CHAPTER 8: ORNITHOLOGY

Chapter Summary

This chapter of the EIA Report considers the potential impacts of the proposed optimised Seagreen Project on offshore ornithology. In line with the 2017 Scoping Opinion the assessment considers potential effects of disturbance, displacement and collision mortality on gannet, guillemot, razorbill, puffin, kittiwake and herring gull.

These potential impacts and receptors are scoped in due to changes in the design of WTG, namely the inclusion of a larger rotor diameter to that previously considered, availability of further site-specific survey data and updated methods relating to the assessment of displacement and collision mortality impacts. All other potential impacts on birds are scoped out because the findings of the assessments completed for the 2012 Offshore ES are considered by Marine Scotland to remain unchanged.

Consultation has been undertaken with MS-LOT, Marine Scotland Science, Scottish Natural Heritage and the RSPB to confirm and clarify the scope of the impact assessment.

The offshore ornithology baseline has been updated with additional survey data collected from the areas of Project Alpha and Project Bravo during the 2017 breeding season using a boat-based survey method. On this occasion, the methods were extended to include more accurate estimation of the flight heights of birds and to survey a larger area, with the addition of 2km buffer surveyed around the original baseline survey area. These survey data have been used to update, interpret and verify the results of surveys undertaken to inform the assessment of impacts on offshore ornithology in the 2012 Offshore ES.

The potential magnitude of impacts due to disturbance and displacement from Project Alpha and Project Bravo remain the same as those previously assessed, despite the calculation of those effects over a larger area than was previously assumed due to the addition of the 2km buffer surveyed. However, no significant displacement impacts are predicted on any species due to those projects alone or cumulatively with one another or any other relevant projects.

The potential magnitude of impacts due to collision mortality from Project Alpha and Project Bravo are generally lower than those previously assessed. The use of fewer, larger turbines typically reduces the risk of collision for seabirds, notwithstanding changes in assessment methodology, which now includes consideration of non-breeding season effects, for example. For gannet, kittiwake and herring gull no significant impacts are predicted due to collision mortality arising from Project Alpha or Project Bravo alone or cumulatively with one another or any other relevant projects.

INTRODUCTION

8.1. As set out in Chapter 1 (Introduction), the original Seagreen Project (herein referred to as the originally consented Project) received development consents from Scottish Ministers in 2014. This was confirmed in November 2017, following legal challenge to the consent award decision. Seagreen is now applying for additional consents for an optimised design (herein referred to as the optimised Seagreen Project), based on fewer, larger, higher capacity wind turbines that have become available, since the 2014 consent decision, and inclusion of monopiles as a foundation option.

8.2. This Environmental Impact Assessment (EIA) Report provides an assessment of the potential environmental impacts of the optimised Seagreen Project, to support a new application for development consent. This chapter of the EIA Report assesses the potential impacts upon offshore ornithology throughout the construction, operation and decommissioning phases of the Project.

8.3. The originally consented project comprises the Project Alpha Offshore Wind Farm (OWF) (herein referred to as 'Project Alpha'), Project Bravo OWF (herein referred to as 'Project Bravo') and the Offshore Transmission Asset. It is noted that the Offshore Transmission Asset has been licenced separately, no changes are proposed and therefore this is not considered further within this assessment. A full description of the optimised Seagreen Project is provided in Chapter 5 (Project Description) of this EIA Report.

8.4. The structure of this chapter is as follows:

- Legislation, policy and guidance: sets out key legislation, policy context and guidance with reference to latest updates in guidance and approaches;
- Consultation: provides details of consultation undertaken to date and how this has informed the assessment;
- Scope of assessment: sets out the scope of the impact assessment for offshore ornithology in line with the 2017 Scoping Opinion and further consultation;
- Methodology: sets out the study area, data collection undertaken and approach to the assessment of impacts for offshore ornithology;
- Baseline Conditions: describes and characterises the baseline environment for offshore ornithology and information used to inform the baseline;
- Assessment of impacts: confirms the project design parameters to be assessed (the Worst Case Scenario [WCS]) and presents the impact assessment for offshore ornithology throughout the construction, operation and decommissioning phases and concludes on the likely significance of impacts. The assessment includes the consideration of any mitigation measures (both embedded and additional) and sets out any monitoring proposals for potentially significant impacts, if required;
- Cumulative impact assessment: presents the cumulative impact assessment for offshore ornithology throughout the construction, operation and decommissioning phases and concludes on the likely significance of impacts with consideration of mitigation measures;
- Interrelationships: Assesses the potential interrelated impacts on any given receptor scoped into the assessment;
- Transboundary impacts: Considers the potential for any transboundary impacts in relation to offshore ornithology; and
- Assessment summary: provides a summary of the impact assessment undertaken.

8.5. The Seagreen Project is located in the North Sea off the Firth of Forth and within the Moray Firth-Aberdeen Bank-Tees area; the third most important area for seabirds in the North Sea (Skov *et al.*, 1995). Within this sea area, the outer Firth of Forth area includes a complex of underwater banks and mounds that are considered to be of international importance to a number of bird species, i.e. breeding and non-breeding seabirds (Stone *et al.* 1995; Wanless *et al.*, 1998; Dawson *et al.*, 2008; Kober *et al.*, 2009).

8.6. The potential impacts of offshore wind farms on birds and the need for assessing these impacts in EIAs is well documented (Exo *et al.*, 2003; OSPAR, 2004; 2006; 2008; Langston, 2010). This EIA Report presents the findings of the EIA for the potential impacts of the optimised Seagreen Project on bird species occurring offshore. The impacts are described in the context of the known ornithological importance of the sea area in which Project Alpha and Project Bravo are located.

8.7. The assessment of potential impacts on bird species occurring offshore in accordance with national and international best practice will ensure that Seagreen is compliant with the UK government's international commitments to conserve biodiversity as implemented by national planning and wildlife protection legislation and national planning policies.

8.8. This chapter therefore describes the existing environment with regard to important offshore ornithological features known to be present at and around the optimised Seagreen Project in the context of the wider Firth of Forth and North Sea. The Baseline Conditions section characterises the distribution, abundance and behaviour of important ornithological features known to occur, or which have been recorded within the optimised Seagreen Project. The subsequent Assessment of Impacts presents the potential impacts of construction, operation and maintenance, and decommissioning of the optimised Seagreen Project on the important ornithological features present, i.e. those species identified as being important in the 2014 consent and in the 2017 Scoping Opinion.

8.9. All Figures supporting this chapter can be found in Volume II: Figures.

8.10. The following documents support this chapter and are provided in Volume III: Appendices:

- Appendix 8A – Ornithology Technical Report (ECON Ltd), including rangefinder technical information;
- Appendix 8B – Collision Risk Modelling (ECON Ltd);
- Appendix 8C – Displacement of Seabirds (NIRAS); and
- Appendix 8D – Population Viability Analysis (DMPStats).

8.11. This chapter was produced by NIRAS Consulting Limited.

8.12. Distinct from the requirements of the EU EIA Directive, as transposed into national legislation in Scotland, a Habitats Regulations Appraisal (HRA) (Chapter 16 of this EIA Report) is required in accordance with the EU Habitats Directive. This technical chapter informs the HRA in respect of potential impacts to sites designated as Special Protection Areas (SPAs) under the EU Birds Directive.

LEGISLATION, POLICY AND GUIDANCE

Policy Context

8.13. National government policy and strategy documents ensure that the functions of all public bodies comply with national legislation and the international commitments undertaken by the UK and Scottish governments; this includes those government bodies that determine planning permissions or license applications.

8.14. In Scotland, biodiversity related policy and strategy documents implement international commitments to biodiversity, including birds in the marine environment. These international biodiversity commitments are included in:

- The European Biodiversity Strategy for 2020 – setting out six targets and 20 actions to halt the loss of biodiversity and ecosystem services in the EU;
- The United Nations' (UN) Convention on Biological Diversity (1992); including the 'Aichi' biodiversity targets;

- The Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Convention 1992); and
- The Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention 1971).

8.15. The Bonn Convention (1979) provides for contracting parties to work together to conserve migratory species and their habitats by providing strict protection for endangered migratory species (listed in Appendix I of the Convention), by concluding multilateral agreements for the conservation and management of migratory species which require or would benefit from international cooperation (listed in Appendix II of the Convention), and by undertaking cooperative research activities.

8.16. The Bern Convention (1979) aims to ensure conservation and protection of wild plant and animal species and their natural habitats (listed in Appendices I and II of the Convention). It also aims to increase cooperation between contracting parties and regulate the exploitation of those species (including migratory species) listed in Appendix III of the Convention.

8.17. 'Scotland's Biodiversity: It's in Your Hands' (Scottish Executive, 2004) together with '2020 Challenge for Scotland's Biodiversity' (The Scottish Government, 2013) together comprise the Scottish Biodiversity Strategy. The strategy, by implementing international biodiversity commitments, seeks to:

- Halt the loss of biodiversity and continue to reverse previous losses; and
- Protect, restore and enhance biodiversity.

8.18. The Scottish Biodiversity Strategy aims are subsequently included in the National Marine Plan. 'The Marine (Scotland) Act 2010' required Scottish ministers to prepare and adopt a national marine plan for the Scottish marine area. The plan states the policies for, amongst other things, sustainable development in the Scottish marine area. The key policies relevant to sustainable wind energy developments and birds in the marine environment are given below in Table 8.1.

8.19. Scottish Planning Policy (February 2010) determines that sites designated under the Ramsar Convention (1971) are also European sites and/or Sites of Special Scientific Interest (SSSI) and are protected under the relevant statutory regimes. Therefore, where the qualifying interest features of Ramsar sites correspond with those of overlapping European sites, "there is no need to consider them separately" (Scottish Government, 2011).

Table 8.1 Policy Issues Considered

Policy Reference	Policy Issue
Scotland's National Marine Plan (The Scottish Government, 2015)	
Renewables 5	Renewable energy projects must demonstrate compliance with Environmental Impact Assessment and Habitats Regulations Appraisal legislative requirements.
Renewables 6	Cable and network owners and marine users should ensure a co-ordinated and strategic approach to development and activities to minimise impacts on the marine natural environment.
Renewables 9	Marine planners and decision makers should support the development of joint research and monitoring programmes for offshore wind and marine renewables energy development.

Legislative Requirements

8.20. National legislation relevant to the assessment of ecological impacts in this chapter and the aims of national government policy and strategy documents, particularly Scotland's National Marine Plan policy 'Renewables 5', are given below in Table 8.2.

Table 8.2 Legislation Issues Considered

Legislation Reference	Legislation Issue
Wildlife and Countryside Act 1981 (as amended in Scotland)	
Part 1	Implements Article 1 and 5 of the European Parliament Council Directive 2009/147/EC on the conservation of wild birds (the 'Birds Directive') making it an offence to intentionally or recklessly: • Kill, injure or take any wild bird; • Take, damage, destroy or otherwise interfere with the nest of any wild bird while that nest is in use or being built; or • At any other time take, damage, destroy or otherwise interfere with any nest habitually used by any wild bird included in Schedule 1A; • Harass any wild bird included in Schedule 1A; • Obstruct or prevent any wild bird from using its nest; and • Take or destroy an egg of any wild bird.
Nature Conservation (Scotland) Act 2004 (as amended)	
Part 2	Makes it an offence for a public body or office-holder to carry out or cause or permit to carry out any operation which is likely to damage any natural feature specified in a SSSI notification except, *inter alia*, with the written consent of SNH given on an application. Public body includes a statutory undertaker.
The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in Scotland) (Conservation of Habitats and Species Regulations 2010 in relation to certain specific activities [reserved matters])	
Part IV	Implements Article 6(3) and 6(4) of the European Parliament Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the 'Habitats Directive') in Scotland and within 12nm making it a requirement for: • A competent authority – before deciding to undertake, or give any consent, permission or other authorisation for a plan or project which is likely to have a significant effect on a European site in Great Britain or a European offshore marine site (either alone or in combination with other plans or projects) and that is not directly connected with or necessary to the management of the site – shall make an appropriate assessment of the implications for the site in view of that site's conservation objectives. • A person applying for any such consent, permission or other authorisation shall provide such information as the competent authority may reasonably require for the purposes of the assessment.
The Conservation of Offshore Marine Habitats and Species Regulations 2017	
Part 2	Implements Article 6(3) and 6(4) of the Habitats Directive beyond 12nm making it a requirement for: • A competent authority before deciding to undertake, or give any consent, permission or other authorisation for a relevant plan or project must make an appropriate assessment of the implications for the site in view of that site's conservation objectives. A relevant plan or project plan is one which is likely to have a significant effect on a European offshore marine site or a European site (either alone or in combination with other plans or projects) and is not directly connected with or necessary to the management of the site. A person applying to a competent authority for any such consent, permission or other authorisation shall provide such information as the competent authority may reasonably require for the purposes of the assessment.

Designated Sites

8.21. The key international conventions promoting the conservation of birds are the Convention on Wetlands of International Importance especially as Waterfowl Habitat (the 'Ramsar Convention'), the Convention on the Conservation of Migratory Species of Wild Animals (the 'Bonn Convention') and the Convention on the Conservation of European Wildlife and Natural Habitats (the 'Bern Convention').

8.22. The Ramsar Convention allows contracting parties to the convention to designate suitable wetlands within their own territory for inclusion in the 'List of Wetlands of International Importance' (the List). Contracting parties are required to incorporate into their planning the conservation of the areas included in the List. In addition, the Ramsar Convention states that "where a Contracting Party in its urgent national interest, deletes or restricts the boundaries of a wetland included in the List, it should as far as possible compensate for any loss of wetland resources, and in particular it should create additional nature reserves for waterfowl and for the protection, either in the same area or elsewhere, of an adequate portion of the original habitat."

8.23. Within the European Union, the key legislative measures providing for the protection of birds are Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (the 'Birds Directive') and Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (the 'Habitats Directive').

8.24. The Birds Directive aims to maintain the populations of wild bird species across their natural range and allows for the designation of Special Protection Areas (SPAs) for rare and vulnerable species listed in Annex I of the Directive and regularly occurring migratory birds.

8.25. The Habitats Directive promotes the maintenance of biodiversity by requiring Member States to maintain or restore natural habitats and wild species listed in the Annexes to the Directive and by introducing protection for habitats and species of European importance. The Habitats Directive contributes to a coherent European ecological network of protected sites by designating Special Areas of Conservation (SACs) for habitats listed on Annex I and for species listed on Annex II of the Directive. Together, SACs and SPAs create a Europe-wide network of designated sites known as Natura 2000.

8.26. The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in Scotland) together with the Conservation of Offshore Marine Habitats and Species Regulations 2017 (the 'Offshore Marine Conservation Regulations') allow for the designation of SACs and SPAs. These Regulations set out a mechanism for the protection of those SPA and SAC sites. Further advice in relation specifically to the optimised Seagreen Project has been sought through consultation with the statutory authorities and from the Marine Scotland scoping opinion.

Guidance

8.27. The principal guidance documents used to inform the assessment of potential impacts on ornithology are given in Table 8.3. A literature review was undertaken to provide information on the bird interest of the optimised Seagreen Project and its importance in a regional, national and international context. This review included general seabird ecology, migration behaviour, population sizes and conservation status, particularly on the Firth of Forth, the North Sea, and Britain as a whole.

8.28. In accordance with British Standard BS 42020:2013 (The British Standards Institution, 2013), the assessment of ecological impacts in this chapter take into account guidance from the Chartered Institute of Ecology and Environmental Management (CIEEM) (IEEM, 2010; CIEEM, in prep.).

Table 8.3 Key guidance documents referred to in this EIA Report in relation to Offshore Ornithology

Title	Source	Year	Author
JNCC Online SPA standard data forms for Natura 2000 sites	JNCC http://jncc.defra.gov.uk/page-1400	Multiple years	JNCC
Existing offshore wind farm Environmental Statements and Monitoring Reports	Multiple	Multiple years	Multiple
Seagreen Scoping Opinion	Marine Scotland Licensing Operations Team: Scoping Opinion for Seagreen Phase 1 Offshore Project http://www.gov.scot/Topics/marine/Licensing/marine/scoping/SeagreenPhase1-2017/SO-15092017	2017	Marine Scotland
Wetland Bird Survey (WeBS) Annual Report and Report Online interface	Wetland Bird Survey(WeBS) https://www.bto.org/volunteer-surveys/ webs/ publications/ webs-annual-report	2018	Frost *et al.*
British Trust for Ornithology (BTO) BirdFacts: profiles of birds occurring in Britain and Ireland.	British Trust for Ornithology https://www.bto.org/about-birds/birdfacts	2005	Robinson
Biologically appropriate, species-specific, geographically non-breeding season population estimates for seabirds	Natural England	2015	Furness
At-Sea Turnover of Breeding Seabirds	Marine Scotland	2015	Searle *et al.*
Population consequences of displacement from proposed offshore wind energy developments for seabirds breeding at Scottish SPAs	Marine Scotland	2014	Searle *et al.*
Population estimates of birds in Great Britain and the UK	*British Birds* (journal)	2013	Musgrove *et al.*
Seabird foraging ranges as a preliminary tool for identifying candidate Marine Protected Areas	British Trust for Ornithology	2012	Thaxter *et al.*
Assessing the risk of offshore wind farm development to migratory birds designated as features of UK SPAs	Strategic Ornithological Support Services	2012	Wright *et al.*
An analysis of the numbers and distribution of seabirds within the British Fishery Limit aimed at identifying areas that qualify as possible marine SPAs	JNCC	2010	Kober *et al.*
A review of assessment methodologies for offshore wind farms	British Trust for Ornithology	2009	Maclean *et al.*
The Migration Atlas	British Trust for Ornithology	2002	Wernham *et al.*
Atlas of seabird distribution in northwest European waters	JNCC	1995	Stone *et al.*
A handbook on environmental impact assessment: Guidance for Competent Authorities, Consultees and others involved in the Environmental Impact Assessment Process in Scotland. Scottish Natural	SNH	2013	SNH
Barriers to movement: Modelling energetic costs of avoiding marine wind farms amongst breeding seabirds.	*Marine Pollution Bulletin* (journal)	2010	Masden *et al*
Developing guidance on ornithological cumulative impact assessment for offshore windfarm developers.	COWRIE	2009	King *et al*
Developing an avian collision risk model to incorporate variability and uncertainty.	Scottish Marine and Freshwater Science Report	2015	Masden *et al*
Mapping Seabird Sensitivity to Offshore Wind Farms.	*PLOS ONE* (Journal)	2014	Bradbury *et al*
Non-breeding season populations of seabirds in UK waters	Natural England	2015	Furness
Joint SNCB Interim Displacement Guidance Note	JNCC	2017	JNCC *et al*
Joint Response from the Statutory Nature Conservation Bodies to the Marine Scotland Science Avoidance Rate Review	JNCC	2014	JNCC *et al*

CONSULTATION

8.29. As part of the EIA process Seagreen has consulted with a number of statutory and non-statutory organisations to inform the approach to assessment on offshore ornithology.

8.30. A Scoping Report was submitted by Seagreen in May 2017. This considered the proposed changes to the optimised Seagreen Project and identified potential requirements for assessment. A Scoping Opinion was issued by Marine Licencing and Operations Team (MS-LOT) on behalf of Scottish Ministers in September 2017. This considered the information presented within the Scoping Report and set out key issues to be addressed within the impact assessment. With regards to assessing ornithology aspects of the EIA, the 2017 Scoping Opinion included details of:

- Which SPAs and qualifying features should be included in the assessment of impacts;
- The expected methodological approach to apportioning impacts to SPAs;
- The expected methodological approach to assessing the impact of displacement and which species should be assessed;
- The expected methodological approach to collision assessment, including population viability analysis (PVA) and which species should be assessed; and
- The expected methodological approach to cumulative impacts and which projects should be included.

8.31. The methodology section of this chapter addresses the scoping opinion expectations regarding the ornithology approach of the EIA, along with deviations and justification provided where appropriate.

8.32. A summary of the issues brought up during the post-scoping opinion consultation process and how the EIA has responded to each issue is given in Table 8.4. The post-scoping opinion consultation process has included the following:

- MS-LOT caseworker meeting (17/11/2017);
- Ornithology meeting with Marine Scotland (MS), Scottish Natural Heritage (SNH) and Marine Scotland Science (MSS) (22/11/17); and
- Ornithology meetings with the Royal Society for the Protection of Birds (RSPB) (20/11/17 and 20/03/18).

8.33. Table 8.4 sets out the consultation undertaken to date, including the date and type of consultation, the issues raised and how these have been addressed within this EIA Report.

Table 8.4 Summary of consultee responses

Consultee and Date	Summary of issues raised	How issues have been addressed
Scoping Opinion 2017		
MS-LOT	Assessment of Outer Firth of Forth and St Andrews Bay Complex pSPA: • Seabird species to be considered in the assessment of Outer Firth of Forth and St Andrews Bay Complex pSPA: gannet, kittiwake, herring gull, puffin, razorbill, guillemot. The assessment carried out for these species at the following breeding colony SPAs listed should also be used for the assessment of the pSPA: • Forth Islands SPA, Fowlsheugh SPA, Buchan Ness to Collieston Coast SPA and St Abb's Head to Fast Castle SPA.	All six SPA/pSPAs identified are as advised considered within the HRA Report (Chapter 16).
	Collision Risk: CRM is required for gannet, herring gull and kittiwake. The nocturnal activity scores of 2 (25%) should be used for herring gull and kittiwake and 1 (0%) for gannet. The mean monthly value should be used, and density of birds in flight values should also have 95% confidence limits presented. The following avoidance rates should be used: • Gannet – 98.9% (±0.002) for Option 2, • Kittiwake – 98.9% (±0.002) for Option 2, • Herring gull – 99.5% (±0.001) for Option 2, 99.0% (± 0.002) for Option 3	This advice is taken forward in this EIA Report. Full details of the collision risk modelling process applied is given in Appendix 8B (Collision Risk Modelling).
	Displacement & Barrier effects: The species to be included are: puffin, guillemot, razorbill and kittiwake. The breeding season months are those described in the SNH advice. Density estimates should be mean seasonal peaks and include a 2km buffer around the site and should include all birds, both those in flight and on the water. Breeding season: Estimates of displacement should be presented following the SNCB guidance (JNCC *et al* 2017). The updated CEH (SeaBORD) model should also be used if available. Outputs from the previous CEH modelling (2014) should be used for context. Non-breeding season: Qualitative assessments should be presented for puffin and kittiwake. For guillemot and razorbill, the approach described in the 2017 SNCB guidance should be used. Non-breeding season effects should be assigned to relevant SPAs as per breeding season. A displacement rate of 60% should be used for auks and 30% for kittiwake. A mortality rate from displacement of 2% for puffin and kittiwake (quantitative assessment is for the breeding season only) and 1% for guillemot and razorbill (same rate across breeding and non-breeding seasons) should be applied. The same rates should be used for immatures as for adult birds.	This advice is taken forward in this EIA Report. Full details of the displacement analysis applied is given in Appendix 8C (Displacement of Seabirds). All displacement and mortality rates recommended in the scoping opinion have been highlighted in this assessment. Para. 8.77 to 8.114 provides a full review of available evidence on levels of displacement and mortality for key species. The CEH (SeaBORD) model has not been published at the time of writing of this EIA Report and is not applied to the assessment.

Consultee and Date	Summary of issues raised	How issues have been addressed
	Apportioning: The methods that should be used are the SNH apportioning approach and the Apportionment tool being produced for Marine Scotland by CEH (if available). The reference populations provided by SNH are to be used for the SPAs. Apportioning impacts between SPA and non-SPA colonies should be done using Seabird 2000 data. Impacts apportioned between SPAs should use most recent colony counts, as provided by SNH. Non-breeding season: The biologically defined minimum population scales (BDMPS) should be used for gannet and kittiwake, using reference populations from Furness (2015). For guillemot and razorbill, all non-breeding season impacts should be assigned to SPAs as per breeding season. Use of the total SPA population, all ages, and apportioning impacts across age classes based on the PVA stable age structure is recommended.	Appendix 16B to Chapter 16 (HRA) provides a full breakdown of the apportioning process, which is based on the advice given in the scoping opinion.
22 November 2017 –Marine Lab, Marine Scotland, Aberdeen		
MSS	Single PVA needed for each scenario (site and species) and all age class; confidence of input numbers needs to be reported.	Appendix 8D (Population Viability Analysis) provides full detail of PVA methodology and outputs.
MSS	Flight height data collection from 2017 surveys: reporting should include all methodological details.	All information is provided in Appendix 8A (Ornithology Technical Report). This includes range finder calibration information.
15 February 2018 – Teleconference–MS-LOT, MSS, SNH		
MSS	Seabird aerial densities: Seagreen baseline boat-survey data follows a 'radial snapshot' methodology which differs from the method applied elsewhere. MSS requested approach to calculating aerial densities from baseline surveys is set out for discussion at a following meeting.	A proposed methodology to allow consistency between projects on aerial density calculation was provided for the subsequent meeting with MSS. This issue is also further explored in Appendix 8B (Collision Risk Modelling).
SNH	Apportioning to SPAs: SNH provided an 'illustrative example' of apportioning of impacts to SPAs. Requested that this be incorporated in to the assessment of Seagreen.	The methodology provided by SNH has been incorporated in to the apportioning process applied for Seagreen–this is fully outlined in Appendix 16B of Chapter 16 (HRA).

Consultee and Date	Summary of issues raised	How issues have been addressed
6 March 2018 – Marine Lab, Marine Scotland, Aberdeen		
SNH and MSS	Calculation of population estimates for displacement assessment: In response to Seagreen presenting a methodology to account for buffer areas not surveyed in 2009 to 2011 by calculating scaling factors from 2017 data, both SNH and MSS confirmed that the approach was appropriate and it should be applied to the impact assessment.	Appendix 8A (Ornithology Technical Report) provides a full overview of the calculation of population estimates and densities.
	Seabird aerial densities: Seagreen detailed that the most practical solution was considered to be adjusting the snapshot area for Seagreen to be consistent with that used at other sites. It was noted that this was consistent with the current guidance on boat-based survey methods and common practice for most surveys of this kind. The adoption of this approach was considered appropriate by both SNH and MSS while explanations should be provided in the assessment.	Appendix 8B (Collision Risk Modelling) provides an overview of the differences and a calculated factor to correct densities using radial snapshot to the more typical box method.
MSS	Displacement assessment: MSS requested information from Searle *et al.* (2014) be included as context in the assessment of displacement.	A review of the findings from Searle *et al.*, (2014) are provided in Para. 8.108 to 8.112. Where appropriate these are also included in the impact assessment sections on key species.
22 November 2017 – RSPB Scotland, Edinburgh		
RSPB	Seagreen presented the intended approach to ornithology assessment as agreed through scoping and subsequent consultation with statutory bodies. RSPB responded that the scoping opinion provided a prescriptive approach to the assessment, to which they agreed, but requested to be further consulted as the assessment progressed.	Seagreen agreed that further information would be provided as the EIA progressed.
20 March 2018– RSPB Scotland, Edinburgh		
RSPB	Flight height values: RSPB queried which flight height values would be used in the assessment including for the non-breeding season. RSPB queried If validation work would be published.	Full details of the methodology applied to calculate flight heights is presented in Appendix 8B (Collision Risk Modelling).
	Seabird aerial densities: It was confirmed that MS-LOT, MSS and SNH had agreed that it was preferable for data from different sites to be comparable, particularly in relation to cumulative and in-combination assessments. The agreed solution was the adjustment of the snapshot area for Seagreen to normalise the Seagreen data with that used at other sites. RSPB accepted this approach and agreed that it was preferable that consistency across adjacent sites was desirable.	Appendix 8B (Collision Risk Modelling) provides an overview of techniques applied.

SCOPE OF ASSESSMENT

8.34. As discussed in Chapter 4 (Policy and Legislation) and Chapter 6 (EIA Process) the optimised Seagreen Project is assessed under the transitional provisions in respect of the Marine Works (Environmental Impact Assessment) Regulations 2017 (as amended) and the equivalent transitional provisions under the Electricity (Environmental Impact Assessment) Regulations 2017 (as amended).

8.35. Under these Regulations, the assessment of significance presented in this chapter of the EIA Report is required to be based on the scoping opinion provided by MS-LOT (Marine Scotland, 2017) and in drawing its conclusions takes account of the results presented in Chapter 16 (Habitats Regulations Assessment).

8.36. The 2017 Scoping Opinion (Marine Scotland, 2017), identified key potential impacts on offshore ornithological receptors. The scoping opinion focussed on the core impacts of displacement and collision in the operational phase of the wind farm, with the former considered to incorporate barrier effects.

8.37. The scoping opinion details that assessment of indirect effects on seabirds (including those considered as qualifying features of the Outer Firth of Forth and St Andrews Bay Complex pSPA) through impacts on prey species are not required.

8.38. Table 8.5 presents the impacts assessed with this being on the optimised Seagreen Project design set out in Chapter 5 (Project Description) and with the assumption that mitigation measures and consent conditions as set out in Chapter 7 (Scope of EIA Report) will be applied.

8.39. The scoping opinion also identified the species to be included in this assessment, these are: gannet *Morus bassanus*, puffin *Fratercula arctica*, razorbill *Alca torda*, guillemot *Uria aalge*, kittiwake *Rissa tridactyla* and herring gull *Larus argentatus*. Marine Scotland (2017) consider that the optimised Seagreen Project does not "present [a] significant risk to any other bird interests and we do not require any individual developer to submit further information in this regard".

Table 8.5 Potential effects of Seagreen Offshore Wind Farm on offshore ornithological receptors

Potential effect	Construction	Operation	Decommissioning
Disturbance	✓	×	✓
Displacement & barrier effects	×	✓	×
Collision	×	✓	×

8.40. The 2017 Scoping Opinion (Marine Scotland, 2017), states that "*The Scottish Ministers advise that the conservation objective relating to the population of species as a viable component of the* (European Protected) *site should be the focus of the assessment, although justification should be provided within the EIA/HRA Report as to why the other conservation objectives are less relevant or are addressed via this conservation objective*".

8.41. This chapter follows the scoping advice, with the assessment of the potential impacts of the project within this chapter being focussed on the conservation objective relating to the population of species as a viable component of a European site. Chapter 16 (Habitats Regulations Appraisal) considers the potential impacts of Project Alpha, Project Bravo and Project Alpha and Project Bravo combined against all the relevant conservation objectives.

Disturbance

8.42. Disturbance effects can operate by deterring birds from using suitable or preferred habitat. During construction disturbance has the potential to arise as a result of the presence of vessels and construction works.

8.43. Different species show differing sensitivities to disturbance. Assessment of a species vulnerability to disturbance will be based upon: the number of birds within Seagreen Offshore Wind Farm, the estimated proportion of those breeding colonies with connectivity to the site that the site population represents, the species' estimated sensitivities to vessel presence (Wade *et al.* 2016), whether their distribution over the wider area is localised or widespread, their reliance on specific habitat types, and any published information on habituation.

8.44. Short-listing of species for disturbance assessment is based on those known to be vulnerable to disturbance impacts (based on Wade *et al.*, 2016; Bradbury *et al.*, 2014) and where the population of the species observed at the development site plus a 2km buffer is considered to be of importance (when compared against a relevant population scale thresholds–regional, national or international).

Displacement and Barrier Effects

8.45. Displacement may effect bird populations by affecting site usage which may be for foraging, resting or moulting purposes. As a result of displacement an individual bird may experience a decrease in fitness, due to the effect of re-locating to alternative foraging grounds and/or changes to energy budgets due to the increased energy expenditure when avoiding a wind farm. These impacts, in turn, may have indirect effects on birds in areas that may be some distance from the wind farm including reduced energy acquisition as a result of increased competition at other foraging sites which can result in further reductions in fitness affecting reproductive success. However, due to limited empirical evidence quantifying the likely energetic consequences of displacement, the advice of the Statutory Nature Conservation Bodies (SNCBs) is to consider displacement impacts in terms of direct mortality on bird populations (JNCC *et al.*, 2017).

8.46. Recent advice published by UK SNCBs (JNCC *et al.*, 2017) suggests that in addition to the defined vulnerability of seabirds, habitat use flexibility can, in-combination with other factors including expert opinion, be used to propose an appropriate rate of mortality that occurs as a result of displacement.

8.47. Short-listing of species for displacement analysis has been identified in the scoping opinion for Seagreen and in general, is based on those known to be vulnerable to displacement impacts (Wade *et al.*, 2016; Bradbury *et al.*, 2014). In essence these species are taken forward for assessment where the population of the species observed at the optimised Seagreen Project site plus 2km buffer is considered to be of importance (when compared against a relevant population scale thresholds–regional, national or international).

8.48. Barrier effects may arise when birds incur extra energetic costs as a result of avoiding a wind farm. Species passing through an area infrequently, such as birds traversing the sites as part of a longer biannual migration flight, would incur much less impact than a species breeding near the development that needed to avoid it on a daily basis as part of its foraging routine. Impacts upon birds simply passing through an area will be negligible (although possibly contributing to cumulative impacts where other barriers exist on a migration route), whereas those making frequent flights across the sites may do so to the detriment of their body condition, which may affect adult survival or reproductive success.

Collision

8.49. Birds can collide with turbine rotor blades, which is almost certain to result in direct mortality. Most studies have found evidence of only low levels of bird mortality associated with operational onshore wind farms, as birds are able to take avoiding action (Drewitt and Langston, 2006), although evidence from offshore wind farms had been limited. However recent monitoring also indicates a low level of collisions is a general characteristic for several species identified as being at risk from collision with offshore wind turbines. The actual risk of collision depends on a number of factors including the location of a wind farm, the bird species using the area, weather and visibility conditions, and the size and design of the wind farm, including the number and size of turbines and the use, or otherwise, of lighting (e.g. Kerlinger and Curry, 2002).

8.50. The effect of collision rates on a population is influenced by various characteristics, notably its size, density, recruitment rate (additions to the population through reproduction and immigration) and mortality rate (the natural rate of losses due to death and emigration). In general, the effect of an individual lost from the population will be greater for species that occur at low density, are relatively long-lived and reproduce at a low rate with most seabird species falling into this category. Conversely, the effect will often be reduced for shorter-lived species with higher reproductive rates found at high densities, including some smaller gull species. Species that habitually fly at night or during low light conditions at dawn and dusk may also be at increased risk from collisions. However, both eider and scoter (not assessed in this EIA) for example, have been shown to detect and avoid offshore turbines at night in both the Netherlands (Winkelman, 1995) and at offshore towers at Tunø Knob in Denmark (Tulp *et al.*, 1999).

