, for the reasons outlined in paragraph 454 and also in volume 3, appendix 11.3. Consequently, no additional mitigation is proposed.

Herring Gull

951. There is potential for cumulative collision impacts on herring gulls from Tier 2 offshore wind farms.

952. The estimated cumulative collision impacts on herring gull from the relevant projects during each bio-season are presented in Table 11.133. There are a number of projects for which there are no, or limited, data on the number of herring gulls predicted to be impacted. In particular, for some of the earlier Round 1 and Round 2 developments.

953. The mean maximum foraging range +1 SD for herring gull is 85.6 km (Woodward et al., 2019). Projects within foraging range during the breeding period are highlighted in bold in Table 11.133 and these have been used to assess the potential cumulative collision impacts on herring gulls during the breeding and non-breeding periods.

Table 11.133: Estimated Cumulative Collisions for Herring Gull by bio-season for Tier 2 Projects based on Consented Scenarios. (Estimates are rounded to nearest whole bird).

Project	Annual Collisions	Breeding Season Collisions	Non-breeding Season Collisions
Aberdeen	**4.8**	**4.8**	**0**
Beatrice	246.8	49.4	197.4
Blyth Demo	2.7	0.5	2.2
Dogger Bank A and B (Creyke Beck)	-	0	-
Dogger Bank C and Sofia (Teesside)	-	0	-
Dudgeon	-	-	-
Dudgeon Expansion and Sheringham Shoal Extension (PEIR)	0.3	0.25	0
East Anglia One	28.0	0	28
East Anglia One North	0.0	0	0
East Anglia Three	23.0	0	23
East Anglia Two	0.5	0	0.5
Galloper	27.2	27.2	-
Greater Gabbard	-	0	-
Gunfleet Sands	-	-	-
Hornsea Project One	14.5	2.9	11.6
Hornsea Project Two	23.8	23.8	-
Hornsea Project Three	5.0	1	4
Hornsea Project Four	1.7	0.8	0.9
Humber Gateway	1.5	0.4	1.1
Hywind	8.4	0.6	7.8
Inch Cape	**13.5**	**0**	**13.5**
Kentish Flats Extension	2.2	0.5	1.7
Kincardine	**1.0**	**1**	**0**
Lincs	0.0	0	-
London Array	0.0	-	-
Lynn & Inner Dowsing	-	0	-
Methil	**9.5**	**5.8**	**3.7**
Moray Firth (EDA)	52.0	52	-
Moray West	13.0	12	1
Neart na Gaoithe	**17.5**	**5**	**12.5**
Norfolk Boreas	6.9	1.5	5.4
Norfolk Vanguard	7.5	0.4	7.1
Race Bank	-	0	-
Rampion	155.0	155	-
Scroby Sands	-	-	-
Seagreen Alpha & Bravo	**31.0**	**10**	**21**
Sheringham Shoal	0.0	0	-
Teesside	43.2	8.7	34.5
Thanet	24.5	4.9	19.6
Triton Knoll	0.0	0	-
Westermost Rough	0.1	0.1	0
Total	**765.0**	**368.5**	**396.5**
Total in range of impact	**77**	**27**	**51**
Berwick Bank (Developers approach)	30	26	4
Berwick Bank (Scoping Approach)	50	43	7
Cumulative (Developers Approach)	**107**	**53**	**55**
Cumulative (Scoping Approach)	**127**	**70**	**58**

Magnitude of Impact

954. The overall baseline mortality rates were based on age-specific demographic rates and age class proportions as presented in Table 11.21. The potential magnitude of impact was estimated by calculating the increase in baseline mortality within each bio-season with respect to the regional populations.

Table 11.134: Estimated Cumulative Numbers of Collisions for Herring Gull for Tier 2 projects by bio-season for Developer Approach

Bio-season	Estimated Seasonal Collision Mortality	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Apr-Aug)[1]	13 adults	29,600	3,611	0.36
Non-breeding (Sep to Mar)	55	49,432	6,970	0.79
Total	68	-	-	1.15

1 Breeding season assessment is for breeding adults only.

Table 11.135: Estimated Cumulative Numbers of Collisions for Herring Gull for Tier 2 projects by bio-season for Scoping Approach

Bio-season	Estimated Seasonal Collision Mortality	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Apr-Aug)[1]	17 adults	29,600	3,611	0.47
Non-breeding (Sep to Mar)	58	49,432	6,970	0.83
Total	75	-	-	1.3

1 Breeding season assessment is for breeding adults only.

Breeding Season

955. The total cumulative estimated number of herring gull collisions based on North Sea offshore wind farm consented estimates and the Development Approach during the breeding season was 53 birds (Table 11.134). However, this includes non-breeding adults and immature birds, as well as breeding adults. For the purposes of this assessment, the estimated proportion of immature, non-breeding herring gulls across all wind farms was based on the age breakdown calculated for the Berwick Bank PVA study (see volume 3, appendix 11.6). Based on this breakdown, 62.2% of birds present are likely to be immature birds, with 37.8% of birds likely to be adult birds. This would mean that 20 collisions would involve adult herring gulls during the breeding period.

956. However, a proportion of adult birds present at colonies in the breeding season will opt not to breed in a particular breeding season. It has been estimated that 35% of adult herring gulls may be "sabbatical" birds in any particular breeding season (volume 3, appendix 11.6), and this has been applied for this assessment. On this basis, seven adult herring gulls were considered to be not breeding and so 13 breeding adult herring gulls were taken forward for the breeding season assessment.