Scoped Out Impacts

8.51. In accordance with the Scoping Opinion (Marine Scotland 2017), potential impacts scoped out of this assessment are:

- Pollution impacts in both construction and operational phases of the development; and
- Indirect impacts on prey species during in both construction and operational phases of the development.

METHODOLOGY

8.52. This section presents the impact assessment methodology applied to assess the potential environmental impacts associated with the construction, operation and decommissioning phases of the optimised Seagreen Project.

Study Area

8.53. In accordance with CIEEM (in prep.) the study area (see Figure 8.1) encapsulates all the areas, no matter how remote from Seagreen Offshore Wind Farm, that are likely to be affected by biophysical changes as a result of the construction, operation and decommissioning ("the zone of influence").

8.54. It is often appropriate to identify different zones of influence for different features (CIEEM, in prep.). In this chapter a zone of influence is defined by the area of direct impact, the area where the physical footprint will occur, the area of indirect impact surrounding the footprint and remote seabird breeding colonies where foraging ranges overlap with the optimised Seagreen Project. The study area for this assessment therefore includes the following zones of influence:

- An area of approximately 391 km^2 within which direct impacts will occur. This area is located to the east of Scalp Bank and occupies the same area as Project Alpha and Project Bravo.
- An area defined by a 2km buffer around Project Alpha and Project Bravo, wholly encompassed within the area covered by site specific boat-based surveys. Impacts due to displacement or disturbance are determined within this zone of influence in accordance with joint SNCB recommendations for all species with the exception of divers and sea ducks (where a 4km displacement buffer is recommended; JNCC *et al.*, 2017). This is defined as the "Project Alpha and Project Bravo combined plus a 2km buffer" area for the purposes of this assessment, or either Project Alpha or Project Bravo with respective 2km buffers.
- Seabird breeding colonies remote from the optimised Seagreen Project where measurable population effects are likely to occur. The seabird colonies included in this zone of influence are defined in the 2017 Scoping Opinion and include: Buchan Ness to Collieston Coast SPA; St Abb's Head to Fast Castle SPA; Forth Islands SPA; Fowlsheugh SPA; and Outer Firth of Forth and St Andrews Bay Complex potential SPA (pSPA).
- In the non-breeding season, seabirds are not constrained by colony location and can, depending on individual species, range widely within UK seas and beyond. The zone of influence for seabird species where an assessment in the non-breeding season is deemed to be required is based on Furness (2015) which presents Biologically Defined Minimum Population Scales (BDMPS[1]).

Data Collection

8.55. The optimised Seagreen Project has the same area and is within the same application boundaries as the originally consented Project and therefore, data collected to inform the 2012 Offshore ES, remains an appropriate source of information to inform the assessment of impacts for this EIA Report. This includes a range of detailed project specific surveys and site characterisation studies to define baseline conditions. Where data from the 2012 Offshore ES are used, this is set out below and data are provided as supporting information to this chapter (see Appendix 8A [Ornithology Technical Report]).

[1]BDMPS combines both a spatial scale and a population scale within which the number and origin of the birds present in a particular season are defined

8.56. Baseline characterisation for offshore ornithology has been undertaken using a combination of desk based research and site specific surveys. The following are core data sources used to inform this assessment:

- Site specific ornithological data collected from boat-based surveys (December 2009 to November 2011 inclusive and April to August 2017 inclusive) and is supported by secondary data sources including:
  - FAME (Future of the Atlantic Marine Environment) and STAR (Seabird Tracking and Research) seabird tracking projects as well as Centre for Ecology & Hydrology (CEH) projects from the Isle of May in 2010 and from Fowlsheugh and St. Abb's Head in 2011;
  - The aerial surveys of the wider Firth of Forth (summer 2009 and winter 2009/2010); and
  - A large body of reference information for what is one of the best studied areas for seabirds in Europe.

8.57. A comprehensive literature review was undertaken to inform the ornithological baseline and its importance in relation to a regional, national and international context (Seagreen Wind Energy, 2012). The information gathered also included more general information on the ecology of relevant seabird species including population size, dynamics and trends, conservation status, breeding phenology and foraging patterns, behaviour and movements and patterns of dispersal and occurrence. Forrester *et al.* (2007) provided information in a Scottish context and reviews of research commissioned by the Forth and Tay Offshore Wind Developers Group (FTOWDG) provided additional local context (Daunt *et al.*, 2011a; Hamer *et al.*, 2011).

8.58. Seabird tracking data was obtained from CEH and the datasets for kittiwake, guillemot and razorbill were sufficient to estimate the range at sea, although this was not the case for puffin (Daunt *et al.*, 2011b; 2011c). In addition, FTOWDG purchased a small dataset relating to breeding puffins tagged on the Isle of May in 2010. The number and proportion of GPS tracks entering "Seagreen Offshore Wind Farm", the distance travelled within the Site and the total GPS fixes according to flight and non-flight behaviours (and combined) was calculated. These calculations were undertaken as a total for all birds and as a mean value by individual bird to account for any individual bias.

8.59. Data (summer 2009 and winter 2009/10) were obtained from aerial surveys of the wider Firth of Forth commissioned by The Crown Estate (TCE). These surveys followed the methodological protocol devised by Collaborative Offshore Wind Research into the Environment (COWRIE) (Camphuysen *et al.*, 2004). Bird density and population estimates could only be produced for gannet and kittiwake and the species groups of 'auks' and 'gulls'. A full description of the aerial survey methodology and analysis is provided in the 2012 Technical Report (Seagreen Wind Energy, 2012).

Baseline Survey

8.60. Site specific ornithological baseline data was collected from boat-based surveys from 2009 to 2011 and validated with additional boat-based survey data collected in 2017. Seabirds and migrants were systematically recorded using the methodological protocol devised by Collaborative Offshore Wind Research into the Environment (COWRIE) (Camphuysen *et al.*, 2004) with a number of modifications (Maclean *et al.*, 2009).

8.61. A full description of the boat-based survey methodology is provided in the Appendix 8A (Ornithology Technical Report). A brief summary follows.

2009 to 2011 Baseline Surveys

8.62. A total of 23 monthly boat-based surveys were completed between December 2009 and November 2011 inclusive. Surveys in January and February 2010 were affected by bad weather however full spatial coverage was achieved over the course of the survey programme and no constraints or errors were considered to have affected the results.

8.63. The surveys covered the Firth of Forth Round 3 Zone 2 from which the 2009 to 2011 baseline characterisation used the surveyed area of Project Alpha and Project Bravo as well as Scalp Bank (see Figures 1 & 2 in Appendix 8A [Ornithology Technical Report]) that equates to approximately 391 km^2.

8.64. In order to take into account the potential for clumped seabird distribution as a result of primary productivity patchiness influencing prey distribution (Scott *et al.*, 2010), four different survey routes were used. Each survey route consisted of transects at 3km intervals. The transects were orientated northwest to southeast with a view to being perpendicular to flight lines of seabirds moving to and from the Firth of Forth and its major colonies in the Forth Islands SPA, including Bass Rock. The survey routes were offset sequentially from one another (see Figure 5 in Appendix 8A [Ornithology Technical Report]). The different routes were selected randomly in diminishing rounds (see Table 4 in Appendix 8A [Ornithology Technical Report]), according to the aim of surveying each route the same number of times i.e. twice in each of three survey periods, i.e. breeding (April to July), dispersal (August to November) and winter (December to March).

8.65. The survey methodology was:

- Both sides of the vessel were surveyed continuously, with all birds recorded;
- Three skilled surveyors were used, with one for each side of the boat supported by one dedicated recorder;
- Birds were initially detected by eye with identification aided by binoculars;
- All birds were assigned a real time (not a time bin) to aid positioning;
- All birds (and marine mammals) were identified to species where possible and assigned to distance bands on port or starboard, perpendicular from the boat (A: 0 to 50m, B: 50 to 100m, C: 100 to 200m, D: 200 to 300m and E: >300m);
- Direction of travel and height (1: <20m, 2: 20 to 120m and 3: >120m) was recorded for flying birds;
- Details of age, plumage and behaviour were recorded where applicable;
- Snapshot counts were recorded at 500m intervals in radial distance bands (A to D; see above) resulting in a 180° arc extending 300m from the vessel; and
- Sea state and other variables (glare, cloud cover and precipitation and general visibility score) were recorded.

2017 Baseline Validation Surveys

8.66. The 2017 boat surveys followed the 2009 to 2011 survey methodology with the following exceptions:

- The survey area covered Project Alpha and Project Bravo and an additional 2km buffer area (see Figure 8.1). The survey area was also extended westwards to include Scalp Bank;
- Six surveys were undertaken, four in the breeding period (May [2], June [1], July[1]) and two in the breeding/dispersal period (August [1] and October [1]). October's survey was incomplete and therefore used only to provide flight height data on any important species present;
- Three survey routes were surveyed (cf. four routes surveyed in 2009 to 2011);
- Records were obtained for the six key species only (gannet, kittiwake, herring gull *Larus argentatus*, guillemot, razorbill and puffin; cf. all birds in 2009 to 2011);
- Bird flight height was visually estimated and recorded in 5m height bands (cf. <20m, 2: 20 to 120m and 3: >120m in 2009 to 2011); and
- An additional fourth surveyor to the three used in 2009 to 2011 baseline surveys, was employed on all surveys to undertake a dedicated, simultaneous survey of flight heights using a Nikon Forestry Pro laser rangefinder (Appendix 8E).

8.67. It should be noted that the reduced number of survey routes in 2017 meant that there was greater separation between routes compared to 2009 to 2011 and as a consequence spatial coverage was lower. This, together with the potential variability in recording of 5m bird flight height bands was not considered to adversely affect the survey data quality in respect of its purpose to validate the 2009 to 2011 baseline data.

Data Analysis

Population Baseline

8.68. A full description of the boat-based survey data analysis methodology is provided in Appendix 8A (Ornithology Technical Report). A brief summary follows.

8.69. Combined densities of flying birds and those sitting on the water (individuals/km^2) were estimated in two ways:

- Using standard European Seabirds at Sea (ESAS) density calculations for birds on the water and the number of birds seen in transect snapshot counts divided by survey effort for birds in flight; and
- Where appropriate using Distance sampling correction for birds on the water in transect (Buckland *et al.* 2001; 2004; Thomas *et al.*, 2010) combined with standard density estimates for birds in flight (as above).

8.70. The total population size is estimated by multiplying the respective density estimate by the total area of the site being surveyed.

8.71. Standard ESAS density calculations for birds on the water were calculated from the number of birds in a transect (300m either side of the vessel) divided by the entire line transect survey area, i.e. the transect length multiplied by the transect width of 600m. Standard densities of flying birds were derived from the total numbers seen in radial snapshot counts to 300 m divided by the total area surveyed by snapshot counts, i.e. the number of snapshot counts multiplied by the radial snapshot count area of 0.141 km^2. This differs from the ESAS 'box' approach used widely elsewhere in Europe and by other Forth and Tay projects which takes a snapshot count within a 300 m x 300 m boxby dividing the snapshot count by the total area of the box (0.18km^2).

8.72. As agreed with Marine Scotland and SNH, when quantitatively assessing an impact i.e. collision risk and displacement, the densities for birds in flight have been corrected by a factor of 0.7853 to allow a common currency approach with other Forth and Tay projects when assessing impact. As detailed in the Ornithology Technical Report (Appendix 8A [Ornithology Technical Report]), there is a clear difference between the 'radial snapshot' methodology in recording aerial densities of birds applied to the baseline boat-based surveys at Seagreen, compared to the more widespread 'box method' applied elsewhere.

8.73. Relative abundance was calculated for each of the two boat-based survey datasets (individuals/km^2). The 2009 to 2011 relative abundance was compared with that of the 2017 surveys to determine if the 2009 to 2011 baseline remains an accurate reflection of current site conditions. Recognising the precautionary principle as a result of the dynamic and highly changeable marine environment over time (CIEEM in prep.), the determination of receptor importance was based on the highest relative abundance values.

Impact Assessment

8.74. The impact assessment follows the principles of the approach set out within Chapter 6 (EIA Process) of this EIA Report. This includes consideration of Project Alpha alone; Project Bravo alone; Project Alpha and Project Bravo combined (the optimised Seagreen Project) and Project Alpha and Project Bravo in a cumulative scenario.

8.75. The significance of potential impacts has been evaluated using a systematic approach, based upon identification of the importance/value of receptors and their sensitivity to the project activity, together with the predicted magnitude of the impact.

Developments in Assessment Methods

8.76. There have been considerable recent developments to impact assessment of offshore ornithology since the original 2012 Offshore ES. These relate to both project specific updates to Seagreen and to wider updates to guidance and methodologies. Table 8.6 presents an overview of these changes with a description of the implications for this EIA Report.

Displacement Analysis

Overview

8.77. The presence of wind turbines has the potential to directly disturb and displace birds from within and around Project Alpha and Project Bravo. As displacement effectively leads to exclusion from areas of suitable habitat, it can be regarded as being similar to habitat loss in its effect on birds, although it may be more spatially extensive. This habitat loss in effect, would reduce the area available for feeding, loafing and moulting for seabird species that may occur at the optimised Seagreen Project.

Table 8.6 Developments in assessment methods for offshore ornithology

Type	Development	Justification/implication
Baseline characterisation	Additional baseline surveys completed in the breeding season of 2017.	Provides contemporary update to characterisation of seabird populations present at Seagreen. These data materially alter baseline populations used to assess both collision risk and displacement effects compared to 2012. The data also influence apportioning to SPAs, as the population age structure for given species changes to some degree.
Baseline characterisation	The additional 2017 surveys collected flight height data supplemented with validation with rangefinders.	Validated flight height data provides a completely new data set for which to inform collision risk assessment.
Study area	Some elements of what is now defined as a buffer from Project Alpha and Project Bravo were not covered in the baseline surveys 2009 to 2011. A full area to 2km was covered in 2017. Population estimates used for displacement assessment for 2009 to 2011 have been corrected to account for areas of sea not surveyed.	Appendix 8A (Ornithology Technical Report) presents the process and results by which correction of the 2009 to 2011 has been undertaken. This has allowed a comprehensive assessment of displacement effects. In essence this has led to higher population estimates than applied in 2012.
Project design	Notwithstanding minor updates to include a relevant buffer area, the major update to the project design relevant to offshore ornithology is a significant change in turbine model proposed for the Development of which several parameters are pertinent to collision risk assessment.	Chapter 5: Project Design provides the full overview of turbines proposed for the application. Appendix 8B (Collision Risk Modelling) presents the approach and outputs to collision risk modelling. Appendix 8B [Collision Risk Modelling] also presents collision risk results of the 2012 consented turbine scenario updated to reflect more contemporary advice and guidance on collision risk modelling.
Guidance	Guidance on displacement has been provided since 2012 (JNCC *et al.*, 2017). This is coupled with more specific guidance on displacement and mortality rates which are typically lower than generic rates applied in 2012.	An overview of the assessment methodology for displacement effects is presented in Appendix 8C (Displacement of Seabirds).
	Guidance on collision risk has been provided since 2012, particularly on avoidance rates (Cook *et al.*, 2014; JNCC *et al.*, 2014). Further information on other aspects of collision risk is available from ORJIPs Bird Collision Avoidance Study (Skov *et al.* 2018).	The approach to assessing collision risk is presented in Appendix 8B (Collision Risk Modelling). The EIA Report utilises all appropriate evidence that has been published at the time of writing. For a comparison of current predictions and what these parameter updates mean for the 2014 consented design see Appendix 8B (Collision Risk Modelling).

8.78. Seabird species vary in their reactions to the presence of operational infrastructure (e.g. wind turbines and offshore substation platforms [OSPs]) and to the maintenance activities that are associated with it (particularly ship and helicopter traffic). Wade *et al.* (2016) presents a scoring system for such disturbance factors, which is used widely in offshore wind farm EIAs.

8.79. Following recently published joint SNCB interim guidance JNCC *et al.* (2017), displacement impacts for each relevant species are presented using a wide range of potential displacement and mortality rates. These have been presented as separate matrix tables, one for each of the seasons being assessed as applicable (e.g. 'breeding', 'post-breeding', 'non-breeding' and 'pre-breeding') in Appendix 8C (Displacement of Seabirds). The matrices and assessments presented in this chapter take into consideration three species-specific factors:

i. intensity of displacement within a given area (i.e. what proportion of the population is displaced);

ii. spatial extent – to what distance from turbines any individuals within the population will be displaced; and

iii. seasonality – what magnitude of impact there will be within a population (taken as percentage mortality), based on the species' particular sensitivity during a particular stage in the life cycle.

8.80. It is recognised that for many species, limited information is available to predict the magnitude of displacement or, should it occur, its resultant effects on populations. The biological consequences of such displacement and any resultant population-level effects will depend on the importance of the area from which birds are displaced and the capacity of alternative habitats to support these displaced birds. Migratory species are unlikely to find the area particularly important unless it is recognised as an important staging area, whereas impacts may be more acutely felt if a loss of prime foraging habitat for a breeding colony results. For most species there has been little evidence of total or near-total displacement from constructed offshore wind farms (e.g. Krijgsveld *et al.*, 2011). For some species, such as auks, the reported levels of displacement have been variable.

8.81. The period of time and constancy that individuals within a population may be subject to displacement impacts is uncertain. It is likely that the impacts will be felt at greatest intensity during the first year of exposure, before there is any opportunity for habituation. Mortality is likely to be greatest in this year while in subsequent years it is possible that birds may become habituated to a certain extent, thereby reducing mortality rates.

8.82. If this is the case then absolute mortality may be lower in subsequent years because the population reaches equilibrium as the result of previous loss of habitat available for foraging. In the long-term the impact is potentially more likely to result in a decrease in productivity rather than an additive annual mortality that has been predicted here, and so these predicted values of annual mortality should not be summed to make total mortality across the lifespan of the Development.

8.83. Disturbance by operating wind turbines can exclude birds from suitable breeding, roosting, and feeding habitats around a larger area than otherwise would occur through direct habitat loss (Exo *et al.*, 2003; Petersen *et al.*, 2006; Maclean *et al.*, 2009). Although some species show little avoidance, others such as divers, auks and pelagic birds may not fly or forage within hundreds of metres of the turbines (Kerlinger and Curry, 2002).

8.84. Comparatively, some gull species, cormorant and terns have generally shown little avoidance to wind farms and for instance were seen regularly foraging within the Egmond aan Zee offshore wind farm (Krijgsveld *et al.*, 2010; 2011). Post-construction surveys at Ormonde Offshore Wind Farm in the north-east Irish Sea inferred an 'attractive' effect of the turbines on kittiwake as abundance was significantly higher compared to control areas (CMACS, 2014). Displacement effects are therefore likely to be minimal on these species.

8.85. A study at Tuno Knob, in Denmark, reported effects on nocturnal flights of eiders out to 1,500 m from turbines (Tulp *et al.*, 1999). Conversely, other studies at operational wind farms have not observed significant impacts on the abundance or distribution of local seabirds (Leopold *et al.*, 2010; Barrow Offshore Wind Ltd., 2009). With the exception of red-throated diver, monitoring at Kentish Flats also reported no avoidance behaviour (Percival, 2009; 2010). It has been postulated that other natural environmental variables were the driver for any observed effects, as well as the influence of fishing vessels on some species (particularly gulls) (e.g. Leopold *et al.*, 2011).

8.86. In general, migrants appear to be more obviously displaced than local resident birds, likely due to the lack of habituation of birds passing briefly through the area (Petersen *et al.*, 2004; Petersen, 2005). Habituation is likely to occur for some species once turbines are operational and human activity is reduced. A study conducted at Blyth Harbour in Northumberland showed that eiders and other birds did habituate to the turbines so that impacts were not considered significant (Lowther, 2000). Seaducks initially avoided the Horns Rev Offshore Wind Farm, but later assembled between turbines, possibly after successful recruitment of benthic prey (Petersen and Fox, 2007).

Spatial Scales

8.87. For all species included in the displacement analysis a 2km buffer around either Project Alpha, Project Bravo or Project Alpha and Project Bravo combined was used with no gradient of displacement impact applied to the buffer zone. This concurs with JNCC *et al.* (2017) interim guidance which recommends that for all the species included in the displacement analysis, a 2km buffer should be used when assessing displacement. JNCC *et al.* (2017) recommend that no gradient of impact of displacement level should be applied to the buffer zone, as there is not sufficient evidence to underpin any such gradient application on a species-by-species basis. This is a precautionary approach that does not represent the reality that some degree of gradient will occur in respect to how close individual birds will approach a source of disturbance influenced by, for example, past exposure to the event (habituation), need to feed chicks and ability to forage as successfully elsewhere.

8.88. A significant degree of precaution is built into the assessment of displacement effects. The JNCC *et al.* (2017) interim guidance underpins the process followed. The assessment applies the mean peak number of birds recorded either Project Alpha, Project Bravo or Project Alpha and Project Bravo combined plus 2km buffers during appropriate seasons defined for each species assessed. Populations (for guillemot, razorbill, puffin and kittiwake) used in the assessment of displacement are identified in Appendix 8A (Ornithology Technical Report).

8.89. The mean peak number (i.e. the mean of the highest population estimates within a particular season) is considered sufficiently precautionary for the realistic worst case. It is considered likely that displacement responses by seabirds are highly likely to decline the greater the distance from the disturbance source. A notable example of this was recorded for red-throated divers at Kentish Flats Offshore Wind Farm (Percival, 2010). However, in general, species specific information is lacking on geographically defined displacement rates and therefore on a precautionary basis a consistent displacement rate (or range of displacement rates) is applied through the Project Alpha, Project Bravo or Project Alpha and Project Bravo combined plus 2km buffers. This, therefore, means that assessments of displacement effects are associated with a significant degree of in-built precaution.

Displacement Rates

8.90. The potential impact of displacement will vary depending on the season. Breeding seabirds are 'central place foragers', with the need to optimise their time spent away from the nest and energy expended in foraging. The range at which they can forage away from the nest site becomes constrained by distance from their nesting site, unlike birds that are not actively breeding, irrespective of season that can forage more widely. Consequently, any displacement during the breeding season of breeding adults from foraging areas is predicted to have a greater magnitude of impact than at other times as birds may struggle to meet their energy requirements.

8.91. JNCC *et al.* (2017) indicates that SNCBs intend to use 'Disturbance Susceptibility' scores from Bradbury *et al.* (2014) (which have in fact been updated by Wade *et al.* [2016]) as a general guide to the appropriate displacement levels to apply for a species. JNCC *et al.* (2017) suggests that displacement rates of 90 to 100% should be used for species with a very high vulnerability (score of 5 in Bradbury *et al.*, 2014), 30 to 70% should be used for species with a high to moderate vulnerability (score of 3 in Bradbury *et al.*, 2014) and 10% should be used for species with a low vulnerability (score of 1 in Bradbury *et al.*, 2014). In addition, where possible, attempts have been made to refine these rates using available published evidence. This has been brought together and summarised in the following section.

8.92. Although concentrating on birds in flight, the study of the operational Egmond aan Zee wind farm by Krijgsveld *et al.* (2011) represents one of the most in-depth studies to date on determining the effect of the presence of operational turbines on birds. Based on radar and panorama scans, macro-avoidance rates (i.e. birds avoiding the wind farm as a whole) were assessed for the majority of species groups present, and this behaviour is likely to be indicative of displacement risks. Gulls were the main species present, and although in the cases of auks and divers too few observations were available to obtain a reliable macro-avoidance rate, from flight paths it was evident that their avoidance behaviour was similar to that of gannets and scoters, rather than that of gulls.

8.93. Construction period records from the Lincs Offshore Wind Farm showed that at least 769 birds (198 observations) including large gulls, kittiwake and terns used turbine bases and monopiles to rest on. On several occasions gulls were clearly associated with the jack-up barge, the guard vessels and with the construction vessel while piling was in progress (RPS, 2012). Similarly, Vanermen *et al.* (2013) in their study of Belgian offshore wind farms, noted that birds (mainly gulls) were attracted to physical structures e.g. turbines, as roost locations and did not show any signs of displacement. Construction disturbance to these species is therefore considered likely to be minimal.

Auks

8.94. Guillemot and razorbill are considered to have a high vulnerability to displacement from offshore wind farms, being assigned a score of 4 (out of 5) by Wade *et al.* (2016). Puffin is assigned a score of 3 and considered to be moderately vulnerable to displacement. JNCC *et al.* (2017) suggests that a 30 to 70% displacement rate range would be assumed for species with moderate or high vulnerability.

8.95. Krijgsveld *et al.* (2011) identified auks as higher sensitivity species to displacement calculating a macro-avoidance rate of 68%; however, this was only relatively close to turbines (within 500 m). Dierschke and Garthe (2006) present evidence that also suggests guillemot and razorbill have a relatively high sensitivity to displacement from offshore wind farms. Danish studies at Horns Rev, whilst showing considerable variability, also suggest this, noting total absence from the wind farm footprint following construction (Petersen *et al.*, 2006).

8.96. Studies undertaken at Dutch wind farms have reported displacement effects of less than 50% (Leopold *et al*. 2011). Leopold *et al.* (2010) found that at Egmond aan Zee, auks enter the wind farm area by swimming, and both species were regularly foraging within the site. However, a number of more recent studies have not shown a similar level of impact. Arklow Bank Offshore Wind Farm did not find any significant difference in the number of guillemots present pre- and post-construction with an increase in the abundance of razorbill suggesting no impact due to the presence of turbines (Barton *et al.*, 2009). Post construction monitoring at North Hoyle Offshore Wind Farm indicated an increase of up to 55% in the number of guillemots present compared to before the wind farm was constructed (nPower, 2008).

8.97. The abundance of razorbill at the Robin Rigg offshore wind farm was not significantly affected by the development phase of the wind farm, although densities of razorbill on the sea did increase within the wind farm area between the pre-construction and operational phases (Nelson *et al.* 2014). The abundance of guillemot at the same wind farm was significantly affected by the development phase of the wind farm, increasing between pre-construction and operation.

8.98. The abundance of guillemot at the Thortonbank offshore wind farm was shown to have decreased once the wind farm was operational (69% in the wind farm plus 500 m buffer area) with these decreases significant within the wind farm plus 500 m buffer area. Although decreases were also noted in the buffer area (500 m to 3 km) these were not significant. The abundance of razorbill decreased within the wind farm area but increased in the surrounding buffer. When these two areas were combined there was no apparent effect on the abundance of razorbill due to the presence of the wind farm (Vanerman *et al.*, 2017). Similar results were found at the Alpha Ventus offshore wind farm with the abundance of guillemot significantly lower after the construction of the wind farm (Mendel *et al.*, 2014). At Blighbank offshore wind farm both guillemot and razorbill appeared to avoid the wind farm area with decreases of 75% and 67%, respectively however, decreases were lower (and not significant) in the buffer area (49 and 32%, respectively) (Vanerman *et al.*, 2016).

8.99. It is important to note that some of the high displacement rates reported in the studies summarised in here apply to the wind farm alone whereas the displacement analyses for the optimised Seagreen Project calculate the number of birds displaced from the relevant wind farm area plus a 2km buffer. A number of studies found no significant effect on the number of birds present in buffer areas around wind farms and therefore displacement rates from those studies that considered the wind farm only are likely to be overestimates.

8.100. Monitoring studies have often recorded auks inside of wind farm areas and on the basis of the above information, a displacement value of 50% has been used for guillemots based on the conclusions of Vanerman *et al.*, (2016; 2017) and Nelson *et al.*, (2014), in particular. This is presented in addition to a 60% rate advised on all auk species for Forth and Tay projects by Marine Scotland (e.g. Scoping Opinion for Seagreen Offshore Wind Farm, 2017).

8.101. Based on the studies summarized above, razorbill appears to have a lower vulnerability to displacement impacts than guillemot, especially when considering the results obtained at Thortonbank (Vanerman *et al.* 2017), Blighbank (Vanerman *et al.*, 2016) and Robin Rigg (Nelson *et al.* 2014) which show lower displacement rates than those calculated for guillemot. As such, a displacement rate of 40% is considered appropriate for razorbill. This is presented in addition to a 60% rate advised on all auk species for Forth and Tay projects by Marine Scotland (e.g. Scoping Opinion for Seagreen Offshore Wind Farm, 2017).

8.102. There have been few studies which have included puffin as a separate species to assess displacement rates, with the majority combining all auks together. For assessment purposes, a displacement value of 50% from the Project Alpha and Project Bravo areas plus 2km buffer during the breeding and non-breeding seasons is considered appropriate for puffin, based on the rationale described for razorbill, but with an added degree of precaution due to a lower level of empirical evidence. This is again presented in addition to a 60% rate advised on all auk species for Forth and Tay projects by Marine Scotland (e.g. Scoping Opinion for Seagreen Offshore Wind Farm, 2017).

Kittiwake

8.103. There was no impact on the distribution of gulls (including kittiwake) arising from the construction of the Egmond aan Zee Offshore Wind Farm (Leopold *et al*, 2011). At Robin Rigg, the number of kittiwakes on the sea decreased within the Robin Rigg OWF during the construction phase, although this reduction was not statistically significant (Walls *et al.*, 2013a, 2013b). During operation, modelled kittiwake abundance across the Robin Rigg study area was largest within and immediately east and west of the Robin Rigg OWF, providing clear evidence that kittiwakes sitting on the sea had not been displaced from the Robin Rigg OWF during operation. However, results from Alpha Ventus indicated that kittiwakes were displaced (Mendel *et al.*, 2014).

8.104. A 30% rate advised for kittiwake for Forth and Tay projects by Marine Scotland (e.g. Scoping Opinion for Seagreen Offshore Wind Farm, 2017) and this is taken as being a precautionary guiding rate for this assessment.

Mortality Rates

8.105. There are no directly appropriate studies of the effects of displacement on mortality of seabirds. It is however reasonable to consider as overly precautionary, the assumption of 100% of displaced birds will die. It follows that the density of birds within areas to which birds are displaced will increase as a result of the relocation of the displaced birds to where others may already be occupying. There is the possibility that there will be additional mortality experienced by these birds due to increased resource competition and that this “additional mortality” will be a function of density, i.e. the mortality rate increases as density increases.

8.106. There is little or no evidence on what the extent of mortality may be, although a typical ceiling of under 10% is often applied by advisers. Rates advised by Marine Scotland (e.g. Scoping Opinion for Seagreen Offshore Wind Farm, 2017) include the following which are followed for the purposes of this assessment:

- Guillemot and razorbill: 1% mortality rate due to displacement; and
- Puffin and kittiwake: 2% mortality rate due to displacement.

8.107. The mortality rate varies between species, with actual assigned values dependent on that species’ known behaviour (e.g. habitat and foraging flexibility as defined in Wade *et al.*, 2016). These rates are considered suitably precautionary for EIA requirements, although the matrices presented show rates of up to 100% for both displacement and mortality as recommended in interim guidance (JNCC *et al.*, 2017).

Population Consequences of Displacement/Barrier Effects

8.108. Searle *et al.* (2014) developed a model ('CEH displacement model') to estimate the population consequences of displacement/barrier effects from proposed offshore wind energy developments for key species of seabirds breeding at SPAs in proximity to proposed Forth/Tay offshore wind farm developments. For each of five species (gannet, puffin, razorbill, guillemot and kittiwake), bird densities were estimated from filtered GPS tracking data using a binomial generalized additive model (GAM). The GAMs provided an estimate of the predicted bird density for each species-by-SPA combination, which was then used to select daily foraging locations for each bird in the simulation. Impacts of displacement on population size were considered operating via two main processes: reduced survival of offspring during the breeding season, and reduced body mass of adults leading to lower survival in the following winter.

8.109. The CEH displacement model assumed a 60% displacement rate for auk species and gannet, and 40% for kittiwake. It provided outputs for two types of assumed prey distribution in the absence of direct empirical data:

- A 'homogeneous' (even) distribution of prey across the region; and
- A heterogeneous (variable) prey distribution derived from bird GPS tracking data.

8.110. These represent two extreme scenarios, from which the modelled outputs encompasses the range of possible displacement/barrier effects.

8.111. Though Searle *et al.* (2014) were unable to undertake a full quantitative assessment of uncertainty; qualitatively the indications were that the uncertainty in the magnitude of the wind farm effect is likely to be large. Many parameters used in the CEH displacement model were unknown, poorly estimated or estimated away from the study area (Searle *et al.* 2014). It was therefore recommended that the outputs from the modelling should be "interpreted with considerable caution". (Searle *et al.* 2014) An important step towards reducing the uncertainty of the outputs would be parameterisation of the model with local data, in particular prey distribution, behaviour of seabirds in response to wind farms (including habituation) and influence of adult body mass change on subsequent survival.

8.112. The CEH displacement model's outputs addressed the cumulative development scenario of all four Forth and Tay wind farms (Project Alpha, Project Bravo, Neart na Gaoithe and Inch Cape) in combination as well as each individual wind farm in isolation (provided for all species, excepting gannet). Whilst the output of the CEH displacement model does not provide for quantification of displacement/barrier effect at Seagreen, the findings of this study do provide the current assessment with some context as to the scale of possible displacement/barrier effects upon a species alongside the mortality estimates of the SNCB displacement guidance (2017).

At-Sea Turnover of Breeding Seabirds

8.113. Searle *et al.* (2015) reviewed the 'turnover' of individual seabirds at sea during the breeding season and assessed how this may lead population estimates derived from boat or aerial surveys to underestimate the total number of birds that use an area during the course of the breeding season. In this context, turnover was defined as the total number of birds that will use a particular area of sea at any point during the breeding season, divided by the number of birds that will be present in that area at a particular snapshot in time.

8.114. Searle *et al.* (2015) estimated turnover using modelled foraging densities of the Forth-Tay area derived from GPS tracking data (as generated by Searle *et al.*, 2014 for the CEH displacement model) to simulate the daily foraging locations of individual birds on individual days throughout the breeding season. By assuming that birds rest at their foraging locations, and fly in a straight line between the colony and foraging location, these simulations were used to evaluate the locations that are associated with foraging, commuting and resting at sea. Empirical data on the daily activity budget of birds was used for simulating the number of birds that would be seen performing each behaviour (foraging, commuting and resting at sea) within each wind farm footprint during a "snapshot" survey of the entire footprint area. This enabled for four species (kittiwake, guillemot, razorbill and puffin) in the Forth-Tay region, a direct estimate of turnover to be quantified for site fidelity at a range of spatial scales and levels (i.e. no fidelity to complete fidelity). What this Marine Scotland commissioned study has not enabled is the provision of specific estimates of turnover at a given location until further data on both the level and spatial scale of site fidelity of these species become available. The findings therefore provide a guide to describing how the level of turnover changes with site fidelity behaviours and patterns, and with the spatial scale of wind farm footprints. Quantifying the fate of birds that lie within the development footprint is a related but separate task that was outside of the study's remit.