957. The total herring gull regional baseline breeding population is estimated to be 29,600 individuals. Using the adult baseline mortality rate of 0.122 (Table 11.21), the predicted baseline mortality of herring gulls is 3,611 adult birds per breeding season. The additional predicted mortality of 13 adult herring gulls would increase the baseline mortality rate by 0.36% (Table 11.134).

958. The total cumulative estimated number of herring gull collisions based on North Sea offshore wind farm consented estimates and the Scoping Approach during the breeding season was 70 birds (Table 11.134). For the purposes of this assessment, the estimated proportion of immature, non-breeding herring gulls across all wind farms was based on the age breakdown calculated for the Berwick Bank PVA study (see volume 3, appendix 11.6). Based on this breakdown, 62.2% of birds present are likely to be immature birds, with 37.8% of birds likely to be adult birds. This would mean that 26 collisions would involve adult herring gulls during the breeding period.

959. Applying the 35% rate for "sabbatical" non-breeding birds, resulted in nine birds being considered as non-breeding "sabbatical birds, with 17 adult breeding herring gulls being taken forward for the breeding season assessment.

960. Using the adult baseline mortality rate of 0.122 (Table 11.21), the predicted baseline mortality of herring gulls is 3,611 adult birds per breeding season. The additional predicted mortality of 17 adult herring gulls would increase the baseline mortality rate by 0.47% (Table 11.135).

Non-breeding Season

961. The total cumulative estimated number of herring gull collisions based on North Sea offshore wind farm consented estimates and the Development Approach during the non-breeding season was 55 birds (Table 11.134). However, this includes non-breeding adults and immature birds, as well as breeding adults. Based on information presented in Furness (2015), in the non-breeding season 52% of the population present are immature birds and 48% of birds are adults. Based on this breakdown, 26 collisions would involve adult herring gulls, and 29 collisions would involve immature birds.

962. Scoping Opinion advice for herring gulls was to use the regional breeding population within mean maximum foraging range +1S.D (29,600 birds). as the reference population for the non-breeding season. However, a correction factor was required to account for the influx of continental breeding birds into eastern Scotland/UK in the non-breeding season. At the road map meetings, MSS advised (volume 3, appendix 11.8) that this correction factor should be calculated from the proportions of overseas and western UK birds in the UK North Sea and Channel BDMPS (Furness 2015). This correction factor was calculated to be 0.67 (volume 3, appendix 11.5), which results in an additional 19,832 herring gulls as the estimated influx of continental breeding birds. The total herring gull regional baseline population in the non-breeding season, is therefore estimated to be 49,432 individuals. Using the average baseline mortality rate of 0.141 (Table 11.21), the estimated regional baseline mortality of herring gulls is 6,970 birds in the non-breeding season. The additional predicted mortality of 55 herring gulls would increase the baseline mortality rate by 0.79% (Table 11.134).

963. The total cumulative estimated number of herring gull collisions based on North Sea offshore wind farm consented estimates and the Scoping Approach during the non-breeding season was 58 birds (Table 11.135). However, this includes non-breeding adults and immature birds, as well as breeding adults. Based on information presented in Furness (2015), in the non-breeding season 52% of the population present are immature birds and 48% of birds are adults. Based on this breakdown, 28 collisions would involve adult herring gulls, and 30 collisions would involve immature birds.

964. As above, using the average baseline mortality rate of 0.141 (Table 11.21), the predicted regional baseline mortality of herring gulls is 6,970 birds in the non-breeding season. The additional predicted mortality of 58 herring gulls of all ages would increase the baseline mortality rate by 0.83% (Table 11.135).

Assessment of Cumulative Collision Mortality throughout the Year

965. Predicted herring gull mortality as a result of cumulative collisions for North Sea offshore wind farms and the Developer and Scoping approaches for the Proposed Development for all bio-seasons as calculated above, was summed for the whole year.

966. Based on cumulative collisions for North Sea offshore wind farms and the Developer Approach, the predicted theoretical additional annual cumulative mortality due to collision was an estimated 68 herring gulls. This corresponds to an increase in the baseline mortality rate of 1.15% (Table 11.134).

967. Based on cumulative collisions for North Sea offshore wind farms and the Scoping Approach, the predicted theoretical additional annual mortality due to collision was an estimated 75 herring gulls. This corresponds to an increase in the baseline mortality rate of 1.3% (Table 11.135).

Summary of PVA Assessment

968. As these cumulative collision mortality estimates suggested a potentially significant increase in the cumulative baseline mortality rate for North Sea offshore wind farms and both the Developer Approach and the Scoping Approach, cumulative PVA analysis was conducted on the herring gull regional SPA population. The cumulative PVA analysis was carried out considering a range of cumulative collision scenarios.

969. The results of the cumulative PVA for predicted collision impacts for the Developer Approach and Scoping Approach with both other Forth and Tay consented projects and other North Sea consented projects during the operation phase for the herring gull regional SPA population for the 35-year projection is summarised in Table 11.136. Further details of the PVA methodology, input parameters and an explanation of how to interpret the PVA results can be found in volume 3, appendix 11.6.