Collision Risk Analysis

8.115. Collision risk modelling was undertaken to quantify the potential risk of additional mortality through collisions with operational turbines above the current baseline mortality for each species. Although it is evident that there are a number of areas of uncertainty relative to estimating collision risk at offshore wind farms (e.g. natural variability in bird populations, assumptions made in relation to the geometry of turbines and bird shape, etc.), a quantitative impact assessment is presented in this chapter with this considered to be the most appropriate approach to inform assessment. The most frequently used collision risk model (CRM) in the UK is commonly referred to as 'the Band model'. This model was originally devised in 1995 and has since been subject to a number of iterations, most recently to facilitate application in the offshore environment (Band, 2011) and to allow for the use of flight height distribution data and to include a methodology for considering birds on migration (Band, 2012).

8.116. Masden (2015) presents an update to the Band (2012) which further develops the application of the Band model using a simulation modelling approach to incorporate variability and uncertainty. The update provides for an improved understanding of uncertainty by randomly sampling parameter values from distributions for each parameter, deriving average collision risk estimates with associated measures of variability. However, it has recently come to light through advice from SNH and MSS that further amendment of the Masden (2015) update of the collision risk model is required before they advise its use. These amendments are however expected to be included as part of ongoing work that aims to produce an improved stochastic collision risk model later in 2018. As a result, Masden (2015) has not been used to calculate collision risk estimates for Seagreen Offshore Wind Farm.

8.117. The Band (2012) model incorporates two approaches to calculating the risk of collision referred to as the 'Basic' and 'Extended' versions of the model. A key difference between these versions is the extent to which they account for the flight height distributions of seabirds (Band, 2012). The distribution of seabird flights above the sea is generally strongly skewed towards lower altitudes. As stated by Band (2012) there are three consequences of a skewed flight height distribution:

- the proportion of birds flying at risk height decreases as the height of the rotor is increased;
- more birds miss the rotor, where flights lie close to the bottom of the circle presented by the rotor; and
- the collision risk, for birds passing through the lower parts of a rotor, is less than the average collision risk for the whole rotor.

8.118. The Basic model assumes a uniform distribution of flights across the rotor with a consistent risk of collision across the whole rotor swept area. The Extended model of Band (2012) takes into account the distribution of birds in addition to the differential risk across the rotor swept area. It should be noted that the use of the basic model is precautionary as it does not take into account the variability in risk of collision that occurs across a rotor swept area, with the risk of collision decreasing as the distance from the hub of the turbine increases. If this were to be taken into account (as when using Option 3) it is likely that collision risk estimates would be lower as the vertical distribution of birds flying above the water is skewed towards lower heights (i.e. those associated with a lower risk of collision within a rotor swept area).

8.119. Within each version of the model there are further options. Options 1 and 2 being within the Basic version of the model and Options 3 and 4 utilising the Extended version. The key difference between these options relates to the use of flight height data. Options 2 and 3 use generic data from Johnston *et al.* (2014) whereas Options 1 and 4 use site-specific data derived from site-specific surveys.

8.120. The Band (2012) CRM requires monthly densities of each species assessed to be input. Appendix 8A (Ornithology Technical Report) presents the process by which appropriate densities for the optimised Seagreen Project have been selected to inform the CRM. In order to express the uncertainty associated with the collision risk estimates used in the assessment, modelling has been conducted incorporating upper and lower confidence intervals associated with flight height distributions.

8.121. The flight height data collected as part of site-specific boat-based surveys at Seagreen Offshore Wind Farm are detailed in Appendix 8A (Ornithology Technical Report). Data validated through laser rangefinders from the breeding season surveys in 2017 have been applied to Option 1 modelling through Band (2012).

8.122. As agreed with Marine Scotland and SNH (see Table 8.4), the collision risk outputs presented in Appendix 8B (Collision Risk Modelling) are corrected by a factor of 0.7853 to allow a direct comparison with CRM outputs other Forth and Tay projects. As detailed in Appendix 8A (Ornithology Technical Report), there is a clear difference between the 'radial snapshot' methodology in recording aerial densities of birds applied to the baseline boat-based surveys at Seagreen compared to the more widespread 'box method' applied elsewhere.

8.123. The worst case scenario for collision risk when using the Basic model of Band (2012) comprises up to 70 WTG at either Project Alpha or Project Bravo in isolation, or up to 120 WTG for the combined area of Project Alpha and Project Bravo. A turbine with maximum rotor diameter of 220m was assumed with a maximum blade width of 7.5m. Hub height was calculated based on an assumed air gap of 30.18 m at mean sea level (MSL), equivalent to 32.5m above lowest astronomical tide (LAT), an increase of 2.7m relative to specification used in the 2014 Appropriate Assessment conducted by Marine Scotland. Full details of the parameters and input data used for collision risk modelling are presented in Appendix 8B (Collision Risk Modelling).

8.124. Collision risk modelling was conducted for the following seabird species based on advice from Marine Scotland:

- Gannet;
- Kittiwake; and
- Herring gull.

8.125. Bird biometric parameters for each of these species is presented in Appendix 8B (Collision Risk Modelling).

8.126. The avoidance rates applied for each species are also presented in Appendix 8B (Collision Risk Modelling). The rates applied are in general, taken from Cook *et al.* (2014) which presents avoidance rates for all three species included in the modelling undertaken for this EIA Report. Cook *et al.* (2014) recommended avoidance rates for use with the Basic model for all three species and with the Extended model for herring gull. Cook *et al.* (2014) were unable to recommend an avoidance rate for use in the Extended model for gannet and kittiwake

8.127. In a joint response, UK SNCBs supported the recommended avoidance rates of Cook *et al.* (2014) with the exception of kittiwake (JNCC *et al.*, 2014). The SNCBs did not agree with the application of avoidance rates calculated for the 'small gull' category used in Cook *et al.* (2014) for kittiwake and recommended that the avoidance rate calculated for the 'all gull' category (98.9%) should be applied instead. Collision risk modelling for this EIA Report is presented at a range of avoidance rates; it is however therefore focussed on the avoidance rates presented in Table 8.7 taking into account the recommendations in JNCC *et al.* (2014) and the scoping opinion (Marine Scotland, 2017).

Table 8.7 Avoidance rates applied in collision risk modelling for regularly occurring seabirds

Band (2012) model	Gannet	Kittiwake	Herring gull
Basic	98.9 (±0.2)	98.9 (±0.2)	99.5 (±0.1)
Extended	-	-	99.0 (±0.2)

8.128. Outputs from the collision risk modelling undertaken for the four regularly occurring seabird species are presented in Appendix 8B (Collision Risk Modelling).

8.129. It was advised by Marine Scotland that for non-seabird migratory interests on the 'long-list', information presented in Marine Scotland's strategic collision risk assessment can be utilised[2]. No additional work is deemed to be required in this regard and the strategic assessment (WWT, 2014) provides an overall estimate of collision risk that Scottish offshore wind farms may present to birds on migration.

8.130. The report concludes that birds on migration through Scottish waters are not considered to be at risk of significant levels of additional mortality, due to collisions with Scottish offshore wind farms. Possible exceptions are large gulls, cormorant and common tern. Marine Scotland concluded that there is sufficient "flex" in the report to indicate that any potential impacts from Seagreen lie well within the level of strategic collision risk that have

[2] http://www.gov.scot/Resource/0046/00461026.pdf

been advised for migratory (non-seabird) interests. Since the time of the report, a number of the wind farms included for assessment have now been withdrawn, and the design envelopes for consented schemes have been substantially refined reducing the levels of predicted collision risk. No collision risk modelling has therefore been undertaken for species that are only likely to occur at the optimised Seagreen Project on migration (e.g. skua or tern species).

Assumptions and Precaution in Collision Risk Modelling Parameters

8.131. To quantify bird collision risk, collision risk models such as 'the Band model' (Band 2012) used in the current assessment, use technical specifications of the turbines, bird morphological and behavioural parameters together with site-specific bird data e.g. densities. Models are often finally corrected to take account of behavioural responses of birds to the presence of wind farms and the turbines within, by multiplying the model's outcome with a correction factor that takes into account, among other things, avoidance (action taken by a bird, when close to an operational wind farm, which prevents collision), termed the "avoidance rate".

8.132. It is acknowledged that there is considerable uncertainty surrounding the estimates provided by collision risk models, including that from the Band model (Masden 2015, Skov *et al.* 2018). Any model is only as good as its assumptions and the parameter values used. As more data become available, for example, through radar or tracking studies, effort will be required to refine the models in order to more accurately account for bird movement and behaviour.

8.133. In addition to the uncertainty associated with the collision risk models, it is frequently the case that projects when constructed do not reflect the worst case scenario assessed. In many cases, the as-built scenario will represent a significantly lower impact resulting from predicted collisions than that assessed as the worst case scenario for the purpose of obtaining a consent. When these reduction in predicted collision mortality due to design changes are summed across wind farms, as is required for cumulative impact assessment (CIA), the reduction in predicted mortality can become substantial.

8.134. The recent publication of the ORJIP Bird Collision Avoidance study (Skov *et al.* 2018) provides important and enhanced input for some of the required data used in the Band model, including species-specific data on flight speeds, empirical evidence on nocturnal activity and the best available empirical information to account for avoidance behaviour in seabirds which can be readily applied in CRM. The ORJIP Bird Collision Avoidance study was designed to improve the evidence base for seabird avoidance behaviour and collisions around offshore wind farms. This study generated the most extensive dataset of observations of seabird behaviour in and around an operational offshore wind farm (Thanet Offshore Wind Farm, off the Kent coast) that is currently available. A bird monitoring system was developed for the study that allowed detecting and tracking bird movements at the species level in and around an operational offshore wind farm. Bird behaviour was monitored by deploying a multiple sensor monitoring system partly operated by experienced seabird observers (laser rangefinders and radar equipment), and partly automated through the collection of video evidence, with a focus on five target species: gannet, kittiwake and three species of large gulls (lesser black-backed gull, herring gull, great black-backed gull).

8.135. This section considers these existing opportunities to refine the CRM in order to more accurately account for bird movement and behaviour. Moreover MacArthur Green (2017) calculated collision mortality based on actual wind farm design details and highlighted the ornithological 'headroom' that exists–the difference between the two worst case predictions for consenting purposes and predictions based on final wind farm design. This additional existing opportunity to update CRM parameters by means of reviewing consented and as-built scenarios, is given further consideration in paragraphs 8.640 to 8.643.

Bird Flight Speed

8.136. The ORJIP BCA study has generated the most extensive dataset of observations of seabird behaviour in and around an operational offshore wind farm that is currently available. This includes species-specific data on flight speed that can inform the estimation of a more realistic flux of birds. The Band model makes use of bird speed twice: firstly in order to estimate the flux rate of birds through the wind farm and; secondly to estimate the probability of a bird colliding with a turbine rotor (Skov *et al.* 2018). The Band CRM assumes flight speeds through the wind farm as linear flight patterns. However, the empirical flight speeds obtained by Skov *et al.* (2018) and other studies clearly indicate that seabirds typically perform non-linear movements within a wind farm. Moreover bird flight speeds are highly variable (Thaxter *et al.* 2011) depending on environmental factors, notably wind direction. The duration of a long, convoluted track is also different than the duration of a straight track. The consequence of this is that the flux of birds through the wind farm is likely to be lower than assumed by the Band CRM, which would result in a lower predicted collision rate.

8.137. At present, flight speed data for use in CRM relies on published data (Pennycuick 1997; Alerstam *et al.* 2007) based on very small sample sizes ranging from 32 (gannet) down to 2 (kittiwake). On the other hand, the laser rangefinder track data recorded by Skov *et al.* (2018) offers species-specific empirical data on flight speeds from large numbers of individuals (e.g. 683 gannet and 287 kittiwake), albeit in non-adverse weather conditions. As such, those data are a valuable source of information on more realistic mean flight speeds and associated variability in offshore wind farms necessary for improving estimates of the flux of birds for the species in question.

8.138. Table 8.8 provides a comparison between the species-specific mean flight speeds often used in CRM and those recorded by Skov *et al.* (2018). For the Alerstam *et al.*, (2007) data the total track time for the two radar recordings of kittiwake was 660 seconds. Furthermore, the flight speed data for all four gull species (kittiwake, lesser black-backed gull, great black-backed gull and herring gull) was restricted to radar recordings from migration flight which are expected to be birds flying at an airspeed close to that associated with maximum lift-drag ratio (Alerstam *et al.* 2007). This would imply that the very small sample sizes of flight speed data used at present in CRM are not necessarily behaviourally representative of bird flight at sea. Indeed the flight speeds recorded by Skov *et al.* (2018) were markedly lower than the generic speeds typically recommended in guidance (Alerstam *et al.* 2007).

8.139. Table 14 in Appendix 8B (Collision Risk Modelling) presents, for gannet and kittiwake, the effects of applying the flight speed values from Skov *et al.* (2018) to the collision risk modelling for Seagreen. The decrease in flight speed estimates used in the model for kittiwake could equate to a ~19% reduction in collision estimates. In contrast, the reduction for gannet was less dramatic with the result being around a 6% decrease in collision estimates.

Table 8.8 Species-specific mean flight speeds (m/s) often used in CRM, and those measured from single rangefinder segments recorded at Thanet (Skov *et al.*, (2018) data: SD is shown in brackets).

Species	Commonly applied in CRM	Estimated by the Skov *et al.*, (2018)
Gannet	14.9* (n = 32)	13.33 (4.24) [n=683]
Kittiwake	13.1** (n = 2)	8.71 (3.16) [n= 287]
Herring gull	12.8** (n =18)	9.80 (3.63)*** [n=790]

* Pennycuick (1997)

**Alerstram *et al.* (2007)

***Estimated with data for all large gulls combined

Avoidance Rates

8.140. Species-specific generic avoidance rates currently used are mostly based on mortality rates observed at onshore wind farms with no consideration of actual avoidance behaviour.

8.141. The study by Skov *et al.* (2018) concluded that bird avoidance behaviour is likely to lead to a greater reduction in estimated collision rates than current correction factors (avoidance rates) applied to CRM assume. The differences between avoidance rates and empirical avoidance rates (EAR) as quantified by Skov *et al.* (2018), are mainly driven by the fact that the former have been developed from land-based studies using the Band CRM to fit the observed number of collisions from carcass surveys while assuming flight speeds through the wind farm as linear flight patterns. The Skov *et al.* (2018) empirical avoidance rates are considered the best available empirical information to account for avoidance behaviour. This provides a compelling basis for using higher avoidance rates, for these species, than are currently advised for use in collision risk assessment in the UK. Those rates should be closer to those indicated by the EARs derived in this study.

8.142. The empirical avoidance rates quantified by Skov *et al.* (2018) are considered applicable in the basic and extended version of the Band model (Band 2012); the latter taking more account of the flight height distribution of birds and the differential risk to those birds across the rotor-swept zone. Thus, provided that empirically derived input parameters are applied on flight speed in offshore wind farms and flight height outside offshore wind farms (to identify the proportion of birds at risk flying at rotor-swept zone height), Skov *et al.* (2018) advise that the empirical avoidance rates can be readily used in the Band model. The empirical avoidance rates are provided below with standard deviation below calculated so as to reflect both variability and uncertainty.

- Gannet: 0.999 ± 0.003 SD
- Kittiwake: 0.998 ± 0.006 SD
- Herring gull: 0.999 ± 0.005 SD

Nocturnal Flight Activity

8.143. There is considerable uncertainty about levels of bird flight activity by night and in consequence the nocturnal activity factors to be used in collision risk modelling. Studies had only managed to capture very small sample sizes (Desholm 2005) prior to the study of Skov *et al.* (2018). The thermal video data collected by Skov *et al.* (2018) provide an unprecedented body of evidence on nocturnal flight activity by seabirds in an offshore wind farm, indicating very low activity during hours of darkness throughout the annual cycle. Based on the thermal videos processed, there is an indication that nocturnal flight activity may only constitute a negligible proportion (i.e. < 5%) of total flight activity of the species studied (gannet, kittiwake and herring gull).

8.144. Against this background, Appendix 8B (Collision Risk Modelling) presents an analysis of the potential change in collision risk estimates as a result of updating the nocturnal activity factors used in collision risk modelling at previously consented projects.

Significance Criteria

8.145. The criteria for determining the significance of impacts is a two stage process that involves defining the sensitivity of the receptors and the magnitude of the impact. This section describes the criteria applied in this chapter to assign values to the sensitivity of receptors and the magnitude of potential impacts.

8.146. The terms used to define sensitivity and magnitude are based on those described in further detail in Chapter 6 (EIA Process) of this EIA Report. These criteria have been adapted in order to implement a specific methodology for offshore ornithology. The general principle of determining impact significance from levels of sensitivity of the receptors and magnitude of impact is however consistent with IEMA (2004). In this respect, the methodology used also follows the approach outlined by CIEEM (2010) and CIEEM (in prep.). The Sensitivity Criteria used within this assessment are set out in Table 8.9.

Table 8.9 Sensitivity criteria

Sensitivity	Criteria*
High	A receptor with a very limited ability to resist (or tolerate) a pressure and recover from any impacts induced by the pressure (resilience).
Medium	A receptor with a limited ability to resist (or tolerate) a pressure and recover from any impacts induced by the pressure (resilience).
Low	A receptor with some ability to resist (or tolerate) a pressure and recover from any impacts induced by the pressure (resilience).
Negligible	A receptor which generally resists (or tolerates) a pressure and recovers from any impacts induced by the pressure (resilience).

* Based on sensitivity as defined by Pérez-Domínguez *et al.*, 2016.

8.147. For each impact considered (e.g. habitat loss, disturbance, collision risk), species' sensitivity also takes into consideration how vulnerable a species is to that impact, for example how flexible the species is in its habitat use or susceptibility to disturbance, based on classification by Wade *et al.* (2016). Where species or impacts are not covered by Wade *et al.*, (2016) other key literary sources on the impacts of offshore wind developments on birds are referred to (i.e. Langston, 2010; Maclean *et al.*, 2009; Garthe & Hüppop, 2004). In general, species are determined to be of low, medium or high vulnerability, based on their particular characteristics or requirements, relative to other seabird species.

8.148. The assessment of ornithological recoverability considers the ability of species' populations to return to their former status once background conditions return (i.e. when the effects of a particular impact cease, e.g. upon completion of the construction phase, or as birds habituate to an impact). It is thus important to evaluate the nature of the impact in terms of the duration required for recoverability, which is a factor of a species' natural productivity rate and background population trend in the absence of the impact.

8.149. Species with the potential to produce many young per year are considered to be able to recover more rapidly and hence to be at less risk than species that produce fewer young per year. This was determined using information on clutch size (average clutch size and maximum clutch size) and age at first breeding (as per Williams *et al.*, 1995 and Robinson, 2017). Species such as gannet and guillemot that lay only one egg each year and do not breed until they are several years old have the lowest recoverability.

8.150. A population of a species is typically defined by a geographic frame of reference and a species may be assigned to more than one population within its annual lifecycle. For example, a species may belong to a regional population in the breeding season and a national or flyway (international) population outside of the breeding season. The second factor for recoverability is the status of a species' population within a defined period of time, i.e. whether the population is increasing, stable or declining.

8.151. Regional breeding status has been determined by comparing the trend in the populations of breeding colonies within mean maximum foraging range of the optimised Seagreen Project, between the Seabird 2000 survey results in Mitchell *et al.* (2004) and the most recent counts produced in JNCC's SMP database (JNCC 2017b). Status of migratory/wintering populations has been determined at a broader national scale for each species, based on trends presented by JNCC (http://jncc.defra.gov.uk/page-1419).

8.152. Using these trends, the recoverability of a population can be determined. It was considered that a significantly increasing population (>25% increase) has a high recoverability, with a stable population (<25% change) rated medium, and a declining population (>25% decrease) rated as having a low recoverability (excluding differences in reproductive rate). In exceptional circumstances where the species' population would be at risk of extinction, there may be no ability for recovery.

8.153. Evaluation of the sensitivity of a species can therefore be assessed in relation to its conservation value over a range of geographical scales, its vulnerability to a particular impact, and recoverability based on population status and reproduction rate. Combined, this information can be used to determine each species' overall sensitivity to a particular impact using the definitions in Table 8.9. A summary of the overall sensitivity of the ornithological receptors considered for the optimised Seagreen Project is presented in Table 8.10.

8.154. Table 8.11 presents a summary of species selected for assessment for all individual impacts considered in this chapter.

Table 8.10 Information used to determine overall impact sensitivity of species assessed, based on indications of conservation value, vulnerability and recoverability.

Species	Conservation value[A] (rationale)	Vulnerability (applicable across all phases of Seagreen)[B]					Factors potentially influencing recoverability					
		Collision	Displacement: Structures	Displacement : vessels and helicopter	Barrier Effects	Habitat/prey interactions	Clutch size and year of 1st breeding[C]	Mean-maximum foraging range (±1 SD) (km)[D]	Regional breeding population (individuals)	Regional trend (1986 to 2011)[H]	National trend (2000-16)[E]	Overall recoverability
Gannet	International (SPA)	High	High	Very low	Very low	Very low	1 egg/5 years	229.4(±124.3)	158,212	+33	+ 34%[G]	High
Puffin	International (SPA)	Very low	Moderate	Moderate	High	Moderate	1 egg/5 years	105.4 (± 46.0)	373,138	+13	n/a	Low
Razorbill	International (SPA)	Very low	High	Moderate	High	Moderate	1 egg/4 years	48.5 (± 35.0)	41,009	+13	+ 32%	Medium
Guillemot	International (SPA/non-breeding population importance)	Very low	High	Moderate	High	Moderate	1 egg/5 years	84.2 (± 50.1)	219,623	-24	+ 5%	Medium
Kittiwake	International (SPA)	High	Low	Low	Low	Low	2 eggs/4 years	60 (± 23.3)	77,664	-66%	- 44%	Low
Herring gull	International (SPA)	Very high	Low	Low	Low	Very low	3 eggs/4 years	61.1 (± 44)	35,658	-58%	n/a	Low

[A]*SPA = qualifying species of an SPA either within foraging range during the breeding season or on migratory route;*

[B]*taken from Wade et al. (2016), Bradbury et al. (2014), Langston (2010) or Maclean et al. (2009);*

[C]*taken from Robinson (2017);*

[D]*taken from Thaxter et al. (2012) unless otherwise stated;*

[E]*taken from JNCC (2016);*

[F]*Habitat/prey interactions is termed habitat flexibility by Wade et al. (2016).*

[G]*Change between censuses in 2003-04 and colonies surveyed in 2013-14 and 2015*

[H]*Scottish trend from SNH (2012) or for gannet, razorbill and puffin: Mitchell et al (2001). Razorbill has however shown somewhat of a decline since 2000.*

Table 8.11 Summary of species selected for assessment for all individual impacts considered in this chapter

Species	Conservation value (rationale)	Construction/ Decommissioning	Operation	
		Disturbance/displacement (vessels activity/construction activity)	Displacement/barrier effects	Collision
Gannet	International (European site interest feature)	×	×	✓
Puffin		✓	✓	×
Razorbill		✓	✓	×
Guillemot		✓	✓	×
Kittiwake		×	✓	✓
Herring gull		×	×	✓

8.155. The magnitude of a potential impact will depend upon whether the impact would cause a fundamental, material or detectable change. The factors taken into account when determining the magnitude of the impact are:

- Spatial extent;
- Duration of the impact: long (more than five years), medium (greater than one year and less than five years) or short term (less than one year);
- Frequency (whether the receptor is subject to the effect once, intermittently or continuously); and
- Reversibility (recovery from) upon cessation of the effect.

8.156. Where the predicted additional mortality of a species is equal to or greater than 1% of the baseline mortality further analysis with regards to the population consequences of the impact is undertaken. The further analysis includes assessment of sources of over estimation and PVA for species requiring this analysis (2017 Scoping Opinion).

8.157. These factors are combined to determine the scale of the change from baseline conditions ('Negligible' to 'high'), in relation to the conservation status of a particular feature (in this case a species' population size). The criteria for defining magnitude in this chapter are outlined in Table 8.12 below.

8.158. A significant impact (positive or negative) is defined as "an impact that is sufficiently important to require assessment and reporting so that the decision maker is adequately informed of the environmental consequences of permitting a project" (CIEEM, in prep.).

8.159. The matrix used to determine the significance of an impact combines the importance of the receptor with magnitude of impact (Table 8.13). The matrix produces significance scores ranging from negligible to major. For the purposes of this assessment, potential impacts identified as major or moderate are generally considered to be significant in EIA terms, while impacts identified as minor or negligible are generally considered to be not significant in EIA terms.

Table 8.12 Criteria Used to Define the Magnitude of Impacts

Magnitude	Criteria
High	Fundamental and permanent/irreversible changes to the sum of influences acting on the conservation status of the receptor concerned that may affect its abundance and distribution within a given geographical area.
Medium	Material and permanent/irreversible changes to the sum of influences acting on the conservation status of the receptor concerned that may affect its abundance and distribution within a given geographical area.
Low	Detectable and temporary (throughout project duration) change to the sum of influences acting on the conservation status of the receptor concerned that may affect its abundance and distribution within a given geographical area.
Negligible	Detectable and temporary (for part of the project duration) change, or barely discernible change for any length of time, to the sum of influences acting on the conservation status of the receptor concerned that may affect its abundance and distribution within a given geographical area.

Table 8.13 Criteria Used to Define the Significance of Impacts

Value/Sensitivity	Magnitude			
	High	Medium	Low	Negligible
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Minor	Negligible
Low	Moderate	Minor	Negligible	Negligible
Negligible	Minor	Negligible	Negligible	Negligible

Assessment Limitations and Uncertainty

8.160. It is not necessary to assess the potential impacts of a project against species that are "sufficiently widespread, unthreatened and resilient to project impacts and will remain viable and sustainable" (CIEEM, in prep.). Therefore this EIA, in accordance with the scoping opinion (Marine Scotland, 2017), is limited in scope to those specific species from specific breeding colonies and all other species where a potentially significant impact has previously been identified. It is considered that the species identified in the scoping opinion includes all the species that occur within the study area and that may be significantly impacted by a constructed and/or operational optimised Seagreen Project.

BASELINE CONDITIONS

8.161. The species considered in this EIA Report and the colonies from which they originate are:

- Buchan Ness to Collieston Coast SPA – guillemot, kittiwake and herring gull;
- Forth Islands SPA – gannet, kittiwake, herring gull, puffin, guillemot, razorbill;
- Fowlsheugh SPA – kittiwake, herring gull, guillemot, razorbill;
- Outer Firth of Forth and St Andrews Bay Complex pSPA – gannet, kittiwake, herring gull, puffin, guillemot, razorbill; and
- St Abb's Head to Fast Castle SPA – kittiwake, herring gull, guillemot and razorbill.

8.162. Similarly, in accordance with the 2017 Scoping Opinion, impacts considered in this EIA Report include:

- Displacement – gannet, guillemot, razorbill, puffin, kittiwake, herring gull, lesser black-backed gull and great black-backed gull;
- Barrier effect – puffin, guillemot, razorbill, kittiwake; and
- Collision risk – gannet, guillemot, razorbill, puffin, kittiwake, herring gull, lesser black-backed gull and great black-backed gull.

8.163. The current baseline conditions are presented below in respect of:

- The structure of each of the receptor population present at the relevant Project area (Project Alpha, Project Bravo and Project Alpha and Project Bravo combined);
- The importance of each receptor population present at the relevant Project area;
- The spatial distribution of each receptor across the relevant Project area;
- The usage of the relevant Project area by the receptors; and
- Flight height evidence for each receptor.

8.164. The sections below provide a summary of the baseline conditions for each receptor; full background is provided in Appendix 8A (Ornithology Technical Report).

8.165. The level of importance of populations utilising the relevant Project area varies between species and between years. A summary of the level of population importance attributed to each species is presented for Project Alpha (Table 8.14), Project Bravo (Table 8.15) and Project Alpha and Project Bravo combined (Table 8.16).

Table 8.14 Summary of Peak Counts and Population Importance for Project Alpha (blue shading = >1% regional population, yellow shading = >1% national population, orange shading = >1% international population)

Species	International population	National Population	Regional Population	Project Alpha peak count 2010 to 2011	Project Alpha peak count 2017
Gannet	1,500,000–1,800,000[A]	293,161[B]	158,212[C]	2,716	1,863
Kittiwake	15,700,000[D]	760,000	77,664[E]	4,510	12,132
Herring gull	2,060,000–2,430,000	280,000	35,658	121	34
Guillemot	2,350,000–3,060,000	1,420,000	219,623[F]	10,811	11,221
Razorbill	979,000–1,020,000	187,100	41,009[F]	2,102	6,142
Puffin	4,800,000–5,800.000	1,161,400	373,138	1,164	1,491

[A]BirdLife International 2015

[B]JNCC 2016

[C]SNH advice to Seagreen 2017

[D]Wetlands International 2016

[E]JNCC SMP Database

[F]Guillemot and Razorbill populations are converted from those provided In Appendix 8A (Ornithology Technical Report) from 'birds on land' to all breeding individuals using corrections factors in Mitchell *et al.* (2004)

Table 8.15 Summary of Peak Counts and Population Importance for Project Bravo (blue shading = >1% regional population, yellow shading = >1% national population, orange shading = >1% international population)

Species	International population	National Population	Regional Population	Project Bravo peak count 2010 to 2011	Project Bravo peak count 2017
Gannet	1,500,000–1,800,000	293,161	158,212	1,141	2,108
Kittiwake	15,700,000[A]	760,000	77,664[B]	2,813	3,655
Herring gull	2,060,000–2,430,000	280,000	35,658	163	38
Guillemot	2,350,000–3,060,000	1,420,000	219,623	10,567	12,536
Razorbill	979,000–1,020,000	187,100	41,009	1,279	6,065
Puffin	4,800,000–5,800.000	1,161,400	373,138	5,439	1,552

[A]Wetlands International 2016

[B]JNCC SMP Database

Table 8.16 Summary of Peak Counts and Population Importance for Projects Project Alpha and Project Bravo Combined (blue shading = >1% regional population, yellow shading = >1% national population, orange shading = >1% international population)

Species	International population	National Population	Regional Population	Peak Count 2010 to 2011	Peak Count 2017
Gannet	1,500,000–1,800,000	293,161	158,212	3,712	3,972
Kittiwake	15,700,000	760,000	77,664	16,485	15,549
Herring gull	2,060,000–2,430,000	280,000	35,658	218	36
Guillemot	2,350,000–3,060,000	1,420,000	219,623	18,514	23,418
Razorbill	979,000–1,020,000	187,100	41,009	2,820	11,933
Puffin	4,800,000–5,800.000	1,161,400	373,138	7,807	3,039

Gannet

8.166. Gannet has a mean maximum foraging range of 229.4 km, resulting in the combined Project Alpha and Project Bravo area falling within the foraging range of 158,212 breeding individuals (Table 16 in Appendix 8A [Ornithology Technical Report]) distributed between two colonies. Of these, the colony on Bass Rock within the Forth Islands SPA at 48.7km from the optimised Seagreen Project is of most relevance as it supports 75,259 breeding pairs and is now the largest colony in the world (Murray *et al.* 2015). Troup Head, incorporated within the Gamrie & Pennan Coast SSSI, supports a much lower population at a greater distance (>70 km). The Bass Rock colony thus accounts for 95.1% of birds breeding within the mean maximum foraging range from Project Alpha and Project Bravo, suggesting just 4.9% of breeding birds within the mean foraging range are not contained within a SPA population.

8.167. It should be noted that of the total number of birds recorded, a proportion of these can, where age class data exists, be assigned to immature or adult age classes. The proportion of adults present can then be assigned ('apportioned') to different breeding colonies. This apportioning is required as part of the Habitats Regulations Appraisal (Chapter 16) in order to assess the predicted impacts on breeding colonies within specific SPAs. The methodology of apportioning baseline data is described in Appendix 16B (Seabird Apportioning).

8.168. Gannets were present throughout the survey period, which covered three breeding seasons from incubation to the fledging period and two migration and winter periods. Peak population estimates were recorded in June in all sites; being 2,716 individuals in 2010 in Project Alpha and 2,180 in 2017 for Project Bravo. During the 2009 to 2011 surveys, population estimates within Project Bravo tended to be lower and less variable than those recorded in Project Alpha, but this trend was reversed in 2017 when numbers in Project Bravo were more variable and a higher peak population was observed. The peak population estimates in Project Alpha and Project Bravo combined were 3,712 and 3,874 in 2010 and 2017 respectively.

8.169. The breeding season peak density calculated within Project Alpha of 10.11 individuals km^2 accords closely with the range to >10 individuals km^2 presented by Camphuysen (2011) for the Firth of Forth. Peak densities of this magnitude are substantially higher than several other areas of importance in the North Sea such as North Shetland (1.8 individuals km^2) and West Orkney (1.5 individuals km^2) (Skov *et al.* 1995), but this is not unexpected given the proximity of the Bass Rock colony. The peak density of 6.81 individuals km^2 in Project Bravo was lower than that within Project Alpha during the breeding season, in keeping with its more offshore location. Through the winter period of October to February densities were greater in Project Bravo, whether or not the 2km buffer was considered.

8.170. Birds were typically encountered in groups commuting between Bass Rock and foraging grounds further offshore, rather than feeding or post-feeding aggregations of birds, although these did occur. Any use of Project Alpha and Project Bravo was thus primarily driven by variation in the encounter rate of large transiting flocks on surveys rather than any location specific habitat utilisation.

8.171. Plots derived from abundance in flight observed during the breeding season surveys conducted in 2010 and 2011 did not reveal any particular patterns of selection across Project Alpha or Project Bravo with a patchy distribution in both years at both sites.

8.172. In the 2009 to 2011 surveys, 88.6% of all gannets were aged in Project Alpha and Project Bravo combined. Where a single bird was observed the proportion aged increased to 92.6% but reduced to 88.6% when two birds were observed together and just 25% within flocks of 21 to 30 individuals. In 2017, a lower proportion of birds were aged (65.7%) as a result of the preponderance of birds within larger flocks.

8.173. Adults were the dominant age class recorded in all months, as to be expected from the fact that most gannets do not return to colonies until they are ready to commence breeding at 5 to 6 years of age (Wernham *et al.*, 2002). The proportion of adults encountered in the breeding season was similar in all sites and years. In 2009 to 2011 in Project Alpha alone, the proportion aged as adults in the breeding season (April to September) was 96.7% from the aged sample of n = 2,299. A similarly high proportion (97.8%) of Gannets were aged as adults in the sample of n = 1,895 in the breeding season in Project Bravo (Table 18 in Appendix 8A [Ornithology Technical Report]). In 2017, the proportions of adults were 97.4% (n = 695) in Project Alpha and 98.4% (n = 556) in Project Bravo.

8.174. The dominant flight direction of birds in all areas during the breeding season was southwest, with the proportion of records transiting on that bearing ranging from 40.3% in Project Bravo during 2009 to 2011 to 73.5% in Project Bravo during 2017. This suggests birds are returning to the Bass Rock colony from offshore foraging grounds to the northeast.

8.175. Observer estimated flight heights in 2017 ranged from >0-1m to >40-45 m, although the majority of birds were recorded flying close to the sea surface, with 84.8% (n = 1881) of birds recorded at <5m. Only 5.0% of birds were recorded at a height of >20m, with this being 2.2% (n = 945) in Project Alpha and 7.3% (n = 914) in Project Bravo. These proportions are lower than had been previously observed in 2009 to 2011, but show a similar difference between Project Alpha and Project Bravo.

Kittiwake

8.176. Within a mean maximum foraging range of 60km (Thaxter *et al.* 2012) from Project Alpha and Project Bravo, kittiwake is designated within two SPAs; Fowlsheugh (27.5 km) and the Forth Islands (48.7 km) and Whiting Ness to Ethie Haven SSSI (33.0 km); that is, a SSSI not covered by an SPA (Figure 26 in Appendix 8A [Ornithology Technical Report]). Eight further colonies fall within the mean foraging range but are currently undesignated.

8.177. Kittiwake was present in all boat-based surveys of Project Alpha and Project Bravo throughout 2009 to 2011 and 2017, although estimated numbers and densities fluctuated between surveys, seasons and years (Figure 28 and Table 21 in Appendix 8A [Ornithology Technical Report]). Nevertheless, the basic pattern is of an increase in late winter and early spring, consistent with kittiwakes returning to their nesting colonies as early as January, although March or April is more typical (Cramp *et al.* 1974). Variable numbers of birds then occurred in the different sites in the different years during the breeding season, albeit with clear peaks in different months. Following fledging, especially in August and the dispersal of adults from breeding colonies, the numbers of birds tended to decline, before a secondary peak in late autumn, coincident with the wider passage of birds presumably from a range of colonies.

8.178. In the 2010 and 2011 breeding seasons peak population estimates in both Project Alpha and Project Bravo tended to be recorded during chick provisioning in June, with peaks of 1,914 individuals in Project Alpha and 2,813 individuals in Project Bravo, both in 2011. In 2017, peak abundance in the breeding season occurred later in July and attained much higher levels than previously recorded with a peak estimate of 13,140 birds in Project Alpha and 3,656 in Project Bravo. At this time, kittiwakes were associated with large numbers of auks, apparently attracted by abundant prey resources, which in turn had also attracted numbers of marine mammals, particularly Common Minke Whales *Balaenoptera acutorostrata*. The combined total of 16,796 in July 2017 would suggest some 34% of all adults from colonies within foraging range were present, which seems exceptionally high especially considering that birds may have been spread over a wider area than just within Project Alpha in the vicinity of Scalp and Montrose Banks, compared to the Wee Bankie and Marr Bank complex further south. This raises the possibility of an influx of failed breeders from elsewhere, perhaps more northerly Scottish colonies (Appendix 8A [Ornithology Technical Report]).

8.179. Prior to the events in July 2017, peak population estimates in both Project Alpha and Project Bravo had been recorded in November 2011, with 4,511 and 2,554 individuals respectively. At this time, the origin of birds seems likely to be a considerable mixture from colonies around the North Sea, if not further afield.

8.180. Distribution maps derived from flying birds in all boat-based surveys during 2009 to 2011 showed widespread coverage at low abundance (1 to 5 flying birds km^2), interspersed by patches of high abundance (10 to 50 flying birds km^2) in the breeding season. In 2017, site utilisation tended to decrease with increasing distance offshore, which also corresponds with increasing distance from both colonies at Fowlsheugh and Forth Islands SPAs.

8.181. In total, 78.5% of all kittiwakes in Project Alpha and Project Bravo combined were aged during the 2009 to 2011 surveys, with this reducing to 40.2% in the 2017 breeding season surveys. The reduction was caused by an increase in the numbers of birds within large groups (mean group size of n = 21 where >5 birds were present), which reduced the proportion of birds that could be aged.

8.182. In Project Alpha and Project Bravo combined in 2017, kittiwakes were recorded by observers within all 5m bands up to a maximum of >45-50m, although only a single bird was assigned to this height band. Birds were most frequently observed flying within the >5-10m height band, accounting for 36.7% of records (Figure 33 in Appendix 8A [Ornithology Technical Report]). Only 10.5% of records were of birds flying at >20m, with this proportion falling to 5.2% at >25m and 2.4% at >30m. This compares with 10.7% and 15.7% at >20m for Project Alpha and Project Bravo respectively in 2009 to 2011.

Herring Gull

8.183. Herring gull has a mean maximum foraging range of 61.1km (Figure 37 in Appendix 8A [Ornithology Technical Report]), which includes the Forth Islands and Fowlsheugh SPAs and nine further non-designated colonies. In combination, these colonies encompass 28,778 breeding individuals within range of Project Alpha and Project Bravo (Table 24 in Appendix 8A [Ornithology Technical Report]). This rises to 35,658 individuals if St Abb's Head to Fast Castle (65.7 km) and Buchan Ness to Collieston Coast SPAs (71.7km), which are outside of the mean maximum range, are included according to the 2017 Scoping Opinion.

8.184. Herring gull was recorded in most surveys of Project Alpha and Project Bravo although it was intermittently absent in all phenological periods. Birds were however generally consistently more numerous in the winter months, following the migration of individuals of the *argentatus* race, especially those breeding in northern Europe, to overwinter in Scottish waters (Forrester *et al.* 2007).

8.185. Nevertheless, peak population estimates in Project Alpha and Project Bravo during 2009 to 2011 were observed in the breeding period in June, with 121 birds estimated in Project Alpha in 2010 and 163 birds estimated in Project Bravo in 2011. These peaks accord with the beginning of chick provisioning as chicks hatch from mid-June onwards following egg laying from mid-April after adults return to colonies in early March (Cramp *et al.* 1974). However, the proportion of adults was relatively low (e.g. 57% in Project Alpha in 2010) and small numbers of birds were observed relative to the size of local breeding populations, suggesting that few locally breeding adults were actually foraging as far offshore as Project Alpha and Project Bravo.

8.186. Similarly, low numbers were recorded in the breeding season surveys in 2017, when the timing of peak population estimates also varied between Project Alpha and Project Bravo. Within Project Alpha the peak estimate of 34 was recorded in July, compared to a peak of 44 birds in May. In Project Alpha and Project Bravo combined, the peak population of 41 was recorded in May.

8.187. Given the very low numbers of herring gull encountered, no firm conclusions could be drawn regarding their distribution. However, in 2009 to 2011 distribution was very patchy in both the breeding and non-breeding seasons, although birds were more widespread in the latter (Seagreen 2012a). In the 2017 breeding season, although not present on all surveys, herring gull had a limited distribution in May, with this expanding in June and July (Seagreen 2017b).

8.188. In 2009 to 2011, the majority of birds encountered during the breeding season between April and August were adults (62%) compared to a greater mixture of ages in the passage/winter period, when 50% were immature birds. The trend of an increased proportion of adults being recorded in July compared to June was reinforced in 2017. The increased proportion of adult birds in July probably represents post-breeding individuals on passage, and as such, their origin cannot readily be determined.

8.189. In 2017, flight heights across Project Alpha and Project Bravo ranged from >5-10m to >40-45m although due to the low number of records not all bands were represented. Whilst a true representation of the species flight behaviour could not be gained, 27% of birds were recorded flying above 25m. This compares with data from 2009 to 2011 where 42% and 62% of birds were recorded above 20m in Project Alpha and Project Bravo respectively.

Guillemot

8.190. In relation to Project Alpha and Project Bravo, there are 14 colonies of guillemots within the mean maximum foraging range of 84.2km. The largest is Fowlsheugh SPA supporting 55,507 individuals, which is also the second closest to Project Alpha at 27.5km to the northwest. The Forth Islands, St Abb's Head to Fast Castle and Buchan Ness to Collieston Coast SPAs also all contain >30,000 individuals. In combination, the SPAs account for 94% of the breeding population within mean maximum foraging range of Project Alpha and Project Bravo. A further ten undesignated colonies support much smaller breeding populations.

8.191. Previous tracking of guillemots from the Isle of May showed that birds did not reach Project Alpha and Project Bravo (Figure 41 in Appendix 8A [Ornithology Technical Report]), at least in the year in question. However, the distance that birds travel will depend on the relative abundance of available resources closer to the colony. Nonetheless, the increasing evidence for the separation of range of seabirds from different colonies even those in close proximity (see Wakefield *et al.* 2013, Soanes *et al.* 2016, Perrow *et al.* 2017), suggests that guillemots from the large, nearby Fowlsheugh colony as well as the smaller colonies in Kincardine and Deeside and Angus will predominate amongst the birds recorded at Project Alpha and Project Bravo.

8.192. Guillemot was present on all surveys and tended to be the dominant feature of the ornithological assemblage. The seasonal trends observed at Project Alpha and Project Bravo broadly correspond with typical patterns according to Cramp *et al.* (1974). Population estimates were consistently low through the early winter period before rising from January to a peak in March, corresponding with large numbers amassing in the waters around colonies in March as well as spring passage to other colonies (Cramp *et al.* 1974). However, numbers were then generally lower in April and May, perhaps indicating birds remained closer to colonies as egg laying and incubation commenced, which is shared by both adults (Cramp *et al.* 1974).

8.193. Chick hatching in June corresponded with a peak in numbers in Project Alpha and Project Bravo in 2010 and 2011, although this was later in July in 2017. Numbers then declined as chicks left the colonies with their male parent and rapidly reduced suggesting complete dispersal from the area, and remained low throughout autumn and winter. Low numbers also suggested little passage through the area from other colonies.

8.194. Peak population estimates within Project Alpha in June showed considerable inter-annual variation with 5,202 to 10,811 individuals in 2010 and 2011 respectively. A similar pattern was noted in Project Bravo, although the peak population estimate of 6,540 individuals in 2010 was actually observed in March. In 2011, 10,567 individuals were estimated at peak in June.

8.195. In the 2017 surveys, peak population estimates were the highest recorded in both Project Alpha and Project Bravo at 11,221 and 12,536 birds respectively, and were slightly later than previously recorded, in July, coincident with the beginning of chick fledging and the end of the breeding season. Population estimates in July were higher than in 2010 and 2011 because of the large numbers of auks and kittiwake, apparently attracted by abundant prey resources. Population estimates preceding the peak were also generally higher and more consistent than recorded in 2010 and 2011.

8.196. The density distribution maps for birds on the water showed the patchy occurrence of guillemot in the breeding seasons of 2010 and 2011 with some densities reaching >50 individuals km^2 and even >100 individuals km^2. In 2011, guillemot was more evenly distributed with considerably more birds being present in conjunction with more high density patches especially in the northwest of Project Alpha. Higher density in the northwest of Project Alpha in the breeding season becomes more apparent when the two years of data from 2010 and 2011 are combined.

8.197. During the 2017 breeding season, guillemot was a nearly constant feature across the study area during all surveys. In each individual survey there were areas where birds appeared to be more concentrated, potentially indicating better foraging locations at those times and leading to a patchy distribution over the site across the survey period.

8.198. In general, the proportion of guillemot aged was very low across both survey periods with 6.1% of birds aged overall in 2009 to 2011 and 3.6% in 2017. Even for single birds in isolation the proportion aged was low at 6.8% in 2009 to 2011 and 1.2% in 2017. The proportion aged increased slightly to 8.2% for two birds recorded together in 2009 to 2011, but increased considerably to 17.1% for two birds together in 2017. The reason for this was a result of adult and chick combinations in the post-breeding period, with the presence of a chick leading to the adult being aged as such.

8.199. Although the first fledged birds were sometimes noted in June, the majority of young fledged guillemots were encountered in July in all breeding seasons surveyed. For all areas, high proportions of those birds that were aged (6.1%) were recorded as juvenile, ranging from 37.8% in Project Bravo during the 2010 and 2011 breeding seasons to 46.8% in Project Bravo during 2017. Some juvenile birds persisted into August as they dispersed from colonies into offshore areas but were not recorded at all in September.

8.200. The dominant flight direction of guillemots in Project Alpha and Project Bravo overall was northwest, followed by southeast. This flight axis suggests a dominance of birds commuting to and from the Fowlsheugh colony, although it is of note that proportions of birds on a northwest transit were even higher in Project Alpha during the non-breeding period.

8.201. Of the birds recorded during the survey programme of 2009 to 2011, only 5% and 2% of birds exhibited feeding behaviour within Project Alpha and Project Bravo respectively. It is worth noting however that the proportion of auks displaying feeding behaviours is invariably underestimated as this occurs underwater and foraging behaviour of single birds or small groups is also much more difficult to detect than those acting in larger flocks. Foraging behaviour was also relatively rarely recorded in the 2017 breeding season surveys, with a total of 122 guillemots observed engaged in foraging or fishing behaviour.

Razorbill

8.202. Razorbill has a mean maximum foraging range of 48.5km, which in relation to Project Alpha and Project Bravo encompasses 11,125 breeding individuals within ten colonies (Figure 51 and Table 32 in Appendix 8A [Ornithology Technical Report]). Fowlsheugh SPA supports the bulk of the breeding population within this range (67%), with the rest supplied by nine small non-designated colonies. Fowlsheugh SPA is the closest designated colony to the Project Alpha and Project Bravo area (27.5km) and thus seems likely to supply most of the razorbills recorded within the sites and surrounds.

8.203. Previous tracking studies from the Isle of May colony (Forth Islands SPA) in 2010 confirmed the potential for birds to reach Project Alpha, although only a low proportion (two trips representing 1.8%) reached the site (Daunt *et al.* 2011a). Most of the apparent foraging effort suggested by the tracking was concentrated to the north and west of the Isle of May in more inshore areas with few tracks intersecting the Inch Cape OWF (4.6%) or Neart Na Gaoithe OWF (6.4%) sites (Daunt *et al.* 2011a). As with guillemot, the potential for inter-annual variability in foraging behaviour has not been fully addressed (see Daunt *et al.* 2011c). Nevertheless, it seems likely that birds from Fowlsheugh, which is considerably closer to Project Alpha and Project Bravo than the Forth Islands, are likely to account for most Razorbills observed in Project Alpha and Project Bravo during the breeding season.

8.204. Razorbill was observed within the Project Alpha and Project Bravo in all surveys undertaken from 2009 to 2011 and 2017, with some differences between sites and according to within site seasonal and inter-annual patterns. In general, after low populations over winter, numbers increased immediately prior to the start of the breeding season in February and March. Populations then tended to decline over egg laying in April and into the incubation (shared by both parents) and early chick provisioning periods. Peak populations were then recorded at the end of the breeding season reflecting fledging and dispersal offshore.

8.205. Populations tended to be higher in Project Alpha, with a peak of 2,102 individuals in July 2011 within the 2009 to 2011 survey period. The equivalent peak in Project Bravo was 1,279 in September 2010 over the same survey period. In 2017, exceptional peak populations of 6,142 and 6,065 individuals in Project Alpha and Project Bravo respectively were noted in July 2017, representing a 24-fold increase from June populations.

8.206. The resultant peak population estimate for Project Alpha and Project Bravo combined of 11,933 is very close to the combined total population of breeding individuals present at Fowlsheugh and Forth Islands SPAs (12,419 individuals) and was an integral part of a large-scale foraging event also involving large numbers of guillemots and kittiwakes (see above).

8.207. The low population estimates during the breeding season suggest Project Alpha and Project Bravo are not important for foraging during the incubation and chick provisioning phases, which is consistent with the results of Daunt *et al.* (2011a) showing the tendency of razorbills to forage in inshore waters in relatively close proximity to the colony (Forth Islands SPA), albeit with particular offshore areas of importance.

8.208. The mean densities by month exceed those derived by Stone *et al.* (1995) for the western North Sea in March, July and August of 0.2, 1.0 and 2.1 individuals km^2 respectively. Mean monthly densities are broadly similar to those presented by Skov *et al.* (1995) for the key areas of Moray Firth (6.1 ind. km^2) and Scalp Bank (7.1 ind. km^2) which is immediately adjacent to Project Alpha, in August. The peak of up to 14.39 individuals km^2 in July within Project Alpha exceeds the range of 2 to 10+ individuals km^2 previously recorded in parts of the Firth of Forth in June/July by Camphuysen (2005), but this is thought to relate to an exceptional event (see above).

8.209. In 2009 to 2011, the distribution of razorbill across Project Alpha and Project Bravo was patchy in both the breeding and non-breeding seasons. Birds were more widespread over the winter period when the area held a relatively stable population. During the breeding season there was a suggestion that the western part of Project Alpha and the eastern part of Project Bravo were preferred, with few records in the centre of the combined area. During the 2017 breeding season, Razorbills utilised much of Project Alpha and Project Bravo, although densities were higher outside of the proposed development zones. Within Project Alpha, an area to the west held few birds while in Project Bravo the southeast corner was similarly unpopulated. Interestingly, these areas supported relatively high densities of birds in the breeding season of 2011.

8.210. A greater proportion (11.7%) of razorbills were aged in 2009 to 2011 compared to guillemots in the surveys of Project Alpha and Project Bravo combined. The contrast between the proportions of birds aged when the observation was of a single bird (3%) compared to two together (26.4%) was also more apparent. This again highlights the increase confidence of ageing an adult bird when with a fledged chick. In 2017, the same trend was noted with 6.0% of razorbills aged and again a marked contrast between the proportion of birds aged with a single bird present (9.7%) compared to two together (28.49%).

8.211. The first fledged chicks were usually noted in June, although the majority fledge in July (Table 34 in Appendix 8A [Ornithology Technical Report]). The aged proportion of birds noted as juvenile ranged from 34.6% in 2017 within Project Bravo to 46.2% within Project Alpha in the same year. Proportions of birds aged as juvenile fell within this range in 2009 to 2011 and showed less variation between Project Alpha and Project Bravo.

8.212. Flight directions of razorbills throughout the year across Project Alpha and Project Bravo clearly show birds in transit to Fowlsheugh on a north-westerly flight path, with a range from 51.3% in Project Alpha in the non-breeding period in 2009 to 2011 to 19.2% in Project Bravo during the 2017 breeding season surveys. The predominance of the north-westerly flight path in the non-breeding season may be linked to the attendance of colonies by the end of March (Forrester *et al.* 2007). In Project Alpha, northerly flights were equally prominent during the breeding seasons in 2009 to 2011, which were thought to be a subtle variation in direction caused by the more coastal location of Project Alpha, not necessitating an obvious westerly component to the flight path.

Puffin

8.213. The mean maximum foraging range for puffin has been estimated at 105km (Thaxter *et al.* 2012). This range from Project Alpha and Project Bravo areas encompasses two SPAs comprising The Forth Islands SPA and the Farne Islands SPAs, four further SSSI sites and 11 other non-designated colonies. The combined breeding population of these sites is 186,569 individuals, with the combination of the Forth Islands and Farne Islands SPAs accounting for 99% of the breeding birds within mean maximum foraging range of Project Alpha and Project Bravo.

8.214. All puffin colonies within 70km of Project Alpha and Project Bravo are relatively small, although according to Seabird 2000, the largest and closest colony at around 27km at its closest point lies along the coastline between Catterline and Inverbervie. Recent surveys in the 2017 breeding season found just 20 individuals present in this area. By comparison the Forth Islands SPA supports 45,005 pairs. The centre of the Forth Islands SPA is just 48.7km away from the closest points of Project Alpha and Project Bravo.

8.215. Tracking of a limited number of individuals from the Isle of May in 2010 suggested only 1% of the trips made by birds reached Project Alpha, with none reaching Project Bravo, relative to the 5% reaching both Inch Cape and Neart Na Gaoithe (Harris *et al.* 2012).

8.216. Puffin was recorded on all surveys and displayed a different pattern of abundance to the other auks. As an extremely pelagic seabird, puffin only returns to land to breed, occupying colonies from March to August. Accordingly, population estimates were low over winter and although spring passage in March (2010) and April (2011) was apparent, the resultant increase in numbers was still low relative to the local breeding population, with an estimated maximum of 693 individuals in Project Bravo in 2011. A typical decline in populations in May coincides with shared incubation (by both parents) of the single egg laid in late April (Cramp *et al.* 1974).

8.217. Substantial increases in population sizes in June across Project Alpha and Project Bravo in 2010 and 2011 coincided with the expected chick hatching period, with overall peak populations of 2,787 and 5,438 individuals in Project Alpha and Project Bravo respectively, in 2011. It is of note that a June peak was not observed in 2017, with a steady rise in the numbers of birds present from June to August, broadly coincident with the six-week provisioning period of chicks within the nest burrow by their parents.

8.218. Puffin numbers increased by five-fold in July 2017 from June values in line with a similar four-fold increase in numbers of guillemot (see above) and the much higher increase (24-fold) in razorbill populations at the same time, all in response to a large-scale feeding event.

8.219. At the peak of the breeding season, Skov *et al.* (1995) recorded a density for the area immediately around the Isle of May of 16.3 individuals km^2, whereas Camphuysen (2005) notes a density of >10 individuals km^2 in several parts of the Firth of Forth in June and July. Peak densities in Project Alpha and Project Bravo reach these values in June. After the breeding season in August and September, Skov *et al.* (1995) recorded 7.5 individuals km^2 in the wider Forth area including around the Isle of May, which are either similar to those recorded in Project Alpha and or exceeded by those in Project Bravo.

8.220. Puffin was similarly distributed within Project Alpha during the 2010 and 2011 breeding seasons at low density (1 to 5 individuals km^2) with occasional patches of higher density (>10 individuals km^2) especially in the western part of the site in closer proximity to Scalp Bank. In contrast, in Project Bravo, there was a considerable difference in the pattern between breeding seasons, driven by the abundance of birds in June 2011 when some patches of very high density (>100 individuals km^2) were recorded in the central part of the site to the mid-point on the southern boundary. Conversely, in 2010, birds were at very low density or even absent from many grid cells in Project Bravo.

8.221. Throughout the breeding season in 2017 the distribution of puffin observations changed considerably over the course of the surveys leading to almost full site coverage. In May, observations were largely limited to the most inshore parts of the study area to the west over Scalp Bank. However, as numbers increased through July and August the distribution shifted further offshore.

8.222. The proportion of puffins aged in 2009 to 2011 was low at 8.8% for Project Alpha and Project Bravo combined. In 2017, the proportion of puffins aged was substantially higher at 36.1%; much higher than for the other auk species although this is to be expected as only breeding season data is considered. Part of the reason for this is that sub-adult (predominantly immature and first year birds) and adult puffins were more confidently differentiated than razorbill and guillemot throughout the breeding season, due to more obvious differences in bill colour and size.

8.223. In general, there is a paucity of records relating to flying puffins, especially in 2017. Nevertheless, at least during the 2010 and 2011 breeding seasons, the flight directions of any flying birds in Project Alpha and Project Bravo appears to confirm a link with the Isle of May in the Forth Islands SPA, with a distinct southwest flight path accounting for 30.0% of flights in Project Alpha and 40.6% in Project Bravo of birds potentially returning to the colony. A less well-represented reciprocal northeast flight path from the colony is also apparent.

Predicted Future Baseline

8.224. The design life of the Project is 25 years. A review of seabird population trends was undertaken in order that this ES takes into account any likely changes to the baseline conditions that can be anticipated.

8.225. Seabird 2000 trend data is summarised below in Table 8.17. Species with a consistent negative population trend across time periods are considered to be vulnerable to a shifting baseline where the magnitude of adverse impacts could increase.

8.226. All the species assessed in this EIA Report, except kittiwake and herring gull, are likely to have smaller populations in the future compared to current baseline conditions. The sensitivity of gannet and herring gull to adverse changes in climate conditions is uncertain. Declines in herring gull may be attributed to multiple factors. The likelihood of changes related to climate change are most likely, in line with a progressively warming climate scenario (Murphy *et al.*, 2010), to manifest themselves over the long term.

Table 8.17 Summary of seabird population trends and sensitivity to adverse changes in climate conditions

Species	Population change (%) [JNCC, 2016b]			Sensitive to adverse changes in climate conditions (Daunt *et al.*, 2017)
	1969-70 to 1985-88	1985-88 to 1998-2002	1998-2002 to 2015	
Gannet	+39	+39*	+34**	Yes
Guillemot	+77	+31	+5	Yes
Razorbill	+16	+21	+32	Yes
Puffin	+15	+19	N/A	Yes
Kittiwake	+24	-25	-44	Yes
Herring gull	-48	-13	N/A	No

* Change between censuses in 1984-85 and 2004-05.

** Change between census in 2003-04 and colonies surveyed in 2013-14 and 2015.

ASSESSMENT OF IMPACTS – WORST CASE SCENARIO

8.227. As identified within the 'Scope of Assessment' the impact assessment for offshore ornithology considers the potential impacts due to collision risk, disturbance and displacement/barrier effects. All other impacts have been scoped out of this EIA Report.

8.228. The assessment considers the potential impacts of Project Alpha alone; Project Bravo alone; Project Alpha and Project Bravo combined (the optimised Seagreen Project) and Project Alpha and Project Bravo in a cumulative scenario. The following sections set out the assessment of potential impacts during construction, operation and decommissioning phases of the Project. As set out in Chapter 6 (EIA Process), impacts reported are adverse unless stated otherwise.

Worst Case Scenario

8.229. To inform the impact assessment on offshore ornithology, a worst case scenario (WCS) has been defined using the information contained within the design envelope for the optimised Seagreen Project, Chapter 5 (Project Description). The WCS represents, for any given impact, the scenario within the range of options in the design envelope that would result in the greatest potential for change to the receptors assessed.

8.230. Table 8.18 identifies the WCS in relation to those issues scoped into the assessment and provides justification as to why no other scenario would result in a greater impact on the receptors considered. The WCS is defined for each impact for both Project Alpha and Project Bravo in isolation, however, the WCS for the optimised Seagreen Project would be Project Alpha and Project Bravo combined (the optimised Seagreen Project). The impact assessment undertaken therefore considers the impacts of each project in isolation as well as the projects combined.

Table 8.18 Worst Case Scenario Justification

Type of Impact	Worst Case Scenario	Justification/Rationale of Selected Design Envelope Parameter
Individual Project (Project Alpha or Project Bravo)		
Construction		
Disturbance	Maximum number of vessel movements 1,320 to 1,760 for each site or 2,640 to 3,520 for Project Alpha and Project Bravo combined (one vessel movement comprises one to- and from- OWF site trip) The maximum anticipated hammer energy for installation of a 10 m monopile foundation at a hammer energy of 3,000 kJ Construction may involve simultaneous pin piling at Project Alpha and Project Bravo, or simultaneous monopile and pin piling at Project Alpha and Project Bravo Maximum duration of construction is 3 years for one site and 4 years for both sites combined. The maximum period for the substructure and foundation installation for the optimised Seagreen Project is anticipated to be 24 months. Installation of the WTGs and inter-array cables is expected to take between 12 and 24 months.	Worst case scenario provides for the greatest number of potential vessels associated with the construction phase and hence the highest likelihood of potential disturbance /displacement to bird species, as a result of multiple activities taking place during the construction period. Worst case scenario provides for the greatest disturbance/displacement effects to bird species due to construction activities (magnitude and duration). Maximum magnitude of piling provides for the maximum increase in background noise levels generated over the largest area. Maximum diameter of piles and maximum number of simultaneous piling events provides for the maximum construction activity generated. Maximum separation distance provides the maximum spatial extent of construction activity impact (construction activity footprint area).

Type of Impact	Worst Case Scenario	Justification/Rationale of Selected Design Envelope Parameter
Operation		
Displacement/ barrier effects	Operation of maximum number of turbines (up to 70 WTGs), within the total area of the Project Alpha Site (197 km²), with a minimum turbine separation distance of 1,000 m. Operation of maximum number of turbines (up to 70 WTGs), within the total area of the Project Bravo Site (194 km²), with a minimum turbine separation distance of 1,000 m. Operation of maximum number of turbines (up to 120 WTGs), within the total Project Alpha and Project Bravo Site (391 km²), with a minimum turbine separation distance of 1,000 m.	Provides for the maximum amount (spatial extent) of habitat loss due to physical displacement effects. For sensitive species, the wind farm as a whole will be avoided, whereas for others only individual turbines will be avoided while within the wind farm.
Collision risk	Operation of maximum number of turbines (up to 70 WTGs for Project Alpha or for Project Bravo or 120 WTGs for Project Alpha and Project Bravo combined). Maximum rotor swept area based on rotor diameter of 220m, max hub height = 170 m (LAT) and lowest rotor tip height of 32.5 m (LAT).	Greatest rotor swept area plus parameters that maximise collision risk and therefore mortality rates for all species as the surface area available for collision increases. This is the turbine layout with the largest combined rotor swept area and collision probability, the latter at its highest when turbines are at maximum rotor speed and at the lowest tip height.
Decommissioning		
In the absence of detailed methodologies and schedules, decommissioning works and the implications for offshore ornithology are considered similar to, or likely less than those of the construction phase. Therefore, the worst case parameters defined for the construction phase also apply to decommissioning.		
Project Alpha and Project Bravo Combined		
In general terms the worst case scenarios identified above for individual projects also apply when considering Project Alpha and Project Bravo combined. Exceptions to this are as follows: • Maximum number of WTGs: 120 (with up to 70 in each project) • Indicative duration of the construction phase: 4 years.		
Cumulative Assessment (Optimised Seagreen Project cumulatively with other projects)		
The specifications of projects considered for assessment of cumulative impacts are provided at the end of this chapter under the Cumulative Impact Assessment section. Projects included for assessment have been identified through Scoping and further consultation.		

Environmental Measures Incorporated into the Project

8.231. Throughout the design evolution process and with consideration of the findings of the 2012 Offshore ES, measures have been taken to avoid potentially significant impacts wherever possible and practical to do so (0). Mitigation measures that are incorporated into the design of the project are referred to as 'environmental measures incorporated into the Project'. These measures are intended to prevent, reduce and where possible offset any significant adverse impacts on the environment. These are effectively 'built in' to the impact assessment and as such, the assessment includes consideration of these measures.

8.232. Mitigation measures that were identified and consent conditions applied to the originally consented project are provided within Chapter 7 (Scope of EIA Report). Measures relevant to the assessment of offshore ornithology are detailed below.

Table 8.19 Environmental measures related to offshore ornithology incorporated into the project

Measures adopted as part of Seagreen	Justification
An appropriate Environmental Management Plan (EMP) will be produced and followed to cover the construction, operation and maintenance phases of the Development. An appropriate Marine Pollution and Contingency Plan (MPCP) will be produced and followed to cover the construction, operation and maintenance phases of the Development. This will include planning for accidental spills, address all potential contaminant releases and include pollution event response protocols.	The Environmental Management Plan for the project provides the overarching framework for on-site environmental management during construction, operation and decommissioning. The plan considers the topic areas assessed within the EIA Report, as well as other considerations such as management of non-native invasive species. Measures will be adopted to ensure that the potential for release of pollutants from construction, operation and maintenance, and decommissioning plant is minimised. In this manner, accidental release of contaminants from rigs and supply/service vessels will be strictly controlled, thus providing protection for birds and their prey species across all phases of the wind farm development.
A vessel management plan (VMP) will be developed which will determine vessel routing to and from construction areas and ports to avoid areas of high risk. This will also include codes of conduct for vessel behaviour and for vessel operators including advice to operators to not deliberately approach aggregations of seabirds.	The VMP will minimise disturbance of seabird species and allow the identification of standard routes that will avoid foraging 'hotpots' for species such as guillemot.
Installation of appropriate lighting on wind farm structures.	Lighting of wind turbines will meet minimum requirements, namely as set out in the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) Recommendation O-117 on 'The Marking of Offshore Wind Farms' for navigation lighting and by the Civil Aviation Authority in the Air Navigation Orders (CAP 393 and guidance in CAP 764). In keeping with the minimum legal requirements, this will minimise the risks of migrating birds becoming attracted to, or disorientated by turbines at night or in poor weather.
A minimum wind turbine hub-height of 170 m (above LAT) will be used for Seagreen. The minimum blade tip height clearance has been increased to 32.5 m LAT.	This blade tip clearance is considered appropriately conservative so as to minimise the risk of bird collisions.

IMPACT ASSESSMENT – CONSTRUCTION PHASE

Project Alpha

Disturbance and Displacement Impacts

8.233. Disturbance during the construction of a wind farm (visual presence, vessel activity and underwater noise) may displace birds from an area of sea, effectively amounting to habitat loss during the period of disturbance (Drewitt and Langston, 2006). Disturbance caused by construction activities may directly displace birds from foraging or loafing areas thus potentially affecting breeding productivity or survival rates of an individual or population. However, on several occasions during the construction of Lincs Offshore Wind Farm, gulls were clearly associated with the jack-up barge, the guard vessels and with the construction vessel while piling was in progress (RPS, 2012). Disturbance caused by construction activities within Project Alpha plus a 2km buffer are considered to represent the WCS for relevant species as it is these areas that will be disproportionately affected by the presence of vessels and/or underwater noise.

8.234. Disturbance associated with vessel movements is of limited duration and also represents a transient impact as vessels/helicopters will move through an area quickly. Impacts are spatially and temporally restricted and are considered unlikely to affect the breeding productivity or survival rates of an individual or population. It is therefore considered that additional vessel and helicopter movements to and from Project Alpha will be indiscernible from baseline levels, whereas the relatively constant presence of vessels in these areas will represent an impact of larger magnitude.

8.235. For each species assessed, the increase in vibration and noise disturbance associated with human construction activities has been evaluated. This involves initially assessing the potential for displacement of mean peak densities within a particular extent around the disturbance source (e.g. piling activities) within Project Alpha.