Table 11.136: Summary of PVA Cumulative Collision Outputs for Herring Gull for the Proposed Development array area after 35 years

Scenario and Start population 15,390 adults[1]	Unimpacted Median Population Size	Impacted Median Population Size	Counterfactual of Population Growth Rate - Median	Counterfactual Population Size - Median	Unimpacted Centile at Impacted 50th Centile - Median
Forth and Tay Consented + Developer Approach	158,405	154,986	0.999	0.980	46.2
Forth and Tay Consented + Scoping Approach b	158,405	153,688	0.999	0.972	44.7
North Sea Consented + Developer Approach	158,405	153,859	0.999	0.970	44.9
North Sea Consented + Scoping Approach b	158,405	151,634	0.999	0.957	42.3

1 Starting population taken from volume 3, appendix 11.6.

Developer Approach = CRM based on mean monthly density.

Scoping Approach = CRM based on maximum monthly density.

970. For both the with and without Project scenarios, the herring gull regional SPA population is predicted to increase over the 35-year period. For the Developer Approach with other Forth and Tay consented projects, the end population size with Project scenario was slightly lower than the without Project scenario. There was a slight predicted decrease in the counterfactual of the population growth rate, and the counterfactual of the population size was also very close to 1.000, while the 50th Centile value was very close to 50. These values indicate that the PVA did not predict a significant negative effect from the cumulative effects of collision mortality from the Developer Approach and other Forth and Tay consented projects on the herring gull regional SPA population after 35 years.

971. For the Scoping Approach with other Forth and Tay consented projects, the end population size with Project scenario was lower than the without Project scenario. There was a slight predicted decrease in the counterfactual of the population growth rate, and the counterfactual of the population size was also close to 1.000, while the 50th Centile value was close to 50. These values indicate that the PVA did not predict a significant negative effect from the cumulative effects of collision mortality from the Scoping Approach and other Forth and Tay consented projects on the herring gull regional SPA population after 35 years.

972. For the Developer Approach with other North Sea consented projects, the end population size with Project scenario was lower than the without Project scenario. There was a slight predicted decrease in the counterfactual of the population growth rate, and the counterfactual of the population size was also close to 1.000, while the 50th Centile value was close to 50. These values indicate that the PVA did not predict a significant negative effect from the cumulative effects of collision mortality from the Developer Approach and other North Sea consented projects on the herring gull regional SPA population after 35 years.

973. For the Scoping Approach with other North Sea consented projects, the end population size with Project scenario was lower than the without Project scenario. There was a slight predicted decrease in the counterfactual of the population growth rate, and the counterfactual of the population size was also close to 1.000, while the 50th Centile value was relatively close to 50. These values indicate that the PVA did not predict a significant negative effect from the cumulative effects of collision mortality from the Scoping Approach and other North Sea consented projects on the herring gull regional SPA population after 35 years.

974. Based on the results from the cumulative collision assessment and the cumulative PVA for the Developer Approach, the magnitude of impact on the regional SPA herring gull population is negligible.

975. Based on the results from the cumulative collision assessment and the cumulative PVA for the Scoping Approach, the magnitude of impact on the regional SPA herring gull population is negligible.

Sensitivity of the receptor

976. Herring gull sensitivity to collision is discussed in paragraph 495 onwards. Based on evidence and reviews from other operational offshore wind farms, herring gull sensitivity to collision impacts from operational offshore wind farms is considered to be very high (Table 11.16).

Significance of the effect

977. For cumulative collision effects for herring gull, for the Developer Approach, the magnitude of the cumulative impact is deemed to be negligible, and the sensitivity of the receptor is considered to be very high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

978. For the Scoping Approach, the magnitude of the cumulative impact is deemed to be negligible, and the sensitivity of the receptor is considered to be very high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

979. No offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **minor** adverse significance, which is not significant in EIA terms.

Lesser Black-backed Gull

980. There is potential for cumulative collision impacts on lesser black-backed gulls from Tier 2 offshore wind farms.

981. The estimated cumulative collision impacts on lesser black-backed gull from the relevant projects during each bio-season are presented in Table 11.137. There are a number of projects for which there are no, or limited, data on the number of lesser black-backed gulls predicted to be impacted. In particular, for some of the earlier Round 1 and Round 2 developments.

982. The mean maximum foraging range +1 SD for lesser black-backed gull is 236 km (Woodward et al., 2019). Projects within foraging range during the breeding period are highlighted in bold in Table 11.137 and these have been used to assess the potential cumulative collision impacts on lesser black-backed gulls during the breeding season.

Table 11.137: Estimated Cumulative Collisions for Lesser Black-backed Gull by bio-season for Tier 2 Projects based on Consented Scenarios. (Estimates are rounded to nearest whole bird).

Project	Annual Collisions	Breeding Season Collisions	Non-breeding Season Collisions
Aberdeen	**0**	**0**	**0**
Beatrice	**0**	**0**	**0**
Blyth Demo	**0**	**0**	**0**
Dogger Bank A and B (Creyke Beck)	**13**	**2.6**	**10.4**
Dogger Bank C and Sofia (Teesside)	**12**	**2.4**	**9.6**
Dudgeon	38.3	7.7	30.6
Dudgeon Expansion and Sheringham Shoal Extension (PEIR)	1.13	0.85	0.28
East Anglia One	39.7	5.9	33.8
East Anglia One North	1.5	0.9	0.6
East Anglia Two	4.36	3.86	0.5
East Anglia Three	10	1.8	8.2
Galloper	138.8	27.8	111
Greater Gabbard	62	12.4	49.6
Gunfleet Sands	1	1	0
Hornsea Project One	21.8	4.4	17.4
Hornsea Project Two	4	2	2
Hornsea Project Three	8	8	0
Hornsea Project Four	0.83	0.83	0
Humber Gateway	1.4	0.3	1.1
Hywind	**0**	**0**	**0**
Inch Cape	**0**	**0**	**0**
Kentish Flats + Extension	1.6	0.3	1.3
Kincardine	**0**	**0**	**0**
Lincs	8.5	1.7	6.8
London Array	0	-	-
Lynn & Inner Dowsing	0	-	-
Methil	**0.5**	**0.5**	**0**
Moray Firth (EDA)	**0**	**0**	**0**
Moray West	**0**	**0**	**0**
Neart na Gaoithe	**1.5**	**0.3**	**1.2**
Norfolk Boreas	14.31	6.24	8.07
Norfolk Vanguard	11.96	8.4	3.56
Race Bank	54	43.2	10.8
Rampion	7.9	1.6	6.3
Scroby Sands	0	-	-
Seagreen Alpha & Bravo	**10.5**	**2.1**	**8.4**
Sheringham Shoal	8.3	1.7	6.6
Teesside	**0**	**0**	**0**
Thanet	16	3.2	12.8
Triton Knoll	37	7.4	29.6
Westermost Rough	0.4	0.1	0.3
Total	**530.3**	**159.5**	**370.8**
Total in Mean max +1SD foraging range (Breeding only)	**7**	**7**	
Berwick Bank (Developers approach)	6	6	0
Berwick Bank (Scoping Approach)	9	9	0
Cumulative (Developers Approach)	**13**	**13**	**-**
Cumulative (Scoping Approach)	**16**	**16**	**-**

Magnitude of Impact

983. The overall baseline mortality rates were based on age-specific demographic rates and age class proportions as presented in Table 11.21. The potential magnitude of impact was estimated by calculating the increase in baseline mortality within each bio-season with respect to the regional populations.

Table 11.138: Estimated Cumulative Numbers of Collisions for Lesser Black-backed Gull for Tier 2 projects by bio-season for Developer Approach

Bio-season	Estimated Seasonal Collision Mortality	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Mid-Mar-Aug)[1]	4 adults	13,994	1,217 adults	0.33

1 Breeding season assessment is for breeding adults only.

Table 11.139: Estimated Cumulative Numbers of Collisions for Lesser Black-backed Gull for Tier 2 projects by bio-season for Scoping Approach

Bio-season	Estimated Seasonal Collision Mortality	Regional Baseline Population	Annual Regional Baseline Mortality	Increase in Baseline Mortality (%)
Breeding (Mid-Mar-Aug)[1]	5 adults	13,994	1,217 adults	0.41

1 Breeding season assessment is for breeding adults only.

Breeding Season

984. The total cumulative estimated number of lesser black-backed gull collisions based on North Sea offshore wind farm consented estimates and the Developer Approach during the breeding season was 13 birds (Table 11.133Table 11.137). However, this includes non-breeding adults and immature birds, as well as breeding adults. For the purposes of this assessment, the estimated proportion of immature, non-breeding lesser black-backed gulls across all wind farms was based on the age breakdown calculated for the Berwick Bank PVA study (see volume 3, appendix 11.6). Based on this breakdown, 53.4% of birds present are likely to be immature birds, with 46.6% of birds likely to be adult birds. This would mean that six collisions would involve adult lesser black-backed gulls during the breeding period.

985. However, a proportion of adult birds present at colonies in the breeding season will opt not to breed in a particular breeding season. It has been estimated that 35% of adult lesser black-backed gulls may be "sabbatical" birds in any particular breeding season (volume 3, appendix 11.6), and this has been applied for this assessment. On this basis, two adult lesser black-backed gulls were considered to be not breeding and so four breeding adult lesser black-backed gulls were taken forward for the breeding season assessment.

986. The total lesser black-backed gull regional baseline breeding population is estimated to be 13,994 individuals (Table 11.9). The adult baseline survival rate is estimated to be 0.913 (Table 11.21), which means that the corresponding rate for adult mortality is 0.087. Applying this mortality rate, the estimated regional baseline mortality of lesser black-backed gulls is 1,217 adult birds per breeding season. The additional predicted cumulative mortality of four adult lesser black-backed gulls would increase the baseline mortality rate by 0.33% (Table 11.138).

987. The total cumulative estimated number of lesser black-backed gull collisions based on North Sea offshore wind farm consented estimates and the Scoping Approach during the breeding season was 16 birds (Table 11.133 Table 11.137). For the purposes of this assessment, the estimated proportion of immature, non-breeding lesser black-backed gulls across all wind farms was based on the age breakdown calculated for the Berwick Bank PVA study (see volume 3, appendix 11.6). Based on this breakdown, 53.4% of birds present are likely to be immature birds, with 46.6% of birds likely to be adult birds. This would mean that seven collisions would involve adult lesser black-backed gulls during the breeding period.

988. Applying the 35% rate for "sabbatical" non-breeding birds, resulted in two birds being considered as non-breeding "sabbatical birds, with five adult breeding lesser black-backed gulls being taken forward for the breeding season assessment.

989. Using the adult baseline mortality rate of 0.087 (Table 11.21), the predicted baseline mortality of lesser black-backed gulls is 1,217 adult birds per breeding season. The additional predicted mortality of five adult lesser black-backed gulls would increase the baseline mortality rate by 0.41% (Table 11.139).