8.236. In general, it is considered that effects are likely to last only for the duration of the construction activities, and therefore are predicted to be direct, but temporary, reversible and short-term in nature for a specific event. Although construction is expected to occur over a maximum duration of a period of 4 years (Table 8.17), piling activities will only occur for a maximum duration of nine months during the overall construction period. The largest impacts are likely to be intensive pile-driving activities which may cause extensive, intermittent noise and vibrations. These are, however, likely to be irregular and occur only for short spans of time. Although effects of underwater noise associated with pile-driving activity are well known on cetaceans and fish (Madsen *et al.*, 2006), very little is known about the effects on seabirds.

8.237. The U.S. Department of the Interior (2004) concluded that noise from seismic studies might only impact those species that spend large quantities of time underwater. Bird species most likely to be vulnerable to underwater sound are those that forage by diving after fish or shellfish, and include auks, divers and seaduck. Gull and tern species feed at the surface only and are considered the least vulnerable.

8.238. Fulmar, gulls and skuas are opportunistic scavengers that will forage within tens of metres of moving machinery, including vessels, and where feeding opportunities are recognised, close to humans when confident from experience to do so. On that basis together with consideration of their vulnerability to underwater noise, species therefore considered for this impact are guillemot, razorbill and puffin.

Guillemot

Magnitude of Impact

8.239. The true population level effects of construction disturbance on guillemots are currently unclear; during construction surveys at Lynn and Inner Dowsing there appeared to be no significant patterns of change in guillemot abundance between the wind farm and control sites (ECON, 2012). Leopold *et al.* (2010) could not find any statistically significant changes to auk abundance at Egmond aan Zee due to disturbance, though the sample size was low.

8.240. Wade *et al.* (2016) report that auks may be disturbed by boats at several hundreds of metres distance although survey vessels have often approached to less than ten metres before eliciting an evasion response.

8.241. Like the other auks, it is considered that the extent of any disturbance due to construction activities is unlikely to extend to 2km from source. Inter-array cable installation may also disturb birds although this is generally considered to be of lower magnitude than disturbance during installation of the offshore wind farm foundations and WTGs.

8.242. The peak population estimate within the Project Alpha plus 2km buffer occurred during the breeding period for both the 2009 to 2011 (June) and 2017 (July) surveys. A mean peak breeding population of 13,606 birds was calculated in the breeding season for use in the assessment of disturbance/displacement (Appendix 8C [Displacement of Seabirds]). This is equivalent to 0.96% of the national breeding population (1,420,000 individuals) or 6.20% of the regional breeding population (219,623 individuals).

8.243. The peak in the number of guillemot recorded in the July 2017 survey is thought to represent an abundance of prey that attracted birds from the surrounding area in addition to the commencement of post-breeding dispersal and passage movements with these birds potentially lingering because of the increased foraging opportunities supported by increased observations of foraging behaviour and a simultaneous increase in marine mammal records at this time. Should data from July 2017 be removed from the process of establishing a metric for use in assessing disturbance and displacement a mean peak population of 9,129 is established. This is equivalent to 0.64% of the national breeding population (1,420,000 individuals) or 4.16% of the regional breeding population (21 individuals).

8.244. A mean peak non-breeding (October to March) population of 4,688 birds has been calculated in Appendix 8A (Ornithology Technical Report) for Project Alpha plus a 2km buffer. Assessed against the North Sea non-breeding population of 1,617,306 individuals as defined as the regional BDMPS by Furness (2015). The mean peak population for Project Alpha accounts for 0.29% of this regional reference population. The national non-breeding population is defined at 2,756,526 individuals, with the non-breeding estimate for the Project Alpha plus a 2km buffer accounting for 0.17%.

8.245. It is considered that extensive and consistent disturbance of the guillemot population within the Project Alpha plus 2km buffer is unlikely, with any disturbance localised within an area around the source (e.g. turbine installation or inter-array cable laying). Numbers affected will depend on the overlap of such activity with food resources at any particular time.

8.246. The impact is predicted to be of local spatial extent, for part of the project duration, intermittent and high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the guillemot populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Receptor Sensitivity

8.247. Guillemot is considered to be of international conservation value within the context of Project Alpha. The species is considered to be of moderate vulnerability to displacement (Wade *et al.*, 2016), and may be particularly sensitive during the post-breeding period during moult and when attending young at sea.

8.248. There has been an increase in national populations over the last decade (+5%), although the Scottish population is relatively stable or possibly slightly in decline[3]. In addition, guillemot lays a single egg and is a late first breeder (Table 8.10). Guillemot is therefore considered to have a medium recoverability potential. Given that guillemot is deemed to be of moderate vulnerability, medium recoverability and international value, the sensitivity of the receptor is considered to be **medium**.

Impact Significance

8.249. Overall, the sensitivity of guillemot is considered to be **medium** and the impact magnitude is deemed to be **low**. The impact of disturbance in the construction phase on guillemot at Project Alpha is predicted to be **Minor Adverse** and therefore **Not Significant** in EIA terms.

Razorbill

Magnitude of Impact

8.250. Effects of construction disturbance on razorbill are currently unclear; however, during construction surveys at Lynn and Inner Dowsing there appeared to be no significant patterns of change in razorbill abundance between the wind farm and control sites (ECON, 2012).

8.251. Similar to guillemot, it is considered that the extent of any disturbance due to construction activities is unlikely to extend to 2km from source. Inter-array cable installation may also disturb birds although this is generally considered to be of lower magnitude than foundation or WTG installation for example.

8.252. The peak population estimate within the Project Alpha plus 2km buffer occurred during the breeding period for both the 2009 to 11 (July) and 2017 (July) surveys. A mean peak breeding population of 5,876 birds was calculated in the breeding season for use in the assessment of disturbance/displacement (Appendix 8A [Ornithology Technical Report]). This is equivalent to 3.14% of the national breeding population (187,100 individuals) or 14.33% of the regional breeding population (41,009 individuals).

8.253. The peak in the number of razorbill recorded in the July 2017 survey is thought to represent an abundance of prey that attracted birds from the surrounding area in addition to the commencement of post-breeding dispersal and passage movements with these birds potentially lingering because of the increased foraging opportunities supported by increased observations of foraging behaviour and a simultaneous increase in marine mammal records at this time. Should data from July 2017 be removed from the process of establishing a metric for use in assessing disturbance and displacement a mean peak population of 3,221 is established. This is equivalent to 1.7% of the national breeding population (187,100 individuals) or 7.85% of the regional breeding population (41,009 individuals).

[3] http://jncc.defra.gov.uk/page-2898

8.254. A mean peak non-breeding (October to March) population of 1,003 birds has been calculated in Appendix 8A (Ornithology Technical Report) for Project Alpha plus a 2km buffer. Assessed against the North Sea non-breeding population of 218,622 individuals as defined as the regional BDMPS by Furness (2015). The mean peak population for Project Alpha plus a 2km buffer accounts for 0.46% of this regional reference population.

8.255. It is considered that extensive disturbance of the razorbill population within the Project Alpha plus 2km buffer is unlikely, with any disturbance localised within an area around the source (e.g. turbine installation or inter-array cable laying). Numbers affected will depend on the overlap of such activity with food resources at any particular time.

8.256. The impact is predicted to be of local spatial extent, for part of the project duration, intermittent and high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the razorbill populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Receptor Sensitivity

8.257. Razorbill is considered to be of international conservation value within the context of Project Alpha. The species is considered to be of moderate vulnerability to displacement (Wade *et al.*, 2016), and may be particularly sensitive during the post-breeding period during moult and when attending young at sea.

8.258. There has been an increase in national populations over the last decade (+21%), although the Scottish population is relatively stable. In addition, razorbill lays a single egg and is a late first breeder (Table 8.10), so is therefore considered to have a medium recoverability potential. Given that razorbill is deemed to be of moderate vulnerability, medium recoverability and international value, the sensitivity of the receptor is therefore considered to be **medium**.

Impact Significance

8.259. Overall, the sensitivity of razorbill is considered to be **medium** and the impact magnitude is deemed to be **low**. The impact of disturbance in the construction phase on razorbill at Project Alpha is predicted to be **Minor Adverse** and therefore **Not Significant** in EIA terms.

Puffin

Magnitude of Impact

8.260. JNCC *et al.* (2017) recommend the use of a 2km displacement buffer for auks. However, considering the limited spatial relevance of construction disturbance with construction slowly moving out across the project, it is considered very unlikely that all puffin will be displaced within Project Alpha plus 2km buffer, even if construction activity is concurrent at two locations. Puffin, in common with other auk species, may continue to forage beyond a 1km buffer from temporary construction activities but may still be located within Project Alpha since construction activities will take place only within a small area of Project Alpha at any time.

8.261. The peak population estimate within Project Alpha plus 2km buffer occurred during the breeding period for both the 2009 to 2011 (June) and 2017 (August) surveys. A mean peak breeding population of 2,572 birds was calculated in the breeding season for use in the assessment of disturbance/displacement (Appendix 8C [Displacement of Seabirds]). This is equivalent to 0.22% of the national breeding population (1,161,400 individuals) or 0.69% of the regional breeding population (373,138 individuals).

8.262. The scoping opinion for Seagreen states that puffin disperse widely in the non-breeding season and will not be present in any significant numbers. It has been advised that assessment of disturbance/displacement is therefore not required.

8.263. The impact is predicted to be of local spatial extent, for part of the project duration, intermittent and high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the puffin populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low.**

Receptor Sensitivity

8.264. Puffin is considered to be of international conservation value within the context of the Project Alpha. The species is considered to be of moderate vulnerability to displacement (Wade *et al.*, 2016), and may be particularly sensitive during the post-breeding period during moult and when attending young at sea.

8.265. There has been an increase in national populations over the last decade (+19%), with a likely increase also occurring in Scotland. Puffin lays a single egg and is a late first breeder (Table 8.10) so is therefore considered to have a medium recoverability potential. Given puffin is deemed to be of moderate vulnerability, medium recoverability and international value, the sensitivity of the receptor is considered to be **medium**.

Impact Significance

8.266. Overall, the sensitivity of puffin is considered to be **medium** and the impact magnitude is deemed to be **low**. The impact of disturbance in the construction phase on puffin at Project Alpha is predicted to be **Minor Adverse** and therefore **Not Significant** in EIA terms.

Additional Mitigation

8.267. No additional mitigation is either required or proposed in relation to the Construction phase disturbance on any species assessed as no adverse significant impacts are predicted.

Project Bravo

Disturbance and Displacement Impacts

Guillemot

Magnitude of Impact

8.268. The approach, assumptions and information used to estimate the magnitude of displacement impacts on guillemot at Project Bravo is consistent with that used in the assessment for Project Alpha.

8.269. The peak population estimate within Project Bravo plus a 2km buffer occurred during the breeding period 2017 (July) surveys, although in 2009 to 2011 the peak occurred in what is considered to be pre-breeding (March). A mean peak breeding population of 11,118 birds was calculated in the breeding season for use in the assessment of disturbance/displacement (Appendix 8A [Ornithology Technical Report]). This is equivalent to 0.78% of the national breeding population (1,420,000 individuals) or 5.06% of the regional breeding population (219,623 individuals). Should data from July 2017 be removed from the process of establishing a metric for use in assessing disturbance and displacement a mean peak population of 6,810 is established. This is equivalent to 0.47% of the national breeding population (1,420,000 individuals) or 3.10% of the regional breeding population (219,623 individuals).

8.270. A mean peak non-breeding (October to March) population of 4,112 birds has been calculated in Appendix 8A (Ornithology Technical Report) for Project Bravo plus a 2km buffer. Assessed against the North Sea non-breeding population of 1,617,306 individuals as defined as the regional BDMPS by Furness (2015). The mean peak population for Project Bravo accounts for 0.25% of this regional reference population. The national non-breeding population is defined at 2,756,526 individuals, with the non-breeding estimate for Project Bravo accounting for 0.15%.

8.271. It is considered that extensive and consistent disturbance of the guillemot population within Project Bravo plus 2km buffer is unlikely, with any disturbance localised within an area around the source (e.g. turbine installation or inter-array cable laying). Numbers affected will depend on the overlap of such activity with food resources at any particular time.

8.272. The impact is predicted to be of local spatial extent, for part of the project duration, intermittent and high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the guillemot populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Receptor Sensitivity

8.273. There has been an increase in national populations over the last decade (+5%), although the Scottish population is relatively stable or possibly slightly in decline[4]. In addition, guillemot lays a single egg and is a late first breeder (Table 8.10). Guillemot is therefore considered to have a medium recoverability potential. Given that guillemot is deemed to be of moderate vulnerability, medium recoverability and international value, the sensitivity of the receptor is considered to be **medium**.

Impact Significance

8.274. Overall, the sensitivity of guillemot is considered to be **medium** and the impact magnitude is deemed to be **low**. The impact of disturbance in the construction phase on guillemot at Project Bravo is predicted to be **Minor Adverse** and therefore **Not Significant** in EIA terms.

Razorbill

Magnitude of Impact

8.275. The approach, assumptions and information used to estimate the magnitude of displacement impacts on razorbill at Project Bravo is consistent with that used in the assessment for Project Alpha.

[4] http://jncc.defra.gov.uk/page-2898

8.276. The peak population estimate within Project Bravo plus a 2km buffer occurred during the breeding period in 2017 (July) surveys, while in September for 2009 to 2010 surveys. A mean peak breeding population of 3,698 birds was calculated in the breeding season for use in the assessment of disturbance/displacement (Appendix 8C [Displacement of Seabirds]). This is equivalent to 1.98% of the national breeding population (187,100 individuals) or 9.02% of the regional breeding population (41,009 individuals). Should data from July 2017 be removed from the process of establishing a metric for use in assessing disturbance and displacement, a mean peak population of 1,442 is established. This is equivalent to 0.77% of the national breeding population (1,187,100 individuals) or 3.52% of the regional breeding population (41,009 individuals).

8.277. A mean peak non-breeding (October to March) population of 1,272 birds has been calculated in Appendix 8A (Ornithology Technical Report) for Project Bravo plus a 2km buffer. Assessed against the North Sea non-breeding population of 218,622 individuals as defined as the regional BDMPS by Furness (2015). The mean peak population for Project Bravo accounts for 0.58% of this regional reference population.

8.278. It is considered that extensive disturbance of the razorbill population within Project Bravo plus 2km buffer is unlikely, with any disturbance localised within an area around the source (e.g. turbine installation or inter-array cable laying). Numbers affected will depend on the overlap of such activity with food resources at any particular time.

8.279. The impact is predicted to be of local spatial extent, for part of the project duration, intermittent and high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the razorbill populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Receptor Sensitivity

8.280. There has been an increase in national populations over the last decade (+21%), although the Scottish population is relatively stable. In addition, razorbill lays a single egg and is a late first breeder (Table 8.10), so is therefore considered to have a medium recoverability potential. Given that razorbill is deemed to be of moderate vulnerability, medium recoverability and international value, the sensitivity of the receptor is therefore considered to be **medium**.

Impact Significance

8.281. Overall, the sensitivity of razorbill is considered to be **medium** and the impact magnitude is deemed to be **low**. The impact of disturbance in the construction phase on razorbill at Project Bravo is predicted to be **Minor Adverse** and therefore **Not Significant** in EIA terms.

Puffin

Magnitude of Impact

8.282. The approach, assumptions and information used to estimate the magnitude of displacement impacts on puffin at Project Bravo is consistent with that used in the assessment for Project Alpha.

8.283. The peak population estimate within Project Bravo plus a 2km buffer occurred during the breeding period for both the 2009 to 2011 (June) and 2017 (August) surveys. A mean peak breeding population of 3,582 birds was calculated in the breeding season for use in the assessment of disturbance/displacement (Appendix 8C [Displacement of Seabirds]). This is equivalent to 0.31% of the national breeding population (1,161,400 individuals) or 0.96% of the regional breeding population (373,138 individuals).

8.284. The scoping opinion for Seagreen states that puffin disperse widely in the non-breeding season and will not be present in any significant numbers. It has been advised that assessment of disturbance/displacement is therefore not required.

8.285. The impact is predicted to be of local spatial extent, for part of the project duration, intermittent and high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the puffin populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Receptor Sensitivity

8.286. There has been an increase in national populations over the last decade (+19%), with a likely increase also occurring in Scotland. Puffin lays a single egg and is a late first breeder (Table 8.10) so is therefore considered to have a medium recoverability potential. Given puffin is deemed to be of moderate vulnerability, medium recoverability and international value, the sensitivity of the receptor is considered to be **medium**.

Impact Significance

8.287. Overall, the sensitivity of puffin is considered to be **medium** and the impact magnitude is deemed to be **low**. The impact of disturbance in the construction phase on puffin at Project Bravo is predicted to be **Minor Adverse** and therefore **Not Significant** in EIA terms.

Additional Mitigation

8.288. No additional mitigation is either required or proposed in relation to Construction phase disturbance on any species assessed at Project Bravo as no adverse significant impacts are predicted.

Project Alpha and Project Bravo Combined

Disturbance and Displacement Impacts

Guillemot

Magnitude of Impact

8.289. The approach, assumptions and information used to estimate the magnitude of displacement impacts on guillemot at Project Alpha and Project Bravo combined is consistent with that used in the assessment for Project Alpha.

8.290. The peak population estimate within the combined Project Alpha and Project Bravo combined plus a 2km buffer occurred during the breeding period in 2017 (July) and in 2009 to 2011 (June). A mean peak breeding population of 22,074 birds was calculated in the breeding season for use in the assessment of disturbance/displacement (Appendix 8A

[Ornithology Technical Report]). This is equivalent to 1.55% of the national breeding population (1,420,000 individuals) or 10.05% of the regional breeding population (219,623 individuals). Should data from July 2017 be removed from the process of establishing a metric for use in assessing disturbance and displacement a mean peak population of 15,104 is established. This is equivalent to 1.06% of the national breeding population (1,420,000 individuals) or 6.88% of the regional breeding population (219,623 individuals).

8.291. A mean peak non-breeding (October to March) population for Project Alpha and Project Bravo combined plus a 2km buffer of 8,949 birds has been calculated in (Appendix 8A [Ornithology Technical Report]). Assessed against the North Sea non-breeding population of 1,617,306 individuals as defined as the regional BDMPS by Furness (2015). The mean peak population for Project Alpha and Project Bravo combined plus a 2km buffer accounts for 0.55% of this regional reference population. The national non-breeding population is defined at 2,756,526 individuals, with the non-breeding estimate for Project Alpha and Bravo combined accounting for 0.32%.

8.292. It is considered that extensive and consistent disturbance of the guillemot population within the Project Alpha and Project Bravo combined plus a 2km buffer is unlikely, with any disturbance localised within an area around the source (e.g. turbine installation or inter-array cable laying). Numbers affected will depend on the overlap of such activity with food resources at any particular time. On this basis, it is considered that no material effects on the regional guillemot population could be envisaged as a result of construction phase disturbance impacts.

8.293. The impact is predicted to be of local spatial extent, for part of the project duration, intermittent and high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the guillemot populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Receptor Sensitivity

8.294. There has been an increase in national populations over the last decade (+5%), although the Scottish population is relatively stable or possibly slightly in decline[5]. In addition, guillemot lays a single egg and is a late first breeder (Table 8.10). Guillemot is therefore considered to have a medium recoverability potential. Given that guillemot is deemed to be of moderate vulnerability, medium recoverability and international value, the sensitivity of the receptor is considered to be **medium**.

Impact Significance

8.295. Overall, the sensitivity of guillemot is considered to be **medium** and the impact magnitude is deemed to be **low**. The impact of disturbance in the construction phase on guillemot at Project Alpha and Project Bravo combined, is predicted to be **Minor Adverse** and therefore **Not Significant** in EIA terms.

[5] http://jncc.defra.gov.uk/page-2898

Razorbill

Magnitude of Impact

8.296. The approach, assumptions and information used to estimate the magnitude of displacement impacts on razorbill at Project Alpha and Project Bravo combined is consistent with that used in the assessment for Project Alpha.

8.297. The peak population estimate within Project Alpha and Project Bravo combined plus a 2km buffer occurred during the breeding period (July) in both 2009 to 2011 and in 2017. A mean peak breeding population of 8,324 birds was calculated in the breeding season for use in the assessment of disturbance/displacement (Appendix 8C [Displacement of Seabirds]). This is equivalent to 4.49% of the national breeding population (187,100 individuals) or 20.29% of the regional breeding population (41,009 individuals). Should data from July 2017 be removed from the process of establishing a metric for use in assessing disturbance and displacement a mean peak population of 4,282 is established. This is equivalent to 2.29% of the national breeding population (187,100 individuals) or 10.44% of the regional breeding population (41,009 individuals).

8.298. A mean peak non-breeding (October to March) population for Project Alpha and Project Bravo combined plus a 2km buffer of 2,105 birds has been calculated in (Appendix 8A [Ornithology Technical Report]). Assessed against the North Sea non-breeding population of 218,622 individuals as defined as the regional BDMPS by Furness (2015). The mean peak population for Project Alpha and Project Bravo combined plus a 2km buffer accounts for 0.96% of this regional reference population.

8.299. It is considered that extensive disturbance of the razorbill population within Project Alpha and Project Bravo combined plus a 2km buffer unlikely, with any disturbance localised within an area around the source (e.g. turbine installation or inter-array cable laying). Numbers affected will depend on the overlap of such activity with food resources at any particular time. It is considered, that it is most appropriate to assess a mean-peak population figure without July 2017 (and therefore part of the unusual foraging event recorded at this time). On this basis, it is considered that no material effects on the regional razorbill population could be envisaged as a result of construction phase disturbance impacts.

8.300. The impact is predicted to be of local spatial extent, for part of the project duration, intermittent and high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the razorbill populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Receptor Sensitivity

8.301. There has been an increase in national populations over the last decade (+21%), although the Scottish population is relatively stable. In addition, razorbill lays a single egg and is a late first breeder (Table 8.10), so is therefore considered to have a medium recoverability potential. Given that razorbill is deemed to be of moderate vulnerability, medium recoverability and international value, the sensitivity of the receptor is therefore considered to be **medium**.

Impact Significance

8.302. Overall, the sensitivity of razorbill is considered to be **medium** and the impact magnitude is deemed to be **low**. The impact of disturbance in the construction phase on razorbill at Project Alpha and Project Bravo combined is predicted to be **Minor Adverse** and therefore **Not Significant** in EIA terms.

Puffin

Magnitude of Impact

8.303. The approach, assumptions and information used to estimate the magnitude of displacement impacts on guillemot at Project Alpha and Project Bravo combined is consistent with that used in the assessment for Project Alpha.

8.304. The peak population estimate within Project Alpha and Project Bravo combined plus a 2km buffer occurred during the breeding period for both the 2009 to 2011 (June) and 2017 (August) surveys. A mean peak breeding population of 5,634 birds was calculated in the breeding season for use in the assessment of disturbance/displacement (Appendix 8A [Ornithology Technical Report]). This is equivalent to 0.49% of the national breeding population (1,161,400 individuals) or 1.51% of the regional breeding population (373,138 individuals).

8.305. The scoping opinion for Seagreen states that puffin disperse widely in the non-breeding season and will not be present in any significant numbers. It has been advised that assessment of disturbance/displacement is therefore not required.

8.306. The impact is predicted to be of local spatial extent, for part of the project duration, intermittent and high reversibility In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the puffin populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Receptor Sensitivity

8.307. There has been an increase in national populations over the last decade (+19%), with a likely increase also occurring in Scotland. Puffin lays a single egg and is a late first breeder (Table 8.10) so is therefore considered to have a medium recoverability potential. Given puffin is deemed to be of moderate vulnerability, medium recoverability and international value, the sensitivity of the receptor is considered to be **medium**.

Impact Significance

8.308. Overall, the sensitivity of puffin is considered to be **medium** and the impact magnitude is deemed to be **low**. The impact of disturbance in the construction phase on puffin at Project Alpha and Project Bravo combined is predicted to be **Minor Adverse** and therefore **Not Significant** in EIA terms.

Additional Mitigation

8.309. No additional mitigation is either required or proposed in relation to Construction phase disturbance on any species assessed at Project Alpha and Project Bravo combined as no adverse significant impacts are predicted.

IMPACT ASSESSMENT – OPERATIONAL PHASE

Project Alpha

Disturbance

8.310. Disturbance to birds due to the presence of operational offshore wind farms is considered to be of a lower intensity than during the construction/decommissioning phases, and limited to maintenance activities as well as vessel and helicopter trips to and from the operations base or site service operations vessel (SOV), and also post-construction monitoring survey activity. The WCS for the Development considered for operation and maintenance disturbance is outlined in Table 8.18.

8.311. In many cases operation and maintenance disturbance may be indistinguishable from displacement, as birds of particular species may be susceptible to both impacts. A bird that has already been displaced from the wind farm may not be affected by operation and maintenance disturbance. Conversely, operation and maintenance disturbance may exacerbate the impact of displacement if it occurs in an area where birds have been displaced to (e.g. supply vessels *en route* to and from Project Alpha). As it is not straightforward to predict the long-term displacement reactions of birds to turbines, the impacts of operation and maintenance disturbance have been considered in isolation. An assessment of displacement impacts follows this section.

8.312. The operation and maintenance of the Development is likely to be managed from an operations base and may involve an SOV on site (with the use of crew transfer vessels and other support vessels if necessary). Regular maintenance of turbines will occur throughout the year. Periodic inspection of the inter-array cables will be undertaken by remotely operated vehicles and/or geophysical survey to check that cables have not been exposed due to seabed movements, in which case remedial burial work or other cable protection methods will be required.

Guillemot, Razorbill, Puffin and Kittiwake

Magnitude of Impact

8.313. It is expected that there will be daily boat movements within Project Alpha during operation and maintenance. Operational vessels are likely to be much less intrusive to seabird species than those associated with construction activities. Impacts on guillemot, razorbill, puffin and kittiwake are therefore likely to be of a lower magnitude than disturbance during construction, with birds likely to be affected in a smaller radius around the area of activity, compared to activities during construction such as foundation and WTG installation for example.

8.314. The ultimate consequence of disturbance may be increased mortality to an extent similar to (although likely more restricted in spatial extent) displacement impacts (see following displacement section) with birds during the breeding season more likely to be susceptible to such impacts. As such, the impact is predicted to be of local spatial extent, long term duration, and intermittent and low to medium reversibility within the context of any international, national or regional population. If it is assumed that the magnitude of loss is similar to the identified displacement impacts (see following displacement section) although reduced in spatial scale it is considered to be **negligible** for all species.

Receptor Sensitivity

8.315. The overall sensitivity of receptors is considered to be of the same levels as those relating to disturbance during construction. Although scientific evidence on the effects of wind farm maintenance activities is lacking, there is no reason to suggest that any receptor will react differently to operation and maintenance activity as opposed to construction phase activity.

Significance of the Impact

8.316. An impact of negligible magnitude on **low** to **medium** sensitivity receptors will produce an impact of **Negligible** or **Minor Adverse** for guillemot, razorbill, puffin and kittiwake, which is considered to be **Not Significant** in EIA terms.

Displacement

8.317. Within this assessment of operational displacement, the species assessed are guillemot, razorbill, puffin and kittiwake. Full displacement matrices for each biological season are presented in Appendix 8C (Displacement of Seabirds). The buffer taken forward to the impact assessment of all species assessed is 2km as recommended by JNCC *et al.* (2017).

Guillemot

Magnitude of Impact

8.318. The displacement rate considered appropriate for guillemot is 50 to 60% across all seasons while the mortality rate considered appropriate is 1%.

8.319. Searle *et al.* (2014) explored the population effects of displacement from proposed wind energy developments, including the guillemot feature of the Forth Islands SPA and Fowlsheugh SPA. The model suggested that population level impact on common guillemot breeding success at colonies in the Forth Islands SPA and other nearby SPAs would be less than a reduction of 1% in all cases and all modelled scenarios, even as a cumulative impact of all proposed new offshore wind farms close to the colonies (Inch Cape, Neart na Gaoithe and Project Alpha and Project Bravo). The model suggested that population level impact on guillemot adult survival would be less than a 0.5% reduction in survival.

8.320. The work suggests that displacement/barrier effects of offshore wind farms within the main foraging area of breeding guillemots could have an impact on productivity and adult body condition. However, impacts of the scale assessed were considered to be below levels that would give rise to concern regarding the conservation status of these guillemot populations. Consideration of the species ecology suggested that displacement of non-breeding guillemots is unlikely to affect the survival rates of displaced birds under most circumstances, but that an impact could occur if prey fish abundance was reduced to unusually low levels such that food shortage caused increased mortality. In that situation, loss of foraging habitat due to displacement could marginally increase mortality in combination with the impact caused by food shortage (Searle *et al.* 2014).

Breeding Season

8.321. The mean peak guillemot population estimate calculated for Project Alpha plus a 2km buffer during the breeding season (April to July) was 13,606 birds (Appendix 8A [Ornithology Technical Report]). Based on a displacement rate of 50 to 60% and a mortality rate of 1% during the breeding season, between 68 to 82 guillemots may be lost as a result of displacement (Appendix 8C [Displacement of Seabirds]). However, if July 2017 data is excluded from the process, a mean peak population of 9,129 would result in a displacement mortality of between 46 and 55 guillemots

8.322. Assessed against the defined guillemot regional breeding population (219,623 birds) the predicted mortality from breeding season displacement does not surpass the 1% baseline mortality figure (0.50 to 0.61%) (as calculated in Appendix 8C [Displacement of Seabirds]). This conclusion is reached no matter which mean peak population is applied or whether 50 or 60% displacement rates are applied.

8.323. The impact is predicted to be of regional spatial extent for the project duration, continuous and of high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the razorbill populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Non-breeding Season

8.324. During the non-breeding season (September to March) the mean peak guillemot population estimate analysed in Appendix 8C (Displacement of Seabirds) is 4,688 birds for Project Alpha plus a 2km buffer.

8.325. Based on a 50 to 60% displacement rate and 1% mortality rate, a displacement mortality of 23 to 28 birds is predicted. From a regional BDMPS non-breeding population of 1,617,306 individuals this level of mortality is considerably short of the 1% of baseline mortality figure (0.02 to 0.03%).

8.326. The impact is predicted to be of local spatial extent for the project duration, continuous and of low to medium reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the guillemot populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). The predicted impact in relation to the SPA populations is negligible in real terms and therefore the impact magnitude is considered to be **negligible**.

Receptor Sensitivity

8.327. Guillemot is considered to be of international conservation value within the context of Project Alpha. The species is considered to be of moderate vulnerability to displacement (Wade *et al.*, 2016), and may be particularly sensitive during the post-breeding period during moult and when attending young at sea.

8.328. There has been an increase in national populations over the last decade (+5%), although the Scottish population is relatively stable or possibly slightly in decline. In addition, guillemot lays a single egg and is a late first breeder (Table 8.10). Guillemot is therefore considered to have a medium recoverability potential. Given that guillemot is deemed to be of moderate vulnerability, medium recoverability and international value, the sensitivity of guillemot is considered to be **medium**.

Impact Significance

8.329. Overall, the sensitivity of guillemot is considered to be **medium** and the impact magnitude is deemed to be **negligible** (non-breeding) to **low** (breeding). The impact of displacement in the operational phase on guillemot at Project Alpha, is predicted to be **Negligible** to **Minor Adverse** and therefore **Not Significant** in EIA terms.

Razorbill

Magnitude of Impact

8.330. The displacement rate considered appropriate for razorbill is 40 to 60% across all seasons while the mortality rate considered appropriate is 1%.

8.331. Searle *et al.* (2014) explored the population effects of displacement from proposed wind energy developments, including the razorbill feature of Forth Islands SPA. The analysis investigated change in adult survival and, breeding success, with results for razorbill showing a relatively high degree of certainty. No combinations of impact scenarios indicated a notable decline for razorbill (all individual wind farms produced declines of adult survival of less than 0.12%).

Breeding Season

8.332. The mean peak razorbill population estimate calculated for Project Alpha plus a 2km buffer during the breeding season (April to August) was 5,876 birds (Appendix 8A [Ornithology Technical Report]). Based on a displacement rate of 40 to 60% and a mortality rate of 1% during the breeding season, between 24 and 35 razorbills may be lost as a result of displacement (Appendix 8C [Displacement of Seabirds]). However, if July 2017 data is excluded from the process, a mean peak population of 3,221 would result in a displacement mortality of between 13 and 19 razorbills.

8.333. Assessed against the defined razorbill regional breeding population (41,009 birds) the predicted mortality from breeding season displacement does not surpass the 1% baseline mortality figure (Appendix 8C [Displacement of Seabirds]). This conclusion is reached no matter which mean peak population is applied or whether 40 or 60% displacement rates are applied.

8.334. The impact is predicted to be of regional spatial extent for the project duration, continuous and of high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the razorbill populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Non-breeding Season

8.335. During the non-breeding season (September to March) the mean peak razorbill population estimate analysed in Appendix 8C (Displacement of Seabirds) is 1,003 birds for Project Alpha plus a 2km buffer.

8.336. Based on a 40 to 60% displacement rate and 1% mortality rate, a displacement mortality of 4 to 6 birds is predicted. From a regional BDMPS non-breeding population of 218,622 individuals this level of mortality considerably short of the 1% of baseline mortality figure.

8.337. The impact is predicted to be of local spatial extent for the project duration, continuous and of low to medium reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the razorbill populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). The predicted impact in relation to the SPA populations is negligible in real terms and therefore the impact magnitude is considered to be **negligible**.

Receptor Sensitivity

8.338. Razorbill is considered to be of international conservation value; Project Alpha lies within the mean maximum foraging range of SPA colonies that include this species as a qualifying feature. With a regional and national population trend likely to be relatively stable, but with low productivity rate, the species' recoverability is considered to be medium. Behaviourally, razorbill was considered to be of high vulnerability to displacement by Wade *et al.* (2016), although the results of Searle *et al.* (2014) suggest that this rating may be somewhat precautionary. In summary, razorbill is deemed to be of high vulnerability, medium recoverability and international value. The sensitivity of razorbill is therefore, considered to be **medium**.

Impact Significance

8.339. Overall, the sensitivity of razorbill is considered to be **medium** and the impact magnitude is deemed to be **negligible** (non-breeding) to **low** (breeding). The impact of displacement in the operational phase on razorbill at Project Alpha, is predicted to be **Negligible** to **Minor Adverse** and therefore **not significant** in EIA terms.

Puffin

Magnitude of Impact

8.340. The displacement rate considered appropriate for puffin is 50 to 60% across all seasons while the mortality rate considered appropriate is 2%.