Non-breeding Season

990. As no lesser black-backed gull collisions were predicted for the non-breeding season for either the Developer Approach or the Scoping Approach, no further assessment was undertaken for this period.

Summary of PVA Assessment

991. It was not possible to undertake a cumulative PVA assessment for lesser black-backed gull as there were no in combination totals available for this species. The most relevant information pertaining to effects on the Forth Islands SPA population derived from the 2014 MS AA for the Forth & Tay projects. This stated that a predicted effect of < -0.1% decline in adult survival was identified on this SPA population as a result of the NnG project and concluded no adverse effect on site integrity. Therefore, it is assumed that existing in-combination effects are inconsequential and can be ignored. Further details are presented in Volume 3, Appendix 11.6.

992. Based on the results from the cumulative collision assessment for the Developer Approach and other North Sea projects, the magnitude of impact on the regional SPA lesser black-backed gull population is negligible.

993. Based on the results from the cumulative collision assessment for the Scoping Approach and other Forth and Tay projects, the magnitude of impact on the regional SPA lesser black-backed gull population is negligible.

Sensitivity of the receptor

994. Lesser black-backed gull sensitivity to collision is discussed in paragraph 522 onwards. Based on evidence and reviews from other operational offshore wind farms, lesser black-backed gull sensitivity to collision impacts from operational offshore wind farms is considered to be very high (Table 11.16).

Significance of the effect

995. For cumulative collision effects for lesser black-backed gull, for the Developer Approach, the magnitude of the cumulative impact is deemed to be negligible, and the sensitivity of the receptor is considered to be very high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

996. For the Scoping Approach, the magnitude of the cumulative impact is deemed to be negligible, and the sensitivity of the receptor is considered to be very high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Secondary and Tertiary Mitigation and Residual Effect

997. No offshore and intertidal ornithology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond designed in measures outlined in section 11.10) is not significant in EIA terms. Therefore, the residual impact is considered to be of **minor** adverse significance, which is not significant in EIA terms.

11.12.3. PROPOSED MONITORING

998. As per section 11.11.1 above.

11.13. TRANSBOUNDARY EFFECTS

999. A screening of transboundary impacts has been carried out and any potential for significant transboundary effects with regard to offshore and intertidal ornithology from the Proposed Development upon the interests of other EEA States has been assessed as part of the EIA. The potential transboundary impacts are summarised below:

- disturbance of birds from vessels and other construction activities;
- disturbance from operation and maintenance activities;
- barrier effects arising from presence of wind turbines;
- displacement (avoidance resulting from presence of wind turbines, loss of foraging habitat);
- collisions with wind turbines; and
- changes in prey availability.

1000. Based on the location of the Proposed Development and the likely key receptors, it is considered that there will be no significant transboundary effects on birds in the breeding season, on the basis that, (with the exception of fulmar) there are no non-UK seabird colonies within mean-maximum foraging range (+1SD) of the Proposed Development. Fulmars are not considered at risk of impacts from offshore wind projects due to their typically low flight height and large foraging range (e.g. Furness and Wade, 2012, Bradbury et al., 2014), therefore there will be no transboundary effects for this species.

1001. In the non-breeding season, it is possible that birds from non-UK seabird colonies may occur within the Proposed Development and therefore there may be impacts on birds originating from non-UK colonies.

1002. The above potential impacts are assessed for transboundary effects in Table 11.140 below. Overall, no significant transboundary effects were predicted for seabirds from non-UK seabird colonies in the non-breeding season.

Table 11.140: Assessment of Potential Transboundary Effects for Offshore and Intertidal Ornithology from the Proposed Development upon the interests of other EEA States

Description of Impact	Phase[5] C	O	D	Assessment of Transboundary Effects
Disturbance of birds from vessels and other construction/decommissioning activities;	✓	×	✓	Any disturbance arising from the presence/movement of vessels or other construction activities on seabirds is predicted to be localised, short-term and sporadic in nature, therefore significant effects on birds from non-UK seabird colonies in the non-breeding season are not considered likely to occur.
Disturbance from vessels associated with operation and maintenance activities;	×	✓	×	Any disturbance arising from the presence/movement of vessels associated with operation and maintenance activities on seabirds is predicted to be localised, short-term and sporadic in nature, therefore significant effects on birds from non-UK seabird colonies in the non-breeding season are not considered likely to occur.
Barrier effects arising from presence of wind turbines;	×	✓	×	Barrier effects could potentially occur during a breeding season, when birds breeding at a nearby colony travel around a wind farm in order to reach their foraging grounds, thus incurring potential energy costs due to longer flight times, rather than if they were able to fly directly between the colony and the foraging area. However, barrier effects arising from the presence of wind turbines are not predicted to occur on seabirds from non-UK seabird colonies in the non-breeding season, as any such individuals would be likely to be moving through the area, therefore significant additional flight costs from flying around the Proposed Development are not considered likely to occur.
Displacement (avoidance resulting from presence of wind turbines, loss of foraging habitat);	✓	✓	✓	Displacement effects could potentially occur during a breeding season, when birds breeding at a nearby colony are unable to forage within an offshore wind farm due to the presence of wind turbines. In this situation, this would be considered a loss of foraging habitat. However, displacement effects arising from the presence of wind turbines are not predicted to occur on seabirds from non-UK seabird colonies in the non-breeding season, as any such individuals would be likely to be moving through the area, therefore significant additional costs from foraging outside the Proposed Development are not considered likely to occur.
Collisions with wind turbines; and	×	✓	×	Seabirds from non-UK seabird colonies could potentially collide with wind turbines within the Proposed Development array area in the non-breeding season. However, it is not considered likely that significant numbers of seabirds from non-UK seabird colonies would be involved in any such collisions for the following reasons: • regional populations of seabird species in the non-breeding season will involve individuals from a wide geographical area, therefore no single colony would be significantly impacted; • predicted impacts in the non-breeding season are too small to have a significant impact on the wider non-breeding population; and • CRM undertaken for the EIA Report indicated that for most species, predicted collisions were higher in the breeding season, when birds from non-UK colonies would not be present. On this basis, any collision impacts on seabirds from non-UK seabird colonies in the non-breeding season are not predicted to be significant.
Changes in prey availability.	✓	✓	✓	Changes in prey availability could occur throughout the various stages of the lifespan of the Proposed Development, however no significant effects were predicted on seabirds from changes in prey availability (see paragraph 105 *et seq.*). It is therefore considered unlikely that significant numbers of seabirds from non-UK seabird colonies in the non-breeding season would be affected by any such potential changes in prey availability.