Breeding Season

8.341. The mean peak puffin population estimate calculated for Project Alpha plus a 2km buffer during the breeding season (April to August) was 2,572 birds (Appendix 8A [Ornithology Technical Report]). Based on a displacement rate of 50 to 60% and a mortality rate of 2% during the breeding season, between 26 and 31 puffins may be lost as a result of displacement (Appendix 8C [Displacement of Seabirds]).

8.342. Assessed against the defined puffin regional breeding population (373,138 birds) the predicted mortality from breeding season displacement does not surpass the 1% baseline mortality figure (Appendix 8C [Displacement of Seabirds]). This conclusion is reached no matter whether 50 or 60% displacement rates are applied.

8.343. During the breeding season not all puffins attending colonies and adjacent waters are breeding adults. Puffins do not usually breed until they are five years old (Cramp and Perrins 1977 to 1994) and unlike gannets and gulls it is not possible to separate adults from older age classes from immature birds during site-specific observations offshore. However, data from other studies indicate that during the breeding period at least 35% of all puffins present may be non-breeding or immature birds and therefore not part of the SPA breeding adult population (Harris and Wanless, 2011).

8.344. This is potentially an underestimate of actual proportions of non-breeders further offshore at Project Alpha. Votier *et al.* (2008) observed that immature and non-breeding guillemots from Skomer Island, Wales spread out further than breeding adults and it is likely that this pattern is replicated by puffins. Boat-based surveys in the North Sea by Camphuysen (2005) found that most foraging was concentrated around the major colonies, and that within 20km of land, 99% of puffins were adults in breeding plumage. In contrast, further offshore, many puffins still had traces of winter plumage, suggesting that they were non-breeders that spent less time ashore. A higher proportion of non-breeders are therefore likely to occur further offshore. It is considered likely that a notable proportion of puffins recorded during boat-based surveys in the breeding season are immature individuals. In addition, a further proportion is likely to be non-breeding adult birds. Therefore, mortality predicted during the breeding season is considered likely to result in considerably less than nine adult birds from the regional breeding population.

8.345. The impact is predicted to be of regional spatial extent for the project duration, continuous and of high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the puffin populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Receptor Sensitivity

8.346. Puffin is considered to be of international conservation value and the Project Alpha is within the mean maximum foraging range of SPA colonies that include this species as a qualifying feature. With a regional and national population trend likely to be relatively stable, but with low productivity rate, the species' recoverability is considered to be low. Behaviourally, puffin was considered to be of moderate vulnerability to displacement by Wade *et al.* (2016). In summary, puffin is deemed to be of moderate vulnerability, low recoverability and international value. The sensitivity of the puffin is therefore, considered to be **medium**.

Impact Significance

8.347. Overall, the sensitivity of puffin is considered to be **medium** and the impact magnitude is deemed to be **low**. The impact of displacement in the operational phase on puffin at Project Alpha, is predicted to be **Minor Adverse** and therefore **Not Significant** in EIA terms.

Kittiwake

Magnitude of Impact

8.348. The displacement rate considered appropriate for kittiwake is 30% across all seasons while the mortality rate considered appropriate is 2%.

8.349. Searle *et al.* (2014) modelled the consequences for breeding success and survival of a barrier effect and displacement of breeding kittiwakes at SPA colonies on the east coast of Scotland by proposed offshore wind farms that may be constructed within their colony-specific foraging areas. Simulations suggested that a decline in adult kittiwake survival of more than 0.5% might be possible for kittiwakes at Forth Island SPA and Fowlsheugh SPA but not for kittiwakes at St Abbs Head to Fast Castle SPA or Buchan Ness to Collieston Coast SPA. Results for impact on breeding success were similar, suggesting that it was possible that a relatively small impact was would occur.

Breeding Season

8.350. The mean peak kittiwake population estimate calculated for Project Alpha plus a 2km buffer during the breeding season (April to July) was 7,213 birds (Appendix 8A [Ornithology Technical Report]). Based on a displacement rate of 30% and a mortality rate of 2%, 43 kittiwakes may be lost as a result of displacement (Appendix 8C [Displacement of Seabirds]).

8.351. The peak in the number of kittiwake recorded in the July 2017 survey is thought to represent an abundance of prey that attracted birds from the surrounding area in addition to the commencement of post-breeding dispersal and passage movements with these birds potentially lingering because of the increased foraging opportunities supported by increased observations of foraging behaviour and a simultaneous increase in marine mammal records at this time. If July 2017 data is excluded from the process, a mean peak population of 2,884 would result in a displacement mortality of 17 kittiwakes.

8.352. Assessed against the defined kittiwake regional breeding population (77,664 birds) the predicted mortality from breeding season displacement does not surpass the 1% baseline mortality figure (Appendix 8C [Displacement of Seabirds]). This conclusion is reached no matter which mean peak population is applied.

8.353. The impact is predicted to be of regional spatial extent for the project duration, continuous and of high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the kittiwake populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Post-breeding Season

8.354. During the post-breeding season (September to December) the mean peak kittiwake population estimate analysed in Appendix 8C (Displacement of Seabirds) is 3,184 birds for Project Alpha plus a 2km buffer.

8.355. Based on a 30% displacement rate and 2% mortality rate, a displacement mortality of 19 birds is predicted. From a regional BDMPS non-breeding population of 829,937 individuals this level of mortality considerably short of the 1% of baseline mortality figure.

8.356. The impact is predicted to be of local spatial extent for the project duration, continuous and of low to medium reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the kittiwake populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Pre-breeding Season

8.357. During the post-breeding season (December to March) the mean peak kittiwake population estimate analysed in Appendix 8C (Displacement of Seabirds) is 1,112 birds for Project Alpha plus a 2km buffer.

8.358. Based on a 30% displacement rate and 2% mortality rate, a displacement mortality of seven birds is predicted. From a regional BDMPS non-breeding population of 627,816 individuals this level of mortality is considerably short of the 1% of baseline mortality figure.

8.359. The impact is predicted to be of local spatial extent for the project duration, continuous and of low to medium reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the kittiwake populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Receptor Sensitivity

8.360. Kittiwake is considered to be of international conservation value and Project Alpha lies within the mean maximum foraging range of SPA colonies that include this species as a qualifying feature. With regional and national population trends indicating declines, with low productivity rate, the species' recoverability is considered to be low. Behaviourally, kittiwake was considered to be of low vulnerability to displacement by Wade *et al.* (2016). In summary, kittiwake is deemed to be of low vulnerability, low recoverability and international value. The sensitivity of kittiwake is therefore, considered to be **medium**.

Impact Significance

8.361. Overall, the sensitivity of kittiwake is considered to be **medium** and the impact magnitude is deemed to be **low**. The impact of displacement in the operational phase on kittiwake at Project Alpha is predicted to be **Minor Adverse** and therefore **Not Significant** in EIA terms.

Collision

Overview of Approach

8.362. Table 8.20 presents a summary of mean collision risk modelling results for Project Alpha, showing annual and seasonal results for each species at appropriate Band (2012) model options and avoidance rates. These results apply monthly mean data using all baseline data available (i.e. 2009 to 2011 and 2017). The assessments presented in the following sections for gannet and kittiwake are based on collision risk estimates calculated using Option 1. Option 1 uses site-specific flight height data which is considered to best represent the flight behaviour of birds at the optimised Seagreen Project for use in collision risk modelling. Collision risk estimates calculated using Option 2 for gannet and kittiwake are also presented in the following sections to enable the reader to draw comparisons, if required. Herring gull was not recorded in adequate numbers to allow for site-specific flight height data to be used in collision risk modelling. Therefore collision risk estimates have been calculated using Options 2 and 3 which utilise generic flight height data from Johnston *et al.* (2014).

8.363. Collision risk estimates have also been calculated using the upper and lower confidence metrics associated with flight height data and avoidance rate (where possible), which are fully detailed in Appendix 8B (Collision Risk Modelling). Within the following species sections consideration has been given to the range of collision risk estimates calculated incorporating the variability of metrics (where available). It is however considered that the collision risk estimates calculated using the mean estimate (density data and avoidance rate) or maximum likelihood value (flight height data) are those on which any assessment should be based.

8.364. As advised by Marine Scotland, collision risk estimates used to inform the assessments presented below use flight speed data sourced from Alerstam *et al.* (2007) or Pennycuick (1987). However, more recent, representative flight speed data has been collected by Skov *et al.* (2018) with these data suggesting that the flight speeds presented in Alerstam *et al.* (2007) and Pennycuick (1987) overestimate the realistic flight speeds and therefore the risk of collision for seabirds. The following sections therefore include consideration of the potential implications of using the updated flight speeds from Skov *et al.* (2018) with collision risk estimates calculated using these flight speeds presented in Appendix 8B (Collision Risk Modelling).

Table 8.20 Collision risk results for Project Alpha

Species	Band Model Option	Avoidance Rate (%)	Annual mortality rate at appropriate avoidance rate[B,C]	Number of Collisions[A]			
				Breeding season mortality	Post-breeding season mortality	Non-breeding season mortality	Pre-breeding season mortality
Gannet	1	98.9	90	80	5	-	5
	2	98.9	209	191	8	-	9
Kittiwake	1	98.9	238	114	90	-	34
	2	98.9	231	100	96	-	36
Herring gull	2	99.5	12	3	-	9	-
	3	99.0	8	2	-	6	-

[A]The grey cells denote where no mortality estimates were calculated due to inappropriate model type for the data available and/or a season (1) in which a species has no population that interacts with Project Alpha, or (2) not defined for the species considered.
[B]All mortality estimates presented are rounded to a whole number (i.e. whole bird). Mortality estimates have been summed across seasons using the actual value, the resultant decimal value only then rounded to a whole number. The latter rounded value may differ to the less accurate summation of whole numbers presented for each season.
[C]All collision outputs used within this EIA Report are informed by seabird flight speeds taken from either Alerstam *et al.* (2007) or Pennycuick (1987). The implications of using more contemporary data from Skov *et al.* (2018) is presented in Appendix 8B (Collision Risk Modelling) and further discussed in this EIA Report.

Gannet

Magnitude of Impact

8.365. An annual mortality rate of 90 collisions/annum is predicted for gannet using Band Option 1 at an avoidance rate of 98.9% and 209 collisions/annum when using Band Option 2 at a 98.9% avoidance rate (Table 8.21).

8.366. The variability associated with the collision risk estimates has also been considered in relation to flight height data and avoidance rate. Appendix 8B (Collision Risk Modelling) presents the variability associated with each of these aspects of CRM. The greatest degree of variability in the collision risk estimates for gannet is however caused by the flight height data applied. This variability results from differences between site-specific data (used for Option 1) and generic flight height data (used for Options 2 and 3). Site-specific data is considered to best reflect the behaviour of birds at the optimised Seagreen Project with these data validated by laser rangefinder data.

Breeding Season

8.367. The breeding season for gannet accounts for approximately 89% of annual collisions at Project Alpha. When using Option 1 at a 98.9% avoidance rate (80 collisions) this represents a 0.62% change in baseline mortality of the regional breeding population.

8.368. The degree of variability associated with avoidance rates used in collision risk modelling for gannet is considered to represent a negligible change in resulting collision risk estimates in terms of the effect on the regional breeding population (see monthly collision risk values presented Appendix 8B [Collision Risk Modelling]). If flight speed data from Skov *et al.* (2018) is applied to the CRM, a 6% reduction in gannet collision rates is expected (Appendix 8B [Collision Risk Modelling]).

Table 8.21 Gannet seasonal collision risk results for Project Alpha expressed as change in regional population baseline mortality based on collision risk estimates calculated using the mean estimate

CRM option (Avoidance rate)	Season	Collision mortality	Baseline mortality of regional population (individuals/ annum)	Increase in baseline mortality (%)
Band Option 1 (98.9%)	Breeding	80	12,815	0.62
	Post-breeding	5	36,960	0.01
	Pre-breeding	5	20,119	0.02
	Total	**90**	-	-
Band Option 2 (98.9%)	Breeding	191	12,815	1.49
	Post-breeding	8	36,960	0.02
	Pre-breeding	9	20,119	0.04
	Total	**209**	-	-

8.369. The impact is predicted to be of regional spatial extent for the project duration and of medium reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the gannet populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). The predicted impact in relation to the SPA populations is negligible in real terms and therefore the impact magnitude is considered to be **low**.

Post-breeding Season

8.370. The post-breeding season for gannet accounts for approximately 5% of annual collisions at Project Alpha. When using Option 1 at a 98.9% avoidance rate (five collisions) this represents a 0.01% change in baseline mortality of the regional post-breeding population.

8.371. The impact is predicted to be of regional spatial extent for the project duration, continuous and of low to medium reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the gannet populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). The predicted impact in relation to the SPA populations is negligible in real terms and therefore the impact magnitude is considered to be **negligible**.

Pre-breeding Season

8.372. The pre-breeding season for gannet accounts for a just 6% of annual collisions at Project Alpha. When using Option 1 at a 98.9% avoidance rate (five collisions) this represents a 0.02% change in baseline mortality of the regional post-breeding population.

8.373. The impact is predicted to be of regional spatial extent for the project duration, continuous and of low to medium reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the gannet populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **negligible**.

Sensitivity of the Receptor

8.374. As a qualifying feature of regional SPAs, gannet is afforded international conservation value. It was ranked high in terms of vulnerability to collisions by Wade *et al.* (2016) although moderate vulnerability by Langston (2010). High vulnerability is considered appropriate within this assessment.

8.375. Gannet is deemed to be of high vulnerability, high recoverability and international value. The sensitivity of gannet is therefore, considered to be **high**.

Impact Significance

8.376. Overall, the sensitivity of gannet is considered to be high and the impact magnitude is deemed to be **negligible** (post- and pre-breeding) to **low** (breeding). The impact will therefore be **Minor** to **Moderate Adverse.** The MS-LOT scoping opinion says "The Scottish Ministers advise that the conservation objective relating to the population of species as a viable component of the site should be the focus of the assessment". On this basis the predicted impact is considered **Not Significant** in EIA terms because the risk that the population will reduce below the size at designation (Forth Islands SPA) and from which it has grown to its current size, is considered to be **low**.

Kittiwake

Magnitude of Impact

8.377. At Project Alpha, an annual mortality rate of 238 collisions/annum is predicted for kittiwake using Band Option 1 at an avoidance rate of 98.9% and 231 collisions/annum when using Band Option 2 at a 98.9% avoidance rate (Table 8.22).

Table 8.22 Kittiwake seasonal collision risk results for Project Alpha expressed as change in regional population baseline mortality based on collision risk estimates calculated using the mean estimate

CRM option (Avoidance rate)	Season	Collision mortality	Baseline mortality of regional population (individuals/annum)	Increase in baseline mortality (%)
Band Option 1 (98.9%)	Breeding	114	11,339	1.01
	Post-breeding	90	121,171	0.07
	Pre-breeding	34	91,661	0.04
	Total	**238**	**-**	**-**
Band Option 2 (98.9%)	Breeding	100	11,339	0.88
	Post-breeding	96	121,171	0.08
	Pre-breeding	36	91,661	0.04
	Total	**231**	**-**	**-**

Breeding Season

8.378. The breeding season for kittiwake accounts for approximately 48% of annual collisions at Project Alpha. When using Option 1 at a 98.9% avoidance rate (114 collisions) this represents a 1.01% change in baseline mortality of the regional breeding population.

8.379. The degree of variability associated with avoidance rates used in collision risk modelling for kittiwake is considered to represent a negligible change in resulting collision risk estimates in terms of the effect on the regional breeding population (see monthly collision risk values presented Appendix 8B [Collision Risk Modelling]). If flight speed data from Skov *et al.* (2018) is applied to the CRM, an approximate 19% reduction in kittiwake collision rates is expected (Appendix 8B [Collision Risk Modelling]). In addition, the data assessed for breeding season kittiwake collision impacts includes that from July 2017, when an unusual foraging event occurred with atypically high densities of birds. Considering all these factors, it is likely that the number of collisions predicted is overly precautionary by at least 25%.

8.380. The impact is predicted to be of regional spatial extent, to occur throughout the duration of the project and to be of low to medium reversibility with a slight change from baseline conditions. The impact magnitude is therefore, considered to be **low**.

Post-breeding Season

8.381. The post-breeding season for kittiwake accounts for approximately 38% of annual collisions at Project Alpha. When using Option 1 at a 98.9% avoidance rate (90 collisions) this represents a 0.07% change in baseline mortality of the regional post-breeding population.

8.382. The impact is predicted to be of regional spatial extent for the project duration, continuous and of low to medium reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the kittiwake populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Pre-breeding Season

8.383. The pre-breeding season for kittiwake accounts for 14% of annual collisions at Project Alpha. When using Option 1 at a 98.9% avoidance rate (34 collisions) this represents a 0.04% change in baseline mortality of the regional post-breeding population.

8.384. The impact is predicted to be of local spatial extent for the project duration, continuous and of low to medium reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the kittiwake populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Sensitivity of the Receptor

8.385. Kittiwake was rated as having relatively high vulnerability to collision impacts by Wade *et al.* (2016), due to the proportion of flights likely to occur at potential risk height and percentage of time in flight, including at night. From previous studies in Flanders that have recorded mortality rates and collision rates, estimated micro-avoidance rates were, however, high for smaller gulls (Everaert, 2006; 2008; 2011; Everaert *et al.*, 2002; Everaert and Kuijken, 2007). Studies have also shown that rates are consistently above 98% for flights at rotor height (GWFL, 2011). The report for Marine Scotland (Cook *et al.*, 2014) considers that a 99.2% avoidance rate is appropriate for the 'Basic' Band Model.

8.386. Kittiwake is deemed to be of high vulnerability, low recoverability and international value. The sensitivity of kittiwake is therefore, considered to be **medium**.

Impact Significance

8.387. Overall, the sensitivity of kittiwake is considered to be **medium** and the impact magnitude is deemed to be **low**. The impact will therefore be **Minor Adverse**, which is **Not Significant** in EIA terms.

Herring Gull

Magnitude of impact

8.388. At Project Alpha, an annual mortality rate of twelve collisions/annum is predicted for herring gull using Band Option 2 at an avoidance rate of 99.5% and eight collisions/annum when using Band Option 3 at a 99.0% avoidance rate (Table 8.23).

Table 8.23 Herring gull seasonal collision risk results for Project Alpha expressed as change in regional population baseline mortality based on collision risk estimates calculated using the mean estimate

CRM option (Avoidance rate)	Season	Collision mortality	Baseline mortality of regional population (individuals/annum)	Increase in baseline mortality (%)
Band Option 2 (99.5%)	Breeding	3	5,919	0.05
	Non-breeding	9	77,441	0.01
	Total	**12**	-	-
Band Option 3 (99.0%)	Breeding	2	5,919	0.03
	Non-breeding	6	77,441	0.01
	Total	8	-	-

8.389. The breeding season for herring gull accounts for 25% of annual collisions at Project Alpha. When using Option 2 at a 99.5% avoidance rate (three collisions) this represents a 0.05% change in baseline mortality of the regional breeding population. When using Option 3 at a 99.0% avoidance rate (two collisions) this represents a 0.03% increase in baseline mortality.

8.390. The impact is predicted to be of regional spatial extent, to occur throughout the duration of the project and to be of low to medium reversibility. The predicted impact in relation to the SPA populations is negligible in real terms and therefore population consequences are not certain to arise for any of the SPAs assessed. The impact magnitude is therefore, considered to be **negligible**.

Non-breeding Season

8.391. The non-breeding season for herring gull accounts for approximately 69% of annual collisions at Project Alpha. When using Option 2 at a 99.5% avoidance rate (nine collisions) this represents a 0.01% change in baseline mortality of the regional post-breeding population. When using Option 3 at a 99.0% avoidance rate (six collisions) this represents a 0.01% increase in baseline mortality.

8.392. The impact is predicted to be of regional spatial extent, to occur throughout the duration of the project and to be of low to medium reversibility with a very slight change from baseline conditions (due to a low number of collisions). The impact magnitude is therefore, considered to be **negligible**.

Sensitivity of the Receptor

8.393. Herring gull was rated as being very highly vulnerable to collision impacts by Wade *et al.* (2016), due to the proportion of flights likely to occur at potential risk height and percentage of time in flight, including at night.

8.394. Herring gull is deemed to be of very high vulnerability, low recoverability and international value. The sensitivity of herring gull is therefore, considered to be **high**.

Impact Significance

8.395. Overall, the sensitivity of herring gull is considered to be **high** and the impact magnitude is deemed to be **negligible**. The impact will therefore be **Minor Adverse** which is **Not Significant** in EIA terms.

Project Bravo

Disturbance

Guillemot, Razorbill and Puffin

Magnitude of Impact

8.396. It is expected that there will be daily boat movements within Project Bravo during operation and maintenance. Operational vessels are likely to be much less intrusive to seabird species than those associated with construction activities. Impacts are therefore likely to be of a lower magnitude than disturbance during construction, with birds likely to be affected in a smaller radius around the area of activity, compared to activities during construction such as foundation and WTG installation for example.

8.397. The ultimate consequence of disturbance may be increased mortality to an extent similar to (although likely more restricted in spatial extent) displacement impacts (see following section) with birds during the breeding season more likely to be susceptible to such impacts. As such, the impact is predicted to be of local spatial extent, long term duration, and intermittent and low to medium reversibility within the context of any international, national or regional population. If it is assumed that the magnitude of loss is similar to identified displacement impacts although reduced in spatial scale it is considered to be **negligible** for all species.

Receptor Sensitivity

8.398. The overall sensitivity of receptors is considered to be of the same levels as those relating to disturbance during construction. Although scientific evidence on the effects of wind farm maintenance activities is lacking, there is no reason to suggest that any receptor will react differently to operation and maintenance activity as opposed to construction phase activity.

Impact Significance

8.399. An impact of negligible magnitude on low to medium sensitivity receptors will be of **Negligible** on regional populations for all receptors, which is considered to be **Not Significant** in EIA terms.

Displacement

8.400. Within this assessment of operational displacement, the species considered are guillemot, razorbill, puffin and kittiwake. Full displacement matrices for each biological season are presented in Appendix 8C (Displacement of Seabirds). The buffer taken forward to the impact assessment of all species assessed is 2km as recommended by JNCC *et al.* (2017).

Guillemot

Magnitude of Impact

8.401. The displacement rate considered appropriate for guillemot is 50 to 60% across all seasons while the mortality rate considered appropriate is 1%.

8.402. Searle *et al.* (2014) explored the population effects of displacement from proposed wind energy developments, including the guillemot feature of the Forth Islands SPA and Fowlsheugh SPA. Paragraphs 8.319 and 8.320 provide a summary of the results of the modelling undertaken by Searle *et al.* (2014).

Breeding Season

8.403. The mean peak guillemot population estimate calculated for the Project Bravo plus a 2km buffer during the breeding season (April to July) was 11,118 birds (Appendix 8A [Ornithology Technical Report]). Based on a displacement rate of 50 to 60% and a mortality rate of 1% during the breeding season, between 56 and 67 guillemots may be lost as a result of displacement (Appendix 8C [Displacement of Seabirds]). However, if July 2017 data is excluded from the process, a mean peak population of 6,810 would result in a displacement mortality of between 34 and 41 guillemots.

8.404. Assessed against the defined guillemot regional breeding population (219,623 birds) the predicted mortality from breeding season displacement does not surpass the 1% baseline mortality figure (Appendix 8C [Displacement of Seabirds]). This conclusion is reached no matter which mean peak population is applied or whether 50 or 60% displacement rates are applied.

8.405. The impact is predicted to be of regional spatial extent for the project duration, continuous and of high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the guillemot populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]) Therefore the impact magnitude is considered to be **low**.

Non-breeding Season

8.406. During the non-breeding season (September to March) the mean peak guillemot population estimate analysed in Appendix 8C (Displacement of Seabirds) is 4,112 birds for the Project Bravo plus a 2km buffer.

8.407. Based on a 50 to 60% displacement rate and 1% mortality rate, a displacement mortality of 21 to 25 birds is predicted. From a regional BDMPS non-breeding population of 1,617,306 individuals this level of mortality considerably short of the 1% of baseline mortality figure.

8.408. The impact is predicted to be of local spatial extent for the project duration, continuous and of low to medium reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the guillemot populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Receptor Sensitivity

8.409. There has been an increase in national populations over the last decade (+5%), although the Scottish population is relatively stable or possibly slightly in decline. In addition, guillemot lays a single egg and is a late first breeder (Table 8.10). Guillemot is therefore considered to have a medium recoverability potential. Given that guillemot is deemed to be of moderate vulnerability, medium recoverability and international value, the sensitivity of guillemot is considered to be **medium**.

Impact Significance

8.410. Overall, the sensitivity of guillemot is considered to be **medium** and the impact magnitude is deemed to be negligible (non-breeding) to **low (breeding)**. The impact of displacement in the operational phase on guillemot at Project Bravo, is predicted to be **Negligible** to **Minor Adverse** and therefore **Not Significant** in EIA terms.

Razorbill

Magnitude of Impact

8.411. The displacement rate considered appropriate for razorbill is 40 to 60% across all seasons while the mortality rate considered appropriate is 1%.

8.412. Searle *et al.* (2014) explored the population effects of displacement from proposed wind energy developments, including the razorbill feature of Forth Islands SPA. The analysis investigated change in adult survival and, breeding success, with results for razorbill showing a relatively high degree of certainty. No combinations of impact scenarios indicated a notable decline for razorbill (all individual wind farms produced declines of adult survival of less than 0.12%).

Breeding Season

8.413. The mean peak razorbill population estimate calculated for Project Bravo plus a 2km buffer during the breeding season (April to August) was 3,698 birds (Appendix 8A [Ornithology Technical Report]). Based on a displacement rate of 40 to 60% and a mortality rate of 1% during the breeding season, between 15 and 22 razorbills may be lost as a result of displacement (Appendix 8C [Displacement of Seabirds]). However, if July 2017 data is excluded from the process, a mean peak population of 1,442 would result in a displacement mortality of between 6 and 9 razorbills.

8.414. Assessed against the defined razorbill regional breeding population (41,009 birds) the predicted mortality from breeding season displacement does not surpass the 1% baseline mortality figure (Appendix 8C [Displacement of Seabirds]). This conclusion is reached no matter which mean peak population is applied or whether 40 or 60% displacement rates are applied.

8.415. The impact is predicted to be of regional spatial extent for the project duration, continuous and of high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the razorbill populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Non-breeding Season

8.416. During the non-breeding season (September to March) the mean peak razorbill population estimate analysed in Appendix 8C (Displacement of Seabirds) is 1,272 birds for Project Bravo plus a 2km buffer.

8.417. Based on a 40 to 60% displacement rate and 1% mortality rate, a displacement mortality of 5 to 8 birds is predicted. From a regional BDMPS non-breeding population of 218,622 individuals this level of mortality considerably short of the 1% of baseline mortality figure.

8.418. The impact is predicted to be of local spatial extent for the project duration, continuous and of low to medium reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the razorbill populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Receptor Sensitivity

8.419. Razorbill is considered to be of international conservation value; Project Alpha lies within the mean maximum foraging range of SPA colonies that include this species as a qualifying feature. With a regional and national population trend likely to be relatively stable, but with low productivity rate, the species' recoverability is considered to be medium. Behaviourally, razorbill was considered to be of high vulnerability to displacement by Wade *et al.* (2016), although the results of Searle *et al.* (2014) suggest that this rating may be somewhat precautionary. In summary, razorbill is deemed to be of high vulnerability, medium recoverability and international value. The sensitivity of razorbill is therefore, considered to be **medium**.

Impact Significance

8.420. Overall, the sensitivity of razorbill is considered to be **medium** and the impact magnitude is deemed to be **low**. The impact of displacement in the operational phase on razorbill at Project Bravo, is predicted to be **Minor Adverse** and therefore **Not Significant** in EIA terms.

Puffin

Magnitude of Impact

8.421. The displacement rate considered appropriate for puffin is 50 to 60% across all seasons while the mortality rate considered appropriate is 2%.

Breeding Season

8.422. The mean peak puffin population estimate calculated for Project Bravo plus a 2km buffer during the breeding season (April to August) was 3,582 birds (Appendix 8A [Ornithology Technical Report]). Based on a displacement rate of 50 to 60% and a mortality rate of 2% during the breeding season, between 36 and 43 puffins may be lost as a result of displacement (Appendix 8C [Displacement of Seabirds]).

8.423. Assessed against the defined puffin regional breeding population (373,138 birds) the predicted mortality from breeding season displacement does not surpass the 1% baseline mortality figure (Appendix 8C [Displacement of Seabirds]). This conclusion is reached no matter whether 50 or 60% displacement rates are applied.

8.424. The impact is predicted to be of regional spatial extent for the project duration, continuous and of high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the puffin populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Receptor Sensitivity

8.425. Puffin is considered to be of international conservation value and the Project Alpha is within the mean maximum foraging range of SPA colonies that include this species as a qualifying feature. With a regional and national population trend likely to be relatively stable, but with low productivity rate, the species' recoverability is considered to be low. Behaviourally, puffin was considered to be of moderate vulnerability to displacement by Wade *et al.* (2016). In summary, puffin is deemed to be of moderate vulnerability, low recoverability and international value. The sensitivity of the puffin is therefore, considered to be **medium**.

Impact Significance

8.426. Overall, the sensitivity of puffin is considered to be **medium** and the impact magnitude is deemed to be **low**. The impact of displacement in the operational phase on puffin at Project Bravo, is predicted to be **Minor Adverse** and therefore **Not Significant** in EIA terms.

Kittiwake

Magnitude of Impact

8.427. The displacement rate considered appropriate for kittiwake is 30% across all seasons while the mortality rate considered appropriate is 2%.

8.428. Searle *et al.* (2014) modelled the consequences for breeding success and survival of a barrier effect and displacement of breeding kittiwakes at SPA colonies on the east coast of Scotland by proposed offshore wind farms that may be constructed within their colony-specific foraging areas. Simulations suggested that a decline in adult kittiwake survival of more than 0.5% might be possible for kittiwakes at Forth Island SPA and Fowlsheugh SPA but not for kittiwakes at St Abbs Head to Fast Castle SPA or Buchan Ness to Collieston Coast SPA. Results for impact on breeding success were similar, suggesting that a relatively small impact was possible.

Breeding Season

8.429. The mean peak kittiwake population estimate calculated for Project Bravo plus a 2km buffer during the breeding season (April to July) was 4,159 birds (Appendix 8A [Ornithology Technical Report]). Based on a displacement rate of 30% and a mortality rate of 2%, 25 kittiwakes may be lost as a result of displacement (Appendix 8C [Displacement of Seabirds]). However, if July 2017 data is excluded from the process, a mean peak population of 2,157 would result in a displacement mortality of 13 kittiwakes.

8.430. Assessed against the defined kittiwake regional breeding population (77,664 birds) the predicted mortality from breeding season displacement does not surpass the 1% baseline mortality figure (Appendix 8C [Displacement of Seabirds]). This conclusion is reached no matter which mean peak population is applied.

8.431. The impact is predicted to be of regional spatial extent for the project duration, continuous and of high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the kittiwake populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]), therefore the impact magnitude is considered to be **low**.

Post-breeding Season

8.432. During the post-breeding season (September to December) the mean peak kittiwake population estimate analysed in Appendix 8C (Displacement of Seabirds) is 1,342 birds for Project Bravo plus a 2km buffer.

8.433. Based on a 30% displacement rate and 2% mortality rate, a displacement mortality of eight birds is predicted. From a regional BDMPS non-breeding population of 829,937 individuals this level of mortality considerably short of the 1% of baseline mortality figure.

8.434. The impact is predicted to be of local spatial extent for the project duration, continuous and of low to medium reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion (Appendix 8D [Population Viability Analysis]) do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the kittiwake populations of any of the SPAs assessed (see Chapter 15), therefore the impact magnitude is considered to be **low**.

Pre-breeding Season

8.435. During the post-breeding season (December to March) the mean peak kittiwake population estimate analysed in Appendix 8C (Displacement of Seabirds) is 941 birds for Project Bravo plus a 2km buffer.

8.436. Based on a 30% displacement rate and 2% mortality rate, a displacement mortality of six birds is predicted. From a regional BDMPS non-breeding population of 627,816 individuals this level of mortality is considerably short of the 1% of baseline mortality figure.

8.437. The impact is predicted to be of local spatial extent for the project duration, continuous and of low to medium reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the kittiwake populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]), therefore the impact magnitude is considered to be **low**.

Receptor Sensitivity

8.438. Kittiwake is considered to be a receptor of **medium** sensitivity. Kittiwake is considered to be of international conservation value and Project Bravo lies within the mean maximum foraging range of SPA colonies that include this species as a qualifying feature. With regional and national population trends indicating declines, with low productivity rate, the species' recoverability is considered to be low. Behaviourally, kittiwake was considered to be of low vulnerability to displacement by Wade *et al.* (2016). In summary, kittiwake is deemed to be of low vulnerability, low recoverability and international value. The sensitivity of kittiwake is therefore, considered to be **medium**.

Impact Significance

8.439. Overall, the sensitivity of kittiwake is considered to be **medium** and the impact magnitude is deemed to be **low**. The impact of displacement in the operational phase on kittiwake at Project Bravo, is predicted to be **Minor Adverse** and therefore **Not Significant** in EIA terms.

Collision

8.440. Table 8.24 presents a summary of collision risk modelling results for Project Bravo, showing annual and seasonal results for each species at appropriate Band (2012) model options and avoidance rates. These results apply monthly mean-peak data using all baseline data available (i.e. 2009 to 2011 and 2017).

Table 8.24 Collision risk results for Project Bravo

Species	Band model Option	Avoidance rate (%)	Annual mortality rate at appropriate avoidance rate	Number of Collisions			
				Breeding season mortality	Post-breeding season mortality	Non-breeding season mortality	Pre-breeding season mortality
Gannet	1	98.9	303	250	26	-	26
	2	98.9	157	137	10	-	10
Kittiwake	1	98.9	96	45	27	-	24
	2	98.9	163	65	52	-	46
Herring gull	2	99.5	8	3	-	5	-
	3	99.0	5	2	-	4	-

Gannet

Magnitude of Impact

8.441. An annual mortality rate of 303 collisions/annum is predicted for gannet at Project Bravo using Band Option 1 at an avoidance rate of 98.9% and 157 collisions/annum when using Band Option 2 at a 98.9% avoidance rate (Table 8.25).

8.442. The variability associated with the collision risk estimates has also been considered in relation to flight height data and avoidance rate. Appendix 8B (Collision Risk Modelling) presents the variability associated with each of these aspects of CRM. The greatest degree of variability in the collision risk estimates for gannet is however caused by the flight height data applied with Option 1 using site-specific flight height data and Option 2 using generic flight height data from Johnston *et al.* (2014).