[5] C = Construction, O = Operation and maintenance, D = Decommissioning

11.14. INTER-RELATED EFFECTS (AND ECOSYSTEM ASSESSMENT)

1003. A description of the likely inter-related effects arising from the Proposed Development on offshore and intertidal ornithology is provided in volume 3, appendix 20 of the Offshore EIA Report.

1004. For offshore and intertidal ornithology, the following potential impacts have been considered within the inter-related assessment:

- Disturbance and displacement from increased vessel activity and other construction/decommissioning activity
- Temporary and long-term subtidal habitat loss/disturbance;
- Increased suspended sediment concentrations; and
- Disturbance and loss of seabed habitat arising from cable installation/removal within the Outer Firth of Forth and St Andrews Bay Complex SPA

1005. Table 11.141 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operation and maintenance phase, and decommissioning of the Proposed Development. Table 11.141 also lists the inter-related effects where stressors may combine to lead to greater effects on offshore and intertidal ornithology receptors (receptor-led effects).

1006. One key stressor has been identified for offshore and intertidal ornithology. The assessment considers the overall effects on foraging seabirds from potential changes in prey communities that could be caused by disturbance, habitat loss, SSC, and therefore, in this respect, has taken an ecosystem-based approach. The assessment of effects, however, demonstrated that due to the high mobility of foraging seabirds and their ability to exploit different prey species, and the small scale of potential changes in context of wider available habitat, the changes to fish prey communities are unlikely to have a significant effect on foraging seabirds. Further discussion is presented in volume 3, appendix 20.

Table 11.141: Summary of Potential Inter-Related Effects for Offshore and Intertidal Ornithology from Individual Effects Occurring across the Construction, Operation and Maintenance and Decommissioning Phases of the Proposed Development and from Multiple Effects Interacting Across all Phases (Receptor-led Effects)

Description of Impact	Phase[6] C	Phase[6] O	Phase[6] D	Likely Significant Inter-Related Effects
Disturbance and displacement from increased vessel activity and other construction/decommissioning activity	✓	✓	✓	Disturbance arising from these operations has the potential to affect identified key species directly (e.g., disturbance of individuals) and indirectly (e.g. disturbance to prey distribution or availability). Such disturbance is predicted to occur intermittently throughout the construction and decommissioning periods, with less disturbance from vessel activity predicted in the operation period. As this disturbance will be temporary and intermittent in nature, effects on seabirds are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual period.
Temporary and long term subtidal habitat loss/disturbance	✓	✓	✓	When subtidal habitat loss (temporary and long term) is considered additively across all phases of the project, although the total area of habitat affected is larger than for the individual project stages, similar habitats are widespread across the UK and in the northern North Sea. During the operation and maintenance phase, the majority of the disturbance will be highly localised and the habitats affected are predicted to recover quickly following completion of maintenance activities with prey species for seabirds recovering into the affected areas. In addition, many operation and maintenance activities will be affecting the same areas affected during construction (e.g., jack up operations adjacent to wind turbines, reburial of exposed cables). Therefore, across the project lifetime, the effects on seabirds are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Increased suspended sediment concentrations	✓	×	✓	The majority of the seabed disturbance (resulting in highest SSC will occur during the construction and decommissioning phases. Fish prey species and associated spawning/nursery habitats potentially affected by increased SSC and deposition will recover quickly following impact exposure such that there will be no inter-related effects across the construction and decommissioning phases. Therefore, across the project lifetime, the effects on seabirds are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Disturbance and loss of seabed habitat arising from cable installation/removal within the Outer Firth of Forth and St Andrews Bay Complex SPA	✓	✓	✓	Disturbance arising from these activities has the potential to affect identified species directly (e.g. disturbance of individuals) and indirectly (e.g. disturbance to prey distribution or availability). Such disturbance is predicted to occur intermittently throughout the construction and decommissioning periods, with occasional disturbance predicted in the operation period. As this disturbance will be temporary and intermittent in nature, effects on seabirds are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual period.
Displacement and barrier effects from offshore infrastructure	×	✓	×	This effect will only arise during the operation and maintenance phase and as such there will be no interaction effects across the project phases.
Collision effects from wind turbines during operation phase	×	✓	×	This effect will only arise during the operation and maintenance phase and as such there will be no interaction effects across the project phases.
Receptor Led Effects				

Potential exists for spatial and temporal interactions between habitat loss/disturbance, increased SSC/deposition and colonisation of foundations, scour protection and cable protection, during the lifetime of the Project. Based on current understanding, and expert knowledge, there is scope for potential interaction impacts to arise through the interaction of habitat loss (temporary and long term) and increased SSC.

There is the potential for these identified impacts to interact to cause an additive/synergistic/antagonistic effects on offshore and intertidal ornithology receptors. One key stressor has been identified for offshore and intertidal ornithology:

- changes in prey communities.

Various activities described from the impacts considered above could interact to contribute to a different, or greater effect on changes in prey communities than when the effects are considered in isolation, which in turn could affect foraging seabirds.

[6] C = Construction, O = Operation and maintenance, D = Decommissioning

11.15. SUMMARY OF IMPACTS, MITIGATION MEASURES AND MONITORING

1007. Information on offshore and intertidal ornithology within the Offshore Ornithological regional study area, the Offshore Ornithology study area and the Intertidal Ornithology study area was collected through desktop review, digital aerial and boat-based site surveys, and consultation with stakeholders.

1008. Table 11.142 presents a summary of the potential impacts, mitigation measures and the conclusion of LSEs in EIA terms in respect to offshore and intertidal ornithology. The impacts assessed include: disturbance and displacement from increased vessel activity and other construction activity within proposed development array area, disturbance from aviation and navigation lighting, indirect effects as a result of habitat loss/displacement of prey species due to increased noise and disturbance to seabed, disturbance and loss of seabed habitat arising from cable installation/removal within the Outer Firth of Forth and St Andrews Bay Complex SPA, displacement and barrier effects from offshore infrastructure, and collision effects from wind turbines during operation phase. Overall, it is concluded that there will an LSE on guillemot for Scoping Approach B arising from displacement effects from the Proposed Development during the operation and maintenance phase.

1009. Table 11.143 presents a summary of the potential cumulative impacts, mitigation measures and the conclusion of LSEs on offshore and intertidal ornithology in EIA terms. The cumulative effects assessed include: displacement and barrier effects from offshore infrastructure and collision effects from wind turbines during the operation phase. Overall, it is concluded that there will be an LSE on guillemot for the Developer Approach and Scoping Approaches A and B arising from cumulative displacement effects from the Proposed Development alongside other projects/plans. In addition, there will be an LSE on razorbill for Scoping Approach B from cumulative displacement effects from the Proposed Development alongside other projects/plans. There will also be an LSE on gannet and kittiwake for Scoping Approach B from combined displacement and collision effects from the Proposed Development alongside other projects/plans.

1010. No likely significant transboundary effects have been identified in regard to effects on offshore and intertidal ornithology from the Proposed Development.

Table 11.142: Summary of Likely Significant Environmental Effects, Mitigation and Monitoring

Description of Impact	Phase[7] C	O	D	Receptor	Magnitude of Impact	Sensitivity of Receptor	Significance of Effect	Additional Measures	Significance of Residual Effect	Proposed Monitoring
Disturbance and displacement from increased vessel activity and other construction activity within proposed development array area	✓			All receptors	Negligible	Medium	Negligible to minor adverse	None required	Negligible to minor	N/A
		✓		All receptors	Negligible	Medium	Negligible to minor adverse	None required	Negligible to minor	N/A
			✓	All receptors	Negligible	Medium	Negligible to minor adverse	None required	Negligible to minor	N/A
Disturbance from aviation and navigation lighting		✓		All receptors	Negligible	Medium	Negligible to minor adverse	None required	Negligible to minor	N/A
Indirect effects as a result of habitat loss/displacement of prey species due to increased noise and disturbance to seabed	✓			All receptors	Negligible	Low	Negligible to minor adverse	None required	Negligible to minor	N/A
		✓		All receptors	Negligible	Low	Negligible to minor adverse	None required	Negligible to minor	N/A
			✓	All receptors	Negligible	Low	Negligible to minor adverse	None required	Negligible to minor	N/A
Disturbance and loss of seabed habitat arising from cable installation/removal within the Outer Firth of Forth and St Andrews Bay Complex SPA	✓			Red-breasted merganser, shag, velvet scoter, Slavonian grebe Eider, common scoter, goldeneye, red-throated diver	Negligible	Medium High	Negligible to minor adverse Minor adverse	None required	Minor	N/A
		✓		Red-breasted merganser, shag, velvet scoter, Slavonian grebe Eider, common scoter, goldeneye, red-throated diver	Negligible	Medium High	Negligible to minor adverse Minor adverse	None required	Minor	N/A
			✓	Red-breasted merganser, shag, velvet scoter, Slavonian grebe Eider, common scoter, goldeneye, red-throated diver	Negligible	Medium High	Negligible to minor adverse Minor adverse	None required	Minor	N/A
Displacement and barrier effects from offshore infrastructure		✓		Gannet – All approaches	Negligible	Medium	Negligible to minor adverse	None required	Negligible to minor	To be agreed post-consent
		✓		Kittiwake – All approaches	Negligible	Low	Negligible to minor adverse	None required	Negligible to minor	To be agreed post-consent
		✓		Guillemot – Developer & Scoping A	Low	Medium	Minor adverse	None required	Minor adverse	To be agreed post-consent
		✓		Guillemot – Scoping B	Medium	Medium	Moderate adverse	None required	Moderate adverse	To be agreed post-consent
		✓		Razorbill - Developer & Scoping A	Negligible	Medium	Negligible to minor adverse	None required	Negligible to minor	To be agreed post-consent
		✓		Razorbill – Scoping B	Low	Medium	Minor adverse	None required	Minor adverse	To be agreed post-consent
		✓		Puffin – All approaches	Negligible	Medium	Negligible to minor adverse	None required	Negligible to minor	To be agreed post-consent
Collision effects from wind turbines during operation phase		✓		Herring gull – All approaches	Negligible	Very high	Minor adverse	None required	Minor adverse	To be agreed post-consent
		✓		Lesser black-backed gull – All approaches	Negligible	Very high	Minor adverse	None required	Minor adverse	To be agreed post-consent
		✓		Little gull – All approaches	Negligible	Medium	Negligible to minor adverse	None required	Negligible to minor	To be agreed post-consent
		✓		Common tern – All approaches	Negligible	Medium	Negligible to minor adverse	None required	Negligible to minor	To be agreed post-consent
		✓		Arctic tern – All approaches	Negligible	Medium	Negligible to minor adverse	None required	Negligible to minor	To be agreed post-consent