Table 8.25 Gannet seasonal collision risk results for Project Bravo expressed as change in regional population baseline mortality based on collision risk estimates calculated using the mean estimate

CRM option (Avoidance rate)	Season	Collision mortality	Baseline mortality of regional population (individuals/annum)	Increase in baseline mortality (%)
Band Option 1 (98.9%)	Breeding	250	12,815	1.95
	Post-breeding	26	36,960	0.07
	Pre-breeding	26	20,119	0.13
	Total	**303**	**-**	**-**
Band Option 2 (98.9%)	Breeding	137	12,815	1.07
	Post-breeding	10	36,960	0.03
	Pre-breeding	10	20,119	0.05
	Total	**157**	**-**	**-**

Breeding Season

8.443. The breeding season for gannet accounts for approximately 83% of annual collisions at Project Bravo. When using Option 1 at a 98.9% avoidance rate (250 collisions) this represents a 1.95% change in baseline mortality of the regional breeding population.

8.444. The degree of variability associated with avoidance rates used in collision risk modelling for gannet is considered to represent a negligible change in resulting collision risk estimates in terms of the effect on the regional breeding population (see monthly collision risk values presented Appendix 8B [Collision Risk Modelling]). If flight speed data from Skov *et al.* (2018) is applied to the CRM, a 6% reduction in gannet collision rates is expected (Appendix 8B [Collision Risk Modelling]).

8.445. It is considered likely that a proportion of all birds recorded in the breeding season are immature individuals with older immatures indistinguishable from adult birds. In addition, a further proportion are likely to be non-breeding adult birds. Data from the breeding season at Seagreen collected through the baseline boat-based surveys indicates that 2.7% were aged as being non-adults. A further 10% of adult birds are considered to be on 'sabbatical' from breeding each year (Marine Scotland, 2017).

8.446. The impact of collision on gannet during the breeding season is predicted to be of regional spatial extent, to occur throughout the duration of the project and to be of low to medium reversibility.

8.447. The 2017 Scoping Opinion states *"The Scottish Ministers advise that the conservation objective relating to the population of species as a viable component of the site should be the focus of the assessment"*. For gannet, the relevant breeding colony of interest to SNH is Bass Rock as part of the Forth Islands SPA.

8.448. The magnitude of the impact on the Forth Islands SPA is relatively low in comparison to the size of the gannet population which is currently reported as 75,259 pairs and growing and which far exceeds the gannet population for which the SPA was designated (21,600 pairs). Nevertheless, the predicted mortality exceeds 1% of the baseline mortality within this population (233 cf. 122 individuals) and further work has been undertaken to understand the consequences of this level of impact through PVA (Appendix 8D [Population Viability Analysis]).

8.449. The outputs of the PVA modelling over the 25 year operational life time of the optimised Seagreen Project (see Chapter 16) indicate that:

- The impacted population will continue to grow at a very similar rate to that predicted by the PVA for the un-impacted population. The predicted median population growth rate (1) for the impacted population is essentially indistinguishable from that of the un-impacted population (counterfactual of the median population growth rate ≈ 1); and
- The similarity of the predicted growth rates leads to similar population outcomes. The model predicts a median end population size (in the impacted scenario) of 84,700 pairs. This is similar to the predicted population in the absence of any impact as indicated by the high ratio of the counterfactual of population size (0.96) and the centile of un-impacted population that is equivalent to the 50th centile for the impacted population (0.62).

8.450. The current gannet population far exceeds the population for which the SPA was designated and PVA modelling indicates that this population is likely to continue to grow at the predicted level of collision mortality arising from Project Bravo. At this level of impact it is considered that there is a negligible risk that the population would decline to a level at which it would no longer be considered to be a viable component of the SPA.

8.451. On the basis of the above assessment of potential impact overestimation and the PVA, the impact magnitude is therefore considered to be **low**.

Post-breeding Season

8.452. The post-breeding season for gannet accounts for approximately 8% of annual collisions at Project Bravo. When using Option 1 at a 98.9% avoidance rate (26 collisions) this represents a 0.07% change in baseline mortality of the regional post-breeding population.

8.453. The impact is predicted to be of regional spatial extent throughout the duration of the project and to be of low to medium reversibility. On the basis of the assessment of potential impact overestimation and the PVA described above in the relation to the breeding season, the post-breeding season impact magnitude is therefore considered to be **low**.

Pre-breeding Season

8.454. The pre-breeding season for gannet accounts for 9% of annual collisions at Project Bravo. When using Option 1 at a 98.9% avoidance rate (26 collisions) this represents a 0.13% change in baseline mortality of the regional post-breeding population.

8.455. The impact is predicted to be of regional spatial extent throughout the duration of the project and to be of low to medium reversibility. On the basis of the assessment of potential impact overestimation and the PVA described above in the relation to the breeding season, the pre-breeding season impact magnitude is therefore considered to be **low**.

Sensitivity of the Receptor

8.456. As a qualifying feature of regional SPAs, gannet is afforded international conservation value. It was ranked high in terms of vulnerability to collisions by Wade *et al.* (2016) although moderate vulnerability by Langston (2010). High vulnerability is considered appropriate within this assessment. Gannet is deemed to be of high vulnerability, high recoverability and international value. The sensitivity of gannet is therefore, considered to be **high**.

Impact Significance

8.457. Overall, the sensitivity of gannet is considered to be **high** and the impact magnitude is deemed to be **low.** The impact will therefore be **Moderate adverse.** The MS-LOT scoping opinion says "The Scottish Ministers advise that the conservation objective relating to the population of species as a viable component of the site should be the focus of the assessment". On this basis the predicted impact is considered **not significant** in EIA terms because the risk that the population will reduce below the size at designation (Forth Islands SPA) and from which it has grown to its current size, is considered to be low.

Kittiwake

Magnitude of Impact

8.458. At Project Bravo, an annual mortality rate of 96 collisions/annum is predicted for kittiwake using Band Option 1 at an avoidance rate of 98.9% and 163 collisions/annum when using Band Option 2 at a 98.9% avoidance rate (Table 8.26).

Table 8.26 Kittiwake seasonal collision risk results for Project Bravo expressed as change in regional population baseline mortality based on collision risk estimates calculated using the mean estimate

CRM option (Avoidance rate)	Season	Collision mortality	Baseline mortality of regional population (individuals/annum)	Increase in baseline mortality (%)
Band Option 1 (98.9%)	Breeding	45	11,339	0.40
	Post-breeding	27	121,171	0.02
	Pre-breeding	24	91,661	0.03
	Total	**96**	-	-
Band Option 2 (98.9%)	Breeding	65	11,339	0.57
	Post-breeding	52	121,171	0.04
	Pre-breeding	46	91,661	0.05
	Total	**163**	-	-

Breeding Season

8.459. The breeding season for kittiwake accounts for approximately 47% of annual collisions at Project Bravo. When using Option 1 at a 98.9% avoidance rate (45 collisions) this represents a 0.40% change in baseline mortality of the regional breeding population.

8.460. The degree of variability associated with avoidance rates used in collision risk modelling for kittiwake is considered to represent a negligible change in resulting collision risk estimates in terms of the effect on the regional breeding population (see monthly collision risk values presented Appendix 8B [Collision Risk Modelling]). If flight speed data from Skov *et al.* (2018) is applied to the CRM, an approximate 19% reduction in kittiwake collision rates is expected (Appendix 8B [Collision Risk Modelling]). In addition, the data assessed for breeding season kittiwake collision impacts includes that from July 2017, when the unusual foraging event occurred with atypically high numbers of birds. Considering all these factors, it is likely that the number of collisions predicted is overly precautionary by at least 25%.

8.461. The impact is predicted to be of regional spatial extent for the project duration and of medium reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the kittiwake populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Post-breeding Season

8.462. The post-breeding season for kittiwake accounts for approximately 29% of annual collisions at Project Bravo. When using Option 1 at a 98.9% avoidance rate (27 collisions) this represents a 0.02% change in baseline mortality of the regional post-breeding population.

8.463. The impact is predicted to be of regional spatial extent for the project duration and of low to medium reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the kittiwake populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Pre-breeding Season

8.464. The pre-breeding season for kittiwake accounts for a just 24% of annual collisions at Project Bravo. When using Option 1 at a 98.9% avoidance rate (24 collisions) this represents a 0.03% change in baseline mortality of the regional post-breeding population.

8.465. The impact is predicted to be of regional spatial extent for the project duration and of low to medium reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the kittiwake populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Sensitivity of the Receptor

8.466. Kittiwake was rated as having relatively high vulnerability to collision impacts by Wade *et al.* (2016), due to the proportion of flights likely to occur at potential risk height and percentage of time in flight, including at night. From previous studies in Flanders that have recorded mortality rates and collision rates, estimated micro-avoidance rates were, however, high for smaller gulls (Everaert, 2006; 2008; 2011; Everaert *et al.*, 2002; Everaert and Kuijken, 2007). Studies have also shown that rates are consistently above 98% for flights at rotor height (GWFL, 2011). The report for Marine Scotland (Cook *et al.*, 2014) considers that a 99.2% avoidance rate is appropriate for the 'Basic' Band Model. Kittiwake is deemed to be of high vulnerability, low recoverability and international value. The sensitivity of kittiwake is therefore, considered to be **medium**.

Impact Significance

8.467. Overall, the sensitivity of kittiwake is considered to be **medium** and the impact magnitude is deemed to be **low**. The impact will therefore be **Minor Adverse**, which is **Not Significant** in EIA terms.

Herring gull

Magnitude of Impact

8.468. At Project Bravo, an annual mortality rate of eight collisions/annum is predicted for herring gull using Band Option 2 at an avoidance rate of 99.5% and five collisions/annum when using Band Option 3 at a 99.0% avoidance rate (Table 8.27).

Table 8.27 Herring gull seasonal collision risk results for Project Bravo expressed as change in regional population baseline mortality based on collision risk estimates calculated using the mean estimate

CRM option (Avoidance rate)	Season	Collision mortality	Baseline mortality of regional population (individuals/annum)	Increase in baseline mortality (%)
Band Option 2 (99.5%)	Breeding	3	5,919	0.05
	Non-breeding	5	77,441	0.01
	Total	**8**	-	-
Band Option 3 (99.0%)	Breeding	2	5,919	0.03
	Non-breeding	4	77,441	0.01
	Total	**5**	-	-

8.469. The breeding season for herring gull accounts for 40% of annual collisions at Project Bravo. When using Option 2 at a 99.5% avoidance rate (three collisions) this represents a 0.05% change in baseline mortality of the regional breeding population. When using Option 3 at a 99.0% avoidance rate (two collisions) this represents a 0.03% increase in baseline mortality.

8.470. The impact is predicted to be of regional spatial extent, to occur throughout the duration of the project and to be of low to medium reversibility. The predicted impact in relation to the SPA populations is negligible in real terms and therefore population consequences are not certain to arise for any of the SPAs assessed. The impact magnitude is therefore, considered to be **negligible**.

Non-breeding Season

8.471. The post-breeding season for herring gull accounts for approximately 60% of annual collisions at Project Bravo. When using Option 2 at a 99.5% avoidance rate (five collisions) this represents a 0.01% change in baseline mortality of the regional post-breeding population.

8.472. The impact is predicted to be of regional spatial extent, to occur throughout the duration of the project and to be of low to medium reversibility. The predicted impact in relation to the SPA populations is negligible in real terms and therefore population consequences are not certain to arise for any of the SPAs assessed. The impact magnitude is therefore, considered to be **negligible**.

Sensitivity of the Receptor

8.473. Herring gull is considered to be a receptor of **high** sensitivity. Herring gull was rated as being very highly vulnerable to collision impacts by Wade *et al.* (2016), due to the proportion of flights likely to occur at potential risk height and percentage of time in flight, including at night.

Impact Significance

8.474. Overall, the sensitivity of herring gull is considered to be **high** and the impact magnitude is deemed to be **negligible**. The impact will therefore be **Minor Adverse**, which is **Not Significant** in EIA terms.

Project Alpha and Project Bravo Combined

Disturbance

Guillemot, Razorbill and Puffin

Magnitude of Impact

8.475. It is expected that there will be daily boat movements within Project Alpha and Project Bravo combined plus a 2km buffer during operation and maintenance. Operational vessels are likely to be much less intrusive to seabird species than those associated with construction activities. Impacts are therefore likely to be of a lower magnitude than disturbance during construction, with birds likely to be affected in a smaller radius around the area of activity, compared to activities during construction such as foundation and WTG installation for example.

8.476. The ultimate consequence of disturbance may be increased mortality to an extent similar to (although likely more restricted in spatial extent) displacement impacts (see following section) with birds during the breeding season more likely to be susceptible to such impacts. As such, the impact is predicted to be of local spatial extent, long term duration, and intermittent and low to medium reversibility within the context of any international, national or regional population. If it is assumed that the magnitude of loss is similar to the identified displacement impacts although reduced in spatial scale it is considered to be **negligible** for all species.

Receptor Sensitivity

8.477. The overall sensitivity of receptors is considered to be of the same levels as those relating to disturbance during construction. Although scientific evidence on the effects of wind farm maintenance activities is lacking, there is no reason to suggest that any receptor will react differently to operation and maintenance activity as opposed to construction phase activity.

Impact Significance

8.478. An impact of **negligible** magnitude on **low** to **medium** sensitivity receptors will be of **negligible** for all receptors, which is considered to be **Not Significant** in EIA terms.

Displacement

8.479. Within this assessment of operational displacement, species considered are guillemot, razorbill, puffin and kittiwake. Full displacement matrices for each biological season are presented in Appendix 8C (Displacement of Seabirds). The buffer taken forward to the impact assessment of all species assessed is 2km as recommended by JNCC *et al.* (2017).

Guillemot

Magnitude of Impact

8.480. The displacement rate considered appropriate for guillemot is 50 to 60% across all seasons while the mortality rate considered appropriate is 1%.

Breeding Season

8.481. The mean peak guillemot population estimate calculated for Project Alpha and Project Bravo combined plus a 2km buffer during the breeding season (April to August) was 22,074 birds (8A [Ornithology Technical Report]). Based on a displacement rate of 50 to 60% and a mortality rate of 1% during the breeding season, between 110 and 132 guillemots may be lost as a result of displacement (Appendix 8C [Displacement of Seabirds]). However, if July 2017 data is excluded from the process, a mean peak population of 15,104 would result in a displacement mortality of between 76 and 91 guillemots

8.482. Assessed against the defined guillemot regional breeding population (219,623 birds) the predicted mortality from breeding season displacement does not surpass the 1% baseline mortality figure (Appendix 8C [Displacement of Seabirds]). This conclusion is reached no matter which mean peak population is applied or whether 50 or 60% displacement rates are applied.

8.483. The impact is predicted to be of regional spatial extent for the project duration, continuous and of high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the guillemot populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Non-breeding Season

8.484. During the non-breeding season (September to March) the mean peak guillemot population estimate analysed in Appendix 8C (Displacement of Seabirds) is 8,949 birds for Project Alpha and Project Bravo combined plus a 2km buffer.

8.485. Based on a 50 to 60% displacement rate and 1% mortality rate, a displacement mortality of 45 to 54 birds is predicted. From a regional BDMPS non-breeding population of 1,617,306 individuals this level of mortality considerably short of the 1% of baseline mortality figure.

8.486. The impact is predicted to be of local spatial extent for the project duration, continuous and of low to medium reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the guillemot populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Receptor Sensitivity

8.487. Guillemot is considered to be a receptor of **medium** sensitivity.

Impact Significance

8.488. Overall, the sensitivity of guillemot is considered to be **medium** and the impact magnitude is deemed to be **low**. The impact of displacement in the operational phase on guillemot at Project Alpha and Project Bravo combined, is predicted to be **Minor Adverse** and therefore **Not Significant** in EIA terms.

Razorbill

Magnitude of Impact

8.489. The displacement rate considered appropriate for razorbill is 40 to 60% across all seasons while the mortality rate considered appropriate is 1%.

Breeding Season

8.490. The mean peak razorbill population estimate calculated for Project Alpha and Project Bravo combined plus a 2km buffer during the breeding season (April to August) was 8,324 birds (Appendix 8A [Ornithology Technical Report]). Based on a displacement rate of 40 to 60% and a mortality rate of 1% during the breeding season, between 33 and 50 razorbills may be lost as a result of displacement (Appendix 8C [Displacement of Seabirds]). However, if July 2017 data is excluded from the process, a mean peak population of 4,282 would result in a displacement mortality of between 17 and 26 razorbills.

8.491. Assessed against the defined razorbill regional breeding population (41,009 birds) the predicted mortality from breeding season displacement surpasses the 1% baseline mortality figure (Appendix 8C [Displacement of Seabirds]) only at a 60% displacement and when July 2017 is included as part of the process of establishing a mean peak population. Therefore, it is considered reasonable that all appropriate scenarios of displacement in the breeding season result in a change in baseline mortality of less than 1%.

8.492. The impact is predicted to be of regional spatial extent for the project duration, continuous and of high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the razorbill populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Non-breeding Season

8.493. During the non-breeding season (September to March) the mean peak razorbill population estimate analysed in Appendix 8C (Displacement of Seabirds) is 2,105 birds for Project Alpha and Project Bravo combined plus a 2km buffer.

8.494. Based on a 40-60% displacement rate and 1% mortality rate, a displacement mortality of 8 to 13 birds is predicted. From a regional BDMPS non-breeding population of 218,622 individuals this level of mortality considerably short of the 1% of baseline mortality figure.

8.495. The impact is predicted to be of local spatial extent for the project duration, continuous and of low to medium reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the razorbill populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]), therefore the impact magnitude is considered to be **low**.

Receptor Sensitivity

8.496. Razorbill is considered to be of international conservation value; Project Alpha lies within the mean maximum foraging range of SPA colonies that include this species as a qualifying feature. With a regional and national population trend likely to be relatively stable, but with low productivity rate, the species' recoverability is considered to be medium. Behaviourally, razorbill was considered to be of high vulnerability to displacement by Wade *et al.* (2016), although the results of Searle *et al.* (2014) suggest that this rating may be somewhat precautionary. In summary, razorbill is deemed to be of high vulnerability, medium recoverability and international value. The sensitivity of razorbill is therefore, considered to be **medium**.

Impact Significance

8.497. Overall, the sensitivity of razorbill is considered to be **medium** and the impact magnitude is deemed to be **low**. The impact of displacement in the operational phase on guillemot at the Project Alpha and Project Bravo combined, is predicted to be **Minor Adverse** and therefore **Not Significant** in EIA terms.

Puffin

Magnitude of Impact

8.498. The displacement rate considered appropriate for puffin is 50 to 60% across all seasons while the mortality rate considered appropriate is 2%.

Breeding Season

8.499. The mean peak puffin population estimate calculated for Project Alpha and Project Bravo combined plus a 2km buffer during the breeding season (April to August) was 5,634 birds (Appendix 8A [Ornithology Technical Report]). Based on a displacement rate of 50 to 60% and a mortality rate of 2% during the breeding season, between 56 and 68 puffins may be lost as a result of displacement (Appendix 8C [Displacement of Seabirds]).

8.500. Assessed against the defined puffin regional breeding population (373,138 birds) the predicted mortality from breeding season displacement does not surpass the 1% baseline mortality figure (Appendix 8C [Displacement of Seabirds]). This conclusion is reached no matter whether 50 or 60% displacement rates are applied.

8.501. The impact is predicted to be of regional spatial extent for the project duration, continuous and of high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the puffin populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]), therefore the impact magnitude is considered to be **low**.

Receptor Sensitivity

8.502. Puffin is considered to be a receptor of **medium** sensitivity. Puffin is considered to be of international conservation value and Project Alpha and Project Bravo combined is within the mean maximum foraging range of SPA colonies that include this species as a qualifying feature. With a regional and national population trend likely to be relatively stable, but with low productivity rate, the species' recoverability is considered to be low. Behaviourally, puffin was considered to be of moderate vulnerability to displacement by Wade *et al.* (2016). In summary, puffin is deemed to be of moderate vulnerability, low recoverability and international value. The sensitivity of puffin is therefore, considered to be **medium**.

Impact Significance

8.503. Overall, the sensitivity of puffin is considered to be **medium** and the impact magnitude is deemed to be **low**. The impact of displacement in the operational phase on puffin at the Project Alpha and Project Bravo combined, is predicted to be **Minor Adverse** and therefore **Not Significant** in EIA terms.

Kittiwake

Magnitude of Impact

8.504. The displacement rate considered appropriate for kittiwake is 30% across all seasons while the mortality rate considered appropriate is 2%.

Breeding Season

8.505. The mean peak kittiwake population estimate calculated for Project Alpha and Project Bravo combined plus a 2km buffer during the breeding season (April to July) was 9,980 birds (Appendix 8A [Ornithology Technical Report]). Based on a displacement rate of 30% and a mortality rate of 2%, 60 kittiwakes may be lost as a result of displacement (Appendix 8C [Displacement of Seabirds]). However, if July 2017 data is excluded from the process, a mean peak population of 4,538 would result in a displacement mortality of 27 kittiwakes

8.506. Assessed against the defined kittiwake regional breeding population (77,664 birds) the predicted mortality from breeding season displacement does not surpass the 1% baseline mortality figure (Appendix 8C [Displacement of Seabirds]). This conclusion is reached no matter which mean peak population is applied.

8.507. The impact is predicted to be of regional spatial extent for the project duration, continuous and of high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the kittiwake populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Post-breeding Season

8.508. During the post-breeding season (September to December) the mean peak kittiwake population estimate analysed in Appendix 8C (Displacement of Seabirds) is 4,598 birds for Project Alpha and Project Bravo combined plus a 2km buffer.

8.509. Based on a 30% displacement rate and 2% mortality rate, a displacement mortality of 28 birds is predicted. From a regional BDMPS non-breeding population of 829,937 individuals this level of mortality considerably short of the 1% of baseline mortality figure.

8.510. The impact is predicted to be of local spatial extent for the project duration, continuous and of low to medium reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the kittiwake populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Pre-breeding Season

8.511. During the post-breeding season (December to March) the mean peak kittiwake population estimate analysed in Appendix 8C (Displacement of Seabirds) is 1,966 birds for Project Alpha and Project Bravo combined plus a 2km buffer.

8.512. Based on a 30% displacement rate and 2% mortality rate, a displacement mortality of 12 birds is predicted. From a regional BDMPS non-breeding population of 627,816 individuals this level of mortality considerably short of the 1% of baseline mortality figure.

8.513. The impact is predicted to be of local spatial extent for the project duration, continuous and of low to medium reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the kittiwake populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Receptor Sensitivity

8.514. Kittiwake is considered to be of international conservation value and Project Alpha and Project Bravo combined lie within the mean maximum foraging range of SPA colonies that include this species as a qualifying feature. With regional and national population trends indicating declines, with low productivity rate, the species' recoverability is considered to be low. Behaviourally, kittiwake was considered to be of low vulnerability to displacement by Wade *et al.* (2016). In summary, kittiwake is deemed to be of low vulnerability, low recoverability and international value. The sensitivity of kittiwake is therefore, considered to be **medium**.

Impact Significance

8.515. Overall, the sensitivity of kittiwake is considered to be **medium** and the impact magnitude is deemed to be **low**. The impact of displacement in the operational phase on kittiwake at Project Alpha and Project Bravo combined, is predicted to be **Minor Adverse** and therefore **Not Significant** in EIA terms.

Collision

8.516. Table 8.28 presents a summary of collision risk modelling results for Project Alpha and Project Bravo combined, showing annual and seasonal results for each species at appropriate Band (2012) model options and avoidance rates. These results apply monthly mean-peak data using all baseline data available (i.e. 2009 to 2011 and 2017).

Table 8.28 Collision risk results for Project Alpha and Project Bravo combined

Species	Band model Option	Avoidance rate (%)	Annual mortality rate at appropriate avoidance rate	Number of collisions			
				Breeding season mortality	Post-breeding season mortality	Non-breeding season mortality	Pre-breeding season mortality
Gannet	1	98.9	407	354	25	-	27
	2	98.9	312	280	16	-	17
Kittiwake	1	98.9	266	130	88	-	48
	2	98.9	338	142	127	-	70
Herring gull	2	99.5	17	5	-	12	-
	3	99.0	11	3	-	8	-

Gannet

Magnitude of Impact

8.517. An annual mortality rate of 407 collisions/annum is predicted for gannet at Project Alpha and Project Bravo combined using Band Option 1 at an avoidance rate of 98.9% and 312 collisions/annum when using Band Option 2 at a 98.9% avoidance rate (Table 8.29).

8.518. The variability associated with the collision risk estimates has also been considered in relation to flight height data and avoidance rate. Appendix 8B (Collision Risk Modelling) presents the variability associated with each of these aspects of CRM. The greatest degree of variability in the collision risk estimates for gannet is however caused by the flight height data applied.

Table 8.29 Gannet seasonal collision risk results for Project Alpha and Project Bravo combined expressed as change in regional population baseline mortality based on collision risk estimates calculated using the mean estimate

CRM option (Avoidance rate)	Season	Collision mortality	Baseline mortality of regional population (individuals/annum)	Increase in baseline mortality (%)
Band Option 1 (98.9%)	Breeding	354	12,815	2.76
	Post-breeding	25	36,960	0.07
	Pre-breeding	27	20,119	0.13
	Total	**407**	**-**	**-**
Band Option 2 (98.9%)	Breeding	280	12,815	2.18
	Post-breeding	16	36,960	0.04
	Pre-breeding	17	20,119	0.08
	Total	**312**	**-**	**-**

Breeding Season

8.519. The breeding season for gannet accounts for approximately 87% of annual collisions at Project Alpha and Project Bravo combined. When using Option 1 at a 98.9% avoidance rate (354 collisions) this represents a 2.76% change in baseline mortality of the regional breeding population.

8.520. The degree of variability associated with avoidance rates used in collision risk modelling for gannet is considered to represent a negligible change in resulting collision risk estimates in terms of the effect on the regional breeding population (see monthly collision risk values presented Appendix 8B [Collision Risk Modelling]). If flight speed data from Skov *et al.* (2018) is applied to the CRM, a 6% reduction in gannet collision rates is expected (Appendix 8B [Collision Risk Modelling]).

8.521. It is considered likely that a proportion of all birds recorded in the breeding season are immature individuals with older immatures indistinguishable from adult birds. In addition, a further proportion are likely to be non-breeding adult birds. Data from the breeding season at Seagreen collected through the baseline boat-based surveys indicates that 2.7% were aged as being non-adults. A further 10% of adult birds are considered to be on 'sabbatical' from breeding each year (Marine Scotland, 2017).

8.522. The impact of collision on gannet during the breeding season is predicted to be of regional spatial extent, to occur throughout the duration of the project and to be of low to medium reversibility.

8.523. The 2017 Scoping Opinion states *"The Scottish Ministers advise that the conservation objective relating to the population of species as a viable component of the site should be the focus of the assessment"*. For gannet, the relevant breeding colony of interest to SNH is Bass Rock as part of the Forth Islands SPA.

8.524. The magnitude of this impact is relatively low in comparison to the size of the gannet population which is currently reported as 75,259 pairs and growing and which far exceeds the gannet population for which the SPA was designated (21,600 pairs). Nevertheless, the predicted mortality exceeds 1% of the baseline mortality within this population (323 cf. 122 individuals) and further work has been undertaken to understand the consequences of this level of impact through PVA (Appendix 8D [Population Viability Analysis]).

8.525. The outputs of the PVA modelling over the 25 year operational life time of the optimised Seagreen Project (see Chapter 16) indicate that:

- The impacted population will continue to grow at a very similar rate to that predicted by the PVA for the un-impacted population. The predicted median population growth rate (1) for the impacted population is essentially indistinguishable from that of the un-impacted population (counterfactual of the median population growth rate ≈ 1); and
- The similarity of the predicted growth rates leads to similar population outcomes. The model predicts a median end population size (in the impacted scenario) of 83,225 pairs. This is similar to the predicted population in the absence of any impact as indicated by the high ratio of the counterfactual of population size (0.94) and the centile of un-impacted population that is equivalent to the 50th centile for the impacted population (0.66).

8.526. The current gannet population far exceeds the population for which the SPA was designated and PVA modelling indicates that this population is likely to continue to grow at the predicted level of collision mortality arising from Project Alpha and Project Bravo combined. At this level of impact it is considered that there is a negligible risk that the population would decline to a level at which it would no longer be considered to be a viable component of the SPA.

8.527. On the basis of the above and the PVA, the impact magnitude is therefore considered to be **low**.

Post-breeding Season

8.528. The post-breeding season for gannet accounts for approximately 6% of annual collisions at Project Alpha and Project Bravo combined. When using Option 1 at a 98.9% avoidance rate (25 collisions) this represents a 0.07% change in baseline mortality of the regional post-breeding population.

8.529. The impact is predicted to be of regional spatial extent for the project duration, continuous and of low to medium reversibility. On the basis of the assessment of potential impact overestimation and the PVA described above in the relation to the breeding season, the post-breeding season impact magnitude is therefore considered to be **low**.

Pre-breeding Season

8.530. The pre-breeding season for gannet accounts for 1% of annual collisions at Project Alpha and Project Bravo combined. When using Option 1 at a 98.9% avoidance rate (27 collisions) this represents a 0.13% change in baseline mortality of the regional post-breeding population.

8.531. The impact is predicted to be of regional spatial extent for the project duration, continuous and of low to medium reversibility. On the basis of the assessment of potential impact overestimation and the PVA described above in the relation to the breeding season, the pre-breeding season impact magnitude is therefore considered to be **low**.

Sensitivity of the Receptor

8.532. As a qualifying feature of regional SPAs, gannet is afforded international conservation value. It was ranked high in terms of vulnerability to collisions by Wade *et al.* (2016) although moderate vulnerability by Langston (2010). High vulnerability is considered appropriate within this assessment. Gannet is deemed to be of high vulnerability, high recoverability and international value. The sensitivity of gannet is therefore, considered to be **high**.

Impact Significance

8.533. Overall, the sensitivity of gannet is considered to be high and the impact magnitude is deemed to be **low**. The impact will therefore be **Moderate adverse**. The 2017 Scoping Opinion says, however, that "*The Scottish Ministers advise that the conservation objective relating to the population of species as a viable component of the site should be the focus of the assessment*". Consequently further analysis of the effects of the predicted impacts on specific breeding populations has been undertaken (see Chapter 16). This analysis does not indicate that there is a risk that the breeding gannet population at Bass Rock will reduce to the level at which it would no longer be considered to be viable component of the Forth Islands SPA, and on this basis, the predicted impact is considered **not significant** in EIA terms.

Kittiwake

Magnitude of Impact

8.534. At Project Alpha and Project Bravo combined, an annual mortality rate of 266 collisions/annum using Band Option 1 at an avoidance rate of 98.9% and 338 collisions/annum at a 98.9% avoidance rate (Table 8.30).

Table 8.30 Kittiwake seasonal collision risk results for Project Alpha and Project Bravo combined expressed as change in regional population baseline mortality based on collision risk estimates calculated using the mean estimate

CRM option (Avoidance rate)	Season	Collision mortality	Baseline mortality of regional population (individuals/annum)	Increase in baseline mortality (%)
Band Option 1 (98.9%)	Breeding	130	11,339	1.15
	Post-breeding	88	121,171	0.07
	Pre-breeding	48	91,661	0.05
	Total	**266**	-	-
Band Option 2 (98.9%)	Breeding	142	11,339	1.25
	Post-breeding	127	121,171	0.10
	Pre-breeding	70	91,661	0.08
	Total	**338**	-	-

Breeding Season

8.535. The breeding season for kittiwake accounts for approximately 49% of annual collisions at Project Alpha and Project Bravo combined. When using Option 1 at a 98.9% avoidance rate (130 collisions) this represents a 1.15% change in baseline mortality of the regional breeding population.

8.536. The degree of variability associated with avoidance rates used in collision risk modelling for kittiwake is considered to represent a negligible change in resulting collision risk estimates in terms of the effect on the regional breeding population (see monthly collision risk values presented Appendix 8B [Collision Risk Modelling]). If flight speed data from Skov *et al.* (2018) is applied to the CRM, an approximate 19% reduction in kittiwake collision rates is expected (Appendix 8B [Collision Risk Modelling]). In addition, the data assessed for breeding season kittiwake collision impacts includes that from July 2017, when the unusual for aging event occurred. Considering all these factors, it is likely that the number of collisions predicted is overly precautionary by at least 25%.

8.537. The impact is predicted to be of regional spatial extent for the project duration and of medium reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the kittiwake populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Post-breeding Season

8.538. The post-breeding season for kittiwake accounts for approximately 33% of annual collisions at Project Alpha and Project Bravo combined. When using Option 1 at a 98.9% avoidance rate (88 collisions) this represents a 0.07% change in baseline mortality of the regional post-breeding population.

8.539. The impact is predicted to be of regional spatial extent for the project duration and of low to medium reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the kittiwake populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Pre-breeding Season

8.540. The pre-breeding season for kittiwake accounts for a just 18% of annual collisions at Project Alpha and Project Bravo combined. When using Option 1 at a 98.9% avoidance rate (48 collisions) this represents a 0.05% change in baseline mortality of the regional post-breeding population.

8.541. The impact is predicted to be of regional spatial extent for the project duration and of low to medium reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the kittiwake populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Sensitivity of the Receptor

8.542. Kittiwake is considered to be of international conservation value and Project Alpha and Project Bravo combined lie within the mean maximum foraging range of SPA colonies that include this species as a qualifying feature. With regional and national population trends indicating declines, with low productivity rate, the species' recoverability is considered to be low. Behaviourally, kittiwake was considered to be of low vulnerability to displacement by Wade *et al.* (2016). In summary, kittiwake is deemed to be of low vulnerability, low recoverability and international value. The sensitivity of kittiwake is therefore, considered to be **medium**.

Impact Significance

8.543. Overall, the sensitivity of kittiwake is considered to be **medium** and the impact magnitude is deemed to be **low**. The impact will be **Minor Adverse** which is **Not Significant** in EIA terms.

Herring gull

Magnitude of Impact

8.544. At Project Alpha and Project Bravo combined, an annual mortality rate of 18 collisions/annum is predicted for herring gull using Band Option 2 at an avoidance rate of 99.5% and 12 collisions/annum when using Band Option 3 at a 99.0% avoidance rate (Table 8.31).