[7] C = Construction, O = Operation and maintenance, D = Decommissioning

	C	O	D							
		✓		Great skua – All approaches	Negligible	Medium	Negligible to minor adverse	None required	Negligible to minor	To be agreed post-consent
Combined displacement and collision effects during operation phase		✓		Gannet – All approaches	Low	Medium	Minor adverse	None required	Minor adverse	To be agreed post-consent
		✓		Kittiwake – All approaches	Low	High	Minor to moderate adverse but considered minor adverse as combining displacement and collision effects considered extremely precautionary.	None required	Minor adverse	To be agreed post-consent

Table 11.143: Summary of Likely Significant Cumulative Environment Effects, Mitigation and Monitoring

Description of Impact	Phase[8] C	O	D	Receptor	Cumulative Effects Assessment Tier	Magnitude of Impact	Sensitivity of Receptor	Significance of Effect	Additional Measures	Significance of Residual Effect	Proposed Monitoring
Displacement and barrier effects from offshore infrastructure		✓		Guillemot – Developer Approach	Tier 2	Low	Medium	Minor adverse	None required	Minor adverse	To be agreed post-consent
		✓		Guillemot – Scoping Approach A	Tier 2	Low	Medium	Minor adverse	None required	Minor adverse	To be agreed post-consent
		✓		Guillemot – Scoping Approach B	Tier 2	Medium	Medium	Moderate adverse	None required	Moderate adverse	To be agreed post-consent
		✓		Razorbill - Developer Approach	Tier 2	Low	Medium	Minor adverse	None required	Minor adverse	To be agreed post-consent
		✓		Razorbill – Scoping Approach A	Tier 2	Low	Medium	Minor adverse	None required	Minor adverse	To be agreed post-consent
		✓		Razorbill – Scoping Approach B	Tier 2	Medium	Medium	Moderate adverse	None required	Moderate adverse	To be agreed post-consent
		✓		Puffin - Developer Approach	Tier 2	Negligible	Medium	Negligible to minor adverse	None required	Negligible to minor adverse	To be agreed post-consent
		✓		Puffin – Scoping Approach A	Tier 2	Negligible	Medium	Negligible to minor adverse	None required	Negligible to minor adverse	To be agreed post-consent
		✓		Puffin – Scoping Approach B	Tier 2	Low	Medium	Minor adverse	None required	Minor adverse	To be agreed post-consent
Collision effects from wind turbines during operation phase		✓		Herring gull – Developer Approach	Tier 2	Negligible	Very high	Minor adverse	None required	Minor adverse	To be agreed post-consent
		✓		Herring gull – Scoping Approach	Tier 2	Negligible	Very high	Minor adverse	None required	Minor adverse	To be agreed post-consent
		✓		Lesser black-backed gull – Developer Approach	Tier 2	Negligible	Very high	Minor adverse	None required	Minor adverse	To be agreed post-consent
		✓		Lesser black-backed gull – Scoping Approach	Tier 2	Negligible	Very high	Minor adverse	None required	Minor adverse	To be agreed post-consent
Combined displacement and collision effects during operation phase		✓		Gannet – Developer Approach	Tier 2	Low	Medium	Minor adverse	None required	Minor adverse	To be agreed post-consent
		✓		Gannet – Scoping Approach A	Tier 2	Low	Medium	Minor adverse	None required	Minor adverse	To be agreed post-consent
		✓		Gannet – Scoping Approach B	Tier 2	Medium	Medium	Moderate adverse	None required	Moderate adverse	To be agreed post-consent
		✓		Kittiwake – Developer Approach	Tier 2	Low	High	Minor to moderate adverse but considered minor adverse as combining displacement and collision effects considered extremely precautionary.	None required	Minor adverse	To be agreed post-consent
		✓		Kittiwake – Scoping Approach A	Tier 2	Low	High	Minor to moderate adverse but considered minor adverse as combining displacement and collision effects considered extremely precautionary.	None required	Minor adverse	To be agreed post-consent

[8] C = Construction, O = Operation and maintenance, D = Decommissioning

✓	Kittiwake – Scoping Approach B	Tier 2	Medium	High	Moderate to major adverse but considered moderate adverse as combining displacement and collision effects considered extremely precautionary.	None required	Moderate adverse	To be agreed post-consent

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