Table 8.31 Herring gull seasonal collision risk results for Project Alpha and Project Bravo combined expressed as change in regional population baseline mortality based on collision risk estimates calculated using the mean estimate

CRM option (Avoidance rate)	Season	Collision mortality	Baseline mortality of regional population (individuals/annum)	Increase in baseline mortality (%)
Band Option 2 (99.5%)	Breeding	5	5,919	0.08
	Non-breeding	12	77,441	0.02
	Total	**18**	-	-
Band Option 3 (99.0%)	Breeding	3	5,919	0.05
	Non-breeding	8	77,441	0.01
	Total	**12**	-	-

8.545. The breeding season for herring gull accounts for 30% of annual collisions at Project Alpha and Project Bravo combined. When using Option 2 at a 99.5% avoidance rate (five collisions) this represents a 0.08% change in baseline mortality of the regional breeding population. When using Option 3 at a 99.0% avoidance rate (three collisions) this represents a 0.05% increase in baseline mortality.

8.546. The impact is predicted to be of regional spatial extent, to occur throughout the duration of the project and to be of low to medium reversibility. The predicted impact in relation to the SPA populations is negligible in real terms and therefore population consequences are not certain to arise for any of the SPAs assessed. The impact magnitude is therefore, considered to be **negligible**.

Non-breeding Season

8.547. The non-breeding season for herring gull accounts for approximately 60% of annual collisions at Project Alpha and Project Bravo combined. When using Option 2 at a 99.5% avoidance rate (12 collisions) this represents a 0.02% change in baseline mortality of the regional post-breeding population.

8.548. The impact is predicted to be of regional spatial extent, to occur throughout the duration of the project and to be of low to medium reversibility. The predicted impact in relation to the SPA populations is negligible in real terms and therefore population consequences are not certain to arise for any of the SPAs assessed. The impact magnitude is therefore, considered to be **negligible**.

Sensitivity of the Receptor

8.549. Herring gull is considered to be a receptor of **high** sensitivity. Herring gull was rated as being very highly vulnerable to collision impacts by Wade *et al.* (2016), due to the proportion of flights likely to occur at potential risk height and percentage of time in flight, including at night.

Impact Significance

8.550. Overall, the sensitivity of herring gull is considered to be **high** and the impact magnitude is deemed to be **negligible**. The impact will therefore be of **Minor Adverse**, which is **Not Significant** in EIA terms.

Displacement and Collision Combined

8.551. As highlighted in the Scoping Opinions for all Forth and Tay Projects (Marine Scotland, 2017), for kittiwake, collision risk and displacement are currently considered to be mutually exclusive impacts, and therefore combining mortality estimates for kittiwake displacement and collision should be considered extremely precautionary.

8.552. In the breeding season, kittiwake mortality at Project Alpha and Project Bravo combined from collision is estimated at 130 birds based on a 98.9% avoidance rate using Option 1. From displacement, mortality is estimated at 27 birds based on 30% displacement and 2% mortality (excluding July 2017 data from consideration). This would therefore result in a combined total of 157 birds, which if taken as appropriate to assess would account for a 1.38% change in baseline mortality of the regional population (77,664 birds). Considering that, firstly, the two impact mechanisms are mutually exclusive and secondly the precaution built in the assessment of both impacts in isolation (avoidance rate and option choice for collision, the potential for exaggeration of the species sensitivity with regards displacement) it is considered unlikely that the magnitude of any combined impacts is any greater than that for collision alone.

8.553. In the post-breeding season, kittiwake mortality from collision is estimated at 88 birds based on a 98.9% avoidance rate using Option 1. From displacement, mortality is estimated at 28 birds based on 30% displacement and 2% mortality. This would result in a combined total of 116 birds, which if taken as appropriate to assess would account for a 0.10% change in baseline mortality of the regional population (829,937 birds).

8.554. In the pre-breeding season, kittiwake mortality from collision is estimated at 48 birds based on a 98.9% avoidance rate using Option 1. From displacement, mortality is estimated at 12 birds based on 30% displacement and 2% mortality. This would result in a combined total of 60 birds, which if taken as appropriate to assess would account for a 0.07% change in baseline mortality of the regional population (627,816 birds).

8.555. The combined impact is predicted to be of regional spatial extent for the project duration, continuous and of high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the kittiwake populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

8.556. Overall, the sensitivity of kittiwake is considered to be **medium** and the impact magnitude is deemed to be **low**. The impact will therefore be **Minor Adverse** which is **Not Significant** in EIA terms.

IMPACT ASSESSMENT – DECOMMISSIONING

8.557. The impacts of the decommissioning the optimised Seagreen Project have been assessed on birds present in the offshore environment. The turbines would be dismantled and removed from the site in a manner similar to that of their installation. Foundations will be removed to an agreed level below the seabed with buried parts remaining in situ. Buried inter-array cables may also be left in-situ. Any section of cable protruding above the surface of the seabed will be removed by cutting the cable at an agreed depth below the seabed. The approach to decommissioning will be agreed as required by consent

8.558. A description of the potential impacts on offshore ornithological receptors is given below.

Project Alpha

Disturbance

8.559. A degree of temporary disturbance and displacement is likely to occur throughout the decommissioning phase. The magnitude and significance of any impact is likely to be of a similar or identical scale to those presented for the construction phase above. The magnitude and significance for each relevant receptor is presented in Table 8.32 below. Overall, the long term effect would be to return Project Alpha to its former state with no long term effects on any of the assessed populations.

Table 8.32 Summary of impacts of decommissioning disturbance/displacement for Project Alpha due to construction activity

Species	Sensitivity	Impact Magnitude	Impact Significance
Guillemot	Medium	Low	Minor adverse
Razorbill	Medium	Low	Minor adverse
Puffin	Medium	Low	Minor adverse

Project Bravo

Disturbance

8.560. A degree of temporary disturbance and displacement is likely to occur throughout the decommissioning phase. The magnitude and significance of any impact is likely to be of a similar or identical scale to those presented for the construction phase above. The magnitude and significance for each relevant receptor is presented in Table 8.33 below. Overall, the long term effect would be to return Project Bravo to its former state with no long term effects on any of the assessed populations.

Table 8.33 Summary of impacts of decommissioning disturbance/displacement for Project Alpha due to construction activity

Species	Sensitivity	Impact Magnitude	Impact Significance
Guillemot	Medium	Low	Minor adverse
Razorbill	Medium	Low	Minor adverse
Puffin	Medium	Low	Minor adverse

Project Alpha and Project Bravo combined

Disturbance

8.561. A degree of temporary disturbance and displacement is likely to occur throughout the decommissioning phase. The magnitude and significance of any impact is likely to be of a similar or identical scale to those presented for the construction phase above. The magnitude and significance for each relevant receptor is presented in Table 8.34 below. Overall, the long term effect would be to return Project Alpha and Project Bravo combined to its former state with no long term effects on any of the assessed populations.

Table 8.34 Summary of impacts of decommissioning disturbance/displacement for Project Alpha and Project Bravo combined due to construction activity

Species	Sensitivity	Impact Magnitude	Impact Significance
Guillemot	Medium	Low	Minor adverse
Razorbill	Medium	Low	Minor adverse
Puffin	Medium	Low	Minor adverse

IMPACT ASSESSMENT: CUMULATIVE

Scope of Assessment

8.562. The EIA Regulations require the assessment of cumulative impacts. This requires consideration and assessment of existing projects, projects under construction and consented or proposed projects identified in relevant development plans and programmes that have the potential to impact cumulatively with the optimised Seagreen Project.

8.563. Cumulative impacts can occur when the impacts from one project on an identified receptor combine (through either spatial or temporal overlap) with similar impacts from other projects on the same receptor. The purpose of considering cumulative impacts is to understand if the impacts from the optimised Seagreen Project parameters (Project Alpha and Project Bravo), when considered together (combined), or cumulatively with other plans and projects are different, or more significant than from the individual projects in isolation. This enables additional mitigation to be identified, as appropriate.

8.564. Cumulative impacts are considered for all stages of the optimised Seagreen Project throughout construction, operation and decommissioning. It should be noted that the offshore Transmission Asset is already licenced and is unchanged, therefore this is considered alongside the other identified projects and plans.

8.565. Identification of relevant projects and developments has been informed by scoping and wider consultation, as set out within Chapter 7 (Scope of EIA Report). Potential cumulative impacts are considered within the assessment set out below.

8.566. For the breeding season, the Cumulative Impact Assessment considers impacts from projects within mean maximum foraging range of the colony SPA under consideration. This has been applied for the following assessments. The approach applied to the non-breeding season depends on the species considered but where projects are considered outside of the Forth and Tay region it typically incorporates impacts from all projects within the defined BDMPS (Furness, 2015) for each species. BDMPS is defined from the total number of birds present in all UK territorial waters during a defined season allocated into spatially distinct BDMPS units. Typically, Seagreen lies within a defined UK North Sea and Channel non-breeding BDMPS unit. Based on advice provided in the 2017 Scoping Opinion, the impacts identified as requiring assessment with respect to potential cumulative impacts on offshore ornithological receptors include:

- Construction:
  - Disturbance and displacement.
- Operation and maintenance:
  - Displacement; and
  - Collision.

Projects Considered

8.567. Table 8.35 lists all projects considered as part of the cumulative assessment. Due to the nature of potential cumulative impacts on offshore ornithology receptors it is considered only necessary to consider other offshore wind farms for this assessment.

8.568. It should be noted that projects have a differing potential to ultimately contribute to an in combination impact alongside Project Alpha, Project Bravo and Project Alpha and Project Bravo combined. For example, relevant projects not yet approved or not yet submitted are less certain to contribute to such an impact, as some may not achieve approval or may not ultimately be built due to other factors. By comparison, projects that are already under construction are more likely to contribute to cumulative impacts.

8.569. For these reasons, all relevant projects considered in combination alongside Project Alpha, Project Bravo and Project Alpha and Project Bravo combined have been allocated a status, reflecting their current stage within the planning and development process. This allows the assessment in this report to consider several future development scenarios, each with a differing potential for being ultimately built out. Appropriate weight may, therefore, be given to each status describing the position of a project in the decision-making process when considering the potential in combination impact associated with Project Alpha, Project Bravo and Project Alpha and Project Bravo combined. For example it may be considered that greater weight can be placed on the conclusion of significance where the projects materially contributing to the impact are:

i. Currently under construction and/or those with a legally secure consent;

ii. Have been awarded a CfD but have not yet been implemented and/or those currently operational that were not operational when baseline data was collected; and

iii. Those that are operational but have an on-going impact.

8.570. Less weight can be placed on the conclusion of significance where the projects materially contributing to the impact are those projects that:

i. Have a legally secure consent but have no CfD; and/or

ii. Have submitted an application which has not yet been determined.

Cumulative Assessment with Other Projects in the Forth and Tay Region

8.571. Seagreen has the potential to affect the species assessed most notably in a cumulative fashion, with the two other projects within the Forth and Tay region, namely Inch Cape OWF and Neart Na Gaoithe OWF. In common with Seagreen, both of these projects received consent in 2014 and are submitting a new application for consent for modified projects in 2017/2018. An application, including an ornithological assessment, has been submitted for Neart Na Gaoithe OWF (Mainstream 2017), while at the time of writing no application has yet been submitted for Inch Cape OWF.

8.572. There are therefore two different scenarios with which this Seagreen application are assessed – revised scenario from 2017/2018 and the 2014 consent. It is considered here, that the primary focus of the cumulative impact assessment will be with the most recent evidence base, i.e. the revised applications for both projects. Collision risk estimates for Neart na Gaoithe have been sourced from the recently submitted application documents (Mainstream, 2017). Appendix 8B (Collision Risk Modelling) presents collision risk numbers for Inch Cape based on scenarios put forward in the scoping report for that project (ICOL, 2017). The assessment below provides, in parentheses, results from the 2014 consent, where appropriate in order to provide comparability.

8.573. It is considered that no update to displacement assessment in terms of advice or methodology has been made since 2014 and that therefore, the only relevant comparison to be made is through collision risk assessment.

Cumulative Construction Impacts

8.574. Any potential cumulative impacts on the species assessed will only occur if the construction phases of wind farm projects within a particular spatial extent (for example foraging range during breeding season or the Firth of Forth/North Sea in winter) are coincidental or sequential, leading to a short- to mid-term impact.

8.575. Although it is difficult to quantify, numbers of birds affected are likely to be lower than those predicted in the cumulative displacement assessment in the following Operation Impacts section. This is on the basis that fewer projects relevant to the assessment will be constructed at the same time as this Development. Impacts experienced during construction will also be of shorter duration and temporary in nature.

Disturbance

8.576. The potential impact of construction activities that may result in direct disturbance or displacement from important foraging and habitat areas of birds, was assessed for guillemot, razorbill and puffin in line with the 2017 Scoping opinion.

Table 8.35 Projects Considered for Cumulative Impact Assessment

Project (offshore wind farm)[B]	Status	Capacity (as built or consented)	Confidence
Beatrice	Under construction	588 MW	High[A]
Blyth Demonstrator	Under construction	40 MW	High[A]
Aberdeen European Offshore Wind Deployment Centre (EOWDC)	Under construction	92.4 MW	High[A]
Dogger Bank Creyke Beck A	Consented – no CfD[C]	2,400 MW	High[A]
Dogger Bank Creyke Beck B			High[A]
Dogger Bank Teesside A	Consented – no CfD	2,400 MW	High[A]
Dudgeon	Operational	400 MW	High[A]
East Anglia ONE	Under construction	714 MW	High[A]
East Anglia Three	Consented – no CfD	1,204 MW	High[A]
Forthwind	Consented		High
Galloper	Under construction	352.8 MW	High[A]
Greater Gabbard	Operational	504 MW	High[A]
Hornsea Project One	Under construction	1,218 MW	High[A]
Hornsea Project Two	Consented and awarded CfD	1,368 MW	High[A]
Hornsea Three	Application submitted	2,400 MW	High[A]
Humber Gateway	Operational	219 MW	High[A]
Hywind	Operational	30 MW	High[A]
Inch Cape	Consented – no CfD	784 MW consented No MW specified in Scoping Report just turbine numbers (up to 72)	High[A]
Kincardine	Under construction	Up to 50 MW	High[A]
Kentish Flats	Operational	49.5 MW	High[A]
Lincs and LID6	Operational	270 MW	High[A]
London Array	Operational	630 MW	High[A]
Moray East	Consented and awarded CfD. Construction starts 2019	950 MW	High[A]
Neart na Gaoithe	Consented and awarded CfD. Construction start 2020	450 MW	High[A]
Race Bank	Under construction	Consented = 580 MW but as built not confirmed	High[A]
Rampion	Under construction	400.2 MW	High[A]
Sheringham Shoal	Operational	316.8 MW	High[A]
Sofia (formerly Dogger Bank Teesside B)	See Dogger Bank Teesside A above	-	High[A]
Teesside	Operational	62.1 MW	High[A]
Thanet	Operational	300 MW	High[A]
Triton Knoll	Consented and awarded CfD. Offshore construction expected in 2020	855 MW	High[A]
Westermost Rough	Operational	210	High[A]

[A]Third party project details published in the public domain and confirmed as being 'accurate'.

[B]Operational projects distant from Seagreen such as Teesside, Scroby Sands and Gunfleet 1,2,3 are not carried forward for further consideration in this cumulative assessment. These sites have been operational for some time and their limited predicted impacts are considered to have been incorporated into baseline conditions.

[C]Contract for difference – Projects without a CfD have no current route to market and therefore delivery timescale is uncertain.

Impact Magnitude

8.577. Disturbance events during construction activities (including piling of foundations) will disturb and displace birds for the duration of the construction period. As construction activities will be focused at specific locations within the optimised Seagreen Project, 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. The installation of the offshore components of the optimised Seagreen Project will occur over a maximum duration of 48 months (Table 8.18).

8.578. The assessment of this impact for Project Alpha and Project Bravo combined was predicted to be at most of low magnitude for the species assessed, on the basis that the extent of disturbance is limited, as construction activities will take place only within a small area of the site at any time (i.e. local spatial extent and intermittent with respect to any one area). There is potential for both Inch Cape and Neart na Gaoithe wind farms to undergo construction simultaneously with the optimised Seagreen Project although Neart na Gaoithe will likely commence construction first. Considering the limited predicted extents of disturbance it is not expected that this will affect the magnitude of impacts on the species assessed. Furthermore, the cumulative impacts arising from the construction phase will be no greater, and likely less than, those previously presented in the original application and addendum, which were considered to be not significant (Seagreen, 2014).

8.579. The impact is predicted to be of local spatial extent for part of the project duration, intermittent and low to medium reversibility. The impact magnitude is therefore, considered to be **low**.

Sensitivity of Receptors

8.580. The sensitivity of all the species assessed to cumulative disturbance due to construction activity is considered to be the same as predicted when assessing this impact for Project Alpha and Project Bravo combined. This is **medium** for guillemot, razorbill and puffin.

Impact Significance

8.581. Overall, the sensitivity of the species assessed is considered to be **medium** and the impact magnitude is deemed to be **low**. The impacted will therefore be at most of **Minor Adverse**, which is **Not Significant** in EIA terms.

Cumulative Operational Impacts

Displacement

8.582. Predicted displacement effects for Project Alpha and Project Bravo combined during the operation phase are discussed previously. With respect to assessing cumulative displacement effects, information on the number of birds predicted to be affected by displacement for each project considered in this cumulative assessment was obtained from relevant chapters of the Environmental Statements (ESs) for these projects and any associated technical reports and other submitted documents.

8.583. Recently published interim guidance by JNCC *et al.* (2017) states that displacement impacts for each relevant species should be assessed based on a wide range of potential displacement and mortality rates in a 'matrix'. While some recent ESs use this matrix approach, many older projects do not. Instead of discounting data from all projects without a matrix approach, their data has been considered here where possible.

8.584. For Project Alpha Project and Project Bravo combined, the mean peak population estimates were calculated for the combined site plus a 2km buffer. As discussed previously in the assessment, data for July 2017 was considered to represent an extreme foraging event leading to unusually high abundances of kittiwake and auks. For the purposes of this cumulative assessment, population estimates for Project Alpha and Project Bravo combined are derived from a dataset excluding July 2017.

8.585. In the large majority of projects that are now operational, no attempt was made to quantify either the number of birds displaced by the wind farm, or the resultant mortality levels. Instead a qualitative assessment is usually conducted and as such these projects cannot be included as part of the quantitative assessment. For certain other projects, 100% displacement has been assumed, but the resultant mortality rate is not considered and in some (e.g. Beatrice Offshore Wind Farm), the impact on productivity rather than mortality is considered the more appropriate metric. These projects are also excluded from the quantitative assessment.

8.586. Data sources used to determine the potential levels of displacement and mortality from wind farms included in the cumulative impact assessment include population data held in individual wind farm project ESs and Habitats Regulations Appraisal (or Assessment) Reports (HRAs) consisting of population estimates for individual project areas rather than raw survey data. Monthly population estimates have been collated where available. For some projects data are not available for the relevant buffer area and the data have been scaled up or down based on data from other project areas.

8.587. Upon obtaining mean-peak population estimates for the individual projects the numbers of birds affected through displacement and subsequent mortality has been calculated using the displacement and mortality rates established for Project Alpha and Project Bravo.

Guillemot

Impact Magnitude

8.588. In the breeding season, it is considered that impacts associated with other offshore wind farm projects in the Forth and Tay region may act cumulatively with the Seagreen Offshore Wind Farm. The population of guillemot that is predicted to be exposed to cumulative displacement impacts in the breeding season will be composed of a proportion of breeding adults, immature birds and non-breeding adults. It is not known how many immature or non-breeding guillemot are present in the Forth and Tay during the breeding season and it is therefore difficult to calculate a population against which impacts can be assessed. In addition, different projects, depending on their proximity to breeding colonies will impact differing proportions of breeding adult, immature or non-breeding adult birds.

8.589. Guillemot is a dispersive rather than a migratory species with birds overwintering in sea areas close to their breeding colonies, although immature birds do disperse further than adults (Wernham *et al.*, 2002). Indeed, when referring to the non-breeding season, the scoping opinion for Seagreen (Marine Scotland, 2017) highlights that guillemot remain in the Forth and Tay region over winter and is one of the factors informing the Outer Firth of Forth and St Andrews Bay Complex pSPA. Therefore the non-breeding assessment for guillemot is restricted to projects within the Forth and Tay region rather than the more extensive UK North Sea Biologically Defined Minimum Population Scale (BDMPS) area defined in Furness (2015). Nevertheless, the cumulative impact is assessed against the BDMPS population (being a component of it) in addition to the regional breeding population. During the non-breeding season the population affected by cumulative displacement impacts is predicted to comprise a mixture of adults and immatures from colonies on the east coast of the UK with smaller proportions from colonies further afield.

Breeding Season

8.590. Using the same assumptions as for Project Alpha and Project Bravo combined alone (60% displacement rate recommended by MSS and SNH and 1% mortality) the precautionary predicted cumulative mortality of guillemot due to the displacement predicted to arise from the Project Alpha and Project Bravo combined, Inch Cape and Neart na Gaoithe offshore wind farms in the breeding season is 146 (Table 8.36). When considering four additional projects that are within foraging range of Buchan Ness and Collieston Coast SPA as is Seagreen (mean maximum foraging range; Thaxter *et al.*, 2012) the breeding season total increases to 154.

8.591. Project Alpha and Project Bravo combined contribute 59% to the cumulative total impact of guillemot in the breeding season. Assessed against the defined guillemot regional breeding population (219,623 birds) the predicted mortality from breeding season displacement represents an increase in baseline mortality of 1.15% (based on survival rate of 0.061 and baseline mortality of 13,397). Appendix 16B (Seabird Apportioning), apportioning impacts on HRA species at Seagreen to SPAs, suggests that the number of breeding adults in a given guillemot population may only be at 57.5%. Combined with the observation that a 60% displacement rate is conservative compared to recent observations it is considered unlikely that the impacts will be either material or permanent on the regional breeding guillemot population.

Table 8.36 Guillemot cumulative displacement results

Project	Population		Displacement rate (%)	Mortality rate (%)	Displacement mortality		Source of data
	Breeding	Non-breeding			Breeding	Non-breeding	
Project Alpha and Project Bravo combined	15104	8949	60	1	91	54	This assessment
Inch Cape (2014)	4371	3176			26	19	Inch Cape Environmental Statement (2013)
Neart na Gaoithe (2018)	4894	7618			29	46	Neart na Gaoithe Environmental Statement 2018
Kincardine	632	Not considered			4	0	Kincardine Environmental Statement 2016
Forthwind Demonstration Project	381	Not considered			2	0	Forthwind Environmental Statement 2015
Hywind	295	Not considered			0	0	Hywind Environmental Statement 2015
EOWDC	772	Not considered			2	0	EOWDC Environmental Statement 2012
Total					**154**	**119**	

8.592. Without considering the likely age structure of the populations impacted, the impact is predicted to be of regional spatial extent for the project duration, continuous and of high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the guillemot populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]), therefore the impact magnitude is considered to be **low**.

Non-breeding Season

8.593. During the non-breeding season, the precautionary predicted cumulative mortality of guillemot due to the displacement predicted to arise from Project Alpha and Project Bravo combined and other projects considered cumulatively is 119 at 60% displacement. Project Alpha and Project Bravo combined account for 45% of the cumulative total. The total of 119 birds represents 0.007% of the BDMPS North Sea non-breeding population of 1,617,306 and does not constitute an increase in baseline mortality of greater than 1%.

8.594. The non-breeding BDMPS population was been defined assuming a spatial scale that extended throughout the UK North Sea. Although there is likely to be a degree of interchange between different areas of the BDMPS as birds exploit these areas due to, for example, weather conditions or food availability, it is possible that birds may exhibit a greater degree of affinity with an area surrounding their breeding colony.

8.595. Without considering the likely age structure of the populations impacted, the impact is predicted to be of local spatial extent for the project duration, continuous and of low to medium reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the guillemot populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Receptor Sensitivity

8.596. Guillemot is considered to be of international conservation value as a result of Project Alpha and Project Bravo combined being within mean maximum foraging range of SPA colonies that include this species as a qualifying feature. With a regional and national population trend likely to be relatively stable, but with low productivity rate, the species' recoverability is considered to be medium. Behaviourally, guillemot was considered to be of high vulnerability to displacement by Wade *et al.* (2016). In summary, razorbill is deemed to be of high vulnerability, medium recoverability and international value. The sensitivity of guillemot is therefore, considered to be **medium**.

Impact Significance

8.597. Overall, the sensitivity of guillemot is considered to be **medium** and the impact magnitude is deemed to be **low**. The impact will therefore be highest during the non-breeding season when it is assessed as being of **Minor Adverse** and **Not Significant** in EIA terms.

Razorbill

Impact Magnitude

8.598. As with guillemot, in the breeding season it is considered that impacts associated with other offshore wind farm projects in the Forth and Tay region on razorbill may act cumulatively with the optimised Seagreen Project. Although the focus population of birds will be of breeding adults, the population of razorbill that is predicted to be exposed to cumulative displacement impacts in the breeding season will be composed of a proportion immature birds and non-breeding adults too.

8.599. When referring to the non-breeding season, the scoping opinion for Seagreen (Marine Scotland, 2017) highlights that razorbill remain in the Forth and Tay region over winter and is one of the factors informing the Outer Firth of Forth and St Andrews Bay Complex pSPA. Therefore the non-breeding assessment for razorbill is restricted to projects within the Forth and Tay region rather than the more extensive UK North Sea BDMPS area defined in Furness (2015). Nevertheless, the cumulative impact is assessed against the BDMPS population (being a component of it) in addition to the regional breeding population. During the non-breeding season the population affected by cumulative displacement impacts is predicted to comprise a mixture of adults and immatures from colonies on the east coast of the UK with smaller proportions from colonies further afield during the non-breeding season.

8.600. Table 8.37 presents cumulative displacement results for the breeding and non-breeding seasons for razorbill.

Table 8.37 Razorbill cumulative displacement results

Project	Population		Displacement rate (%)	Mortality rate (%)	Displacement mortality		Source of data
	Breeding	Non-breeding			Breeding	Non-breeding	
Project Alpha and Project Bravo combined	4,282	2,105	60	1	26	13	This assessment
Inch Cape (2013)	1,637	2,870			10	17	Inch Cape Environmental Statement (2013)
Neart na Gaoithe (2018)	1,248	3,101			7	19	Neart na Gaoithe Environmental Statement 2018
Kincardine	22	Not considered			0	0	Kincardine Environmental Statement 2016
Forthwind Demonstration Project	61	Not considered			0	0	Forthwind Environmental Statement 2015
Hywind	40	Not considered			0	0	Hywind Environmental Statement 2015
Total					**43**	**49**	

Breeding Season

8.601. Using the same assumptions as for Project Alpha and Project Bravo alone (60% displacement rate recommended by MSS and SNH and 1% mortality) the predicted cumulative mortality of razorbill due to the displacement predicted to arise from the Project Alpha and Project Bravo combined, Inch Cape and Neart na Gaoithe offshore wind farms in the breeding season is 43 (Table 8.37).

8.602. Project Alpha and Project Bravo combined contribute 60% to the cumulative total impact on razorbill in the breeding season. Assessed against the defined razorbill regional breeding population (41,009 birds) the predicted mortality from breeding season displacement represents an increase in baseline mortality of 1.00% (based on survival rate of 0.105 and baseline mortality of 4,306). Appendix 16B (Seabird Apportioning), apportioning impacts on HRA species at Seagreen to SPAs, suggests that the number of breeding adults in a given razorbill population may only be at 57.1%. Combined with the observation that a 60% displacement rate is conservative compared to recent observations and it is considered unlikely that the impacts will be either material or permanent on the regional breeding razorbill population.

8.603. Without considering the likely age structure of the populations impacted, the impact is predicted to be of regional spatial extent for the project duration, continuous and of high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the razorbill populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Non-breeding Season

8.604. During the non-breeding season, the precautionary predicted cumulative mortality of razorbill due to the displacement predicted to arise from Project Alpha and Project Bravo combined and other projects considered cumulatively is 49 at 60% displacement. Project Alpha and Project combined account for 27% of the cumulative total. The total of 49 birds represents 0.02% of the BDMPS North Sea non-breeding population of 218,622 and does not constitute an increase in baseline mortality of greater than 1%.

8.605. The non-breeding BDMPS population was been defined assuming a spatial scale that extended throughout the UK North Sea. Although there is likely to be a degree of interchange between different areas of the BDMPS as birds exploit these areas due to, for example, weather conditions or food availability, it is possible that birds may exhibit a greater degree of affinity with an area surrounding their breeding colony. Although razorbills exhibit a greater degree of dispersal and migratory behaviour than other auk species (Furness, 2015) it is considered appropriate to also compare the predicted non-breeding cumulative impact against the regional breeding population. When compared to the regional Forth and Tay breeding population of 41,009 birds a baseline mortality change of 1.14% is predicted.

8.606. Without considering the likely age structure of the populations impacted, the impact is predicted to be of local spatial extent for the project duration, continuous and of low to medium reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the razorbill populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Receptor Sensitivity

8.607. Razorbill is considered to be of international conservation value as a result of Seagreen Offshore Wind Farm being in mean maximum foraging range of SPA colonies that include this species as a qualifying feature. With a regional and national population trend likely to be relatively stable, but with low productivity rate, the species' recoverability is considered to be medium. Behaviourally, razorbill was considered to be of high vulnerability to displacement by Wade *et al.* (2016), although the results of Searle *et al.* (2014) suggest that this rating may be somewhat precautionary. In summary, razorbill is deemed to be of high vulnerability, medium recoverability and international value. The sensitivity of razorbill is therefore, considered to be **medium**.

Impact Significance

8.608. Overall, the sensitivity of razorbill is considered to be **medium** and the impact magnitude is deemed to be **low**. The impact will therefore be of **Minor Adverse** which is **Not Significant** in EIA terms.

Puffin

Impact Magnitude

8.609. As with guillemot and razorbill, in the breeding season it is considered that impacts associated with other offshore wind farm projects in the Forth and Tay region on puffin may act cumulatively with Project Alpha and Project Bravo combined. Although the focus population of birds will be of breeding adults, the population of puffin that is predicted to be exposed to cumulative displacement impacts in the breeding season will be composed of a proportion of immature birds and non-breeding adults too. In line with the 2017 Scoping Opinion, puffin is assessed for the breeding season only.

8.610. Table 8.38 presents cumulative displacement results for the breeding season for puffin.

Breeding Season

8.611. Using the same assumptions as Project Alpha and Project Bravo combined alone (60% displacement rate recommended by MSS and SNH and 2% mortality) the predicted cumulative mortality of puffin due to the displacement predicted to arise from Project Alpha and Project Bravo combined, Inch Cape and Neart na Gaoithe offshore wind farms in the breeding season is 177 (Table 8.38).

8.612. Project Alpha and Project Bravo combined plus a 2km buffer contribute 38% to the cumulative total impact on puffin in the breeding season. Assessed against the defined puffin regional breeding population (373,138 birds) the predicted mortality from breeding season displacement represents an increase in baseline mortality of 0.50% (based on survival rate of 0.094 and baseline mortality of 35,075). Appendix 16B (Seabird Apportioning), apportioning impacts on HRA species at Seagreen to SPAs, suggests that the number of breeding adults in a given puffin population may only be at 49%. Combined with the observation that a 60% displacement rate is conservative compared to recent observations and it is considered unlikely that the impacts will be either material or permanent on the regional breeding puffin population.

8.613. Without considering the likely age structure of the populations impacted, the impact is predicted to be of regional spatial extent for the project duration, continuous and of high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the puffin populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Receptor Sensitivity

8.614. Puffin is considered to be of international conservation value as a result of Seagreen Offshore Wind Farm being in mean maximum foraging range of SPA colonies that include this species as a qualifying feature. With a regional and national population trend likely to be relatively stable, but with low productivity rate, the species' recoverability is considered to be low. Behaviourally, puffin was considered to be of moderate vulnerability to displacement by Wade *et al.* (2016). In summary, puffin is deemed to be of moderate vulnerability, low recoverability and international value. The sensitivity of puffin is therefore, considered to be **medium**.

Table 8.38 Puffin cumulative displacement results

Project	Population	Displacement rate (%)	Mortality rate (%)	Displacement mortality	Source of data
	Breeding			Breeding	
Project Alpha and Project Bravo combined	5634	60	2	68	This assessment
Inch Cape	2700			32	Inch Cape Environmental Statement (2013)
Neart na Gaoithe	6173			74	Neart na Gaoithe Environmental Statement 2018
Kincardine	19			0	Kincardine Environmental Statement 2016
Forthwind Demonstration Project	122			1	Forthwind Environmental Statement 2015
Hywind	138			2	Hywind Environmental Statement 2015
EOWDC	15			0	EOWDC Environmental Statement 2012
Total				**177**	

Impact Significance

8.615. Overall, the sensitivity of puffin is considered to be **medium** and the impact magnitude is deemed to be **low**. The impacts will therefore be highest during the post-breeding season when it is assessed as being of **Minor Adverse** which is **Not Significant** in EIA terms.

Kittiwake

Impact Magnitude

8.616. The impact of displacement from Project Alpha and Project Bravo combined was assessed as being of **low** magnitude for all seasons assessed.

Breeding Season

8.617. Using the same assumptions as for Project Alpha and Project Bravo alone (30% displacement rate recommended by MSS and SNH and 2% mortality) the predicted cumulative mortality of kittiwake due to the displacement predicted to arise from the Project Alpha and Project Bravo combined, Inch Cape and Neart na Gaoithe offshore wind farms in the breeding season is 55 (Table 8.39).

Table 8.39 Kittiwake cumulative displacement results

Project	Population			Displacement rate (%)	Mortality rate (%)	Displacement mortality			Source of data
	Breeding	Post-breeding	Pre-breeding			Breeding	Post-breeding	Pre-breeding	
Project Alpha and Project Bravo combined	4538	4598	1966	30	2	27	28	12	This assessment
Inch Cape	2249	1357	917			13	8	6	Inch Cape Environmental Statement (2013)
Neart na Gaoithe	2164	2016	139			13	12	1	Neart na Gaoithe Environmental Statement 2018
Kincardine	229					1	0	0	Kincardine Environmental Statement 2016
Hywind	112					1	0	0	Hywind Environmental Statement 2015
Total						**55**	**48**	**19**	

8.618. Project Alpha and Project Bravo combined contribute 49% to the cumulative total impact on kittiwake in the breeding season. Assessed against the defined kittiwake regional breeding population (77,664 birds) the predicted mortality from breeding season displacement represents an increase in baseline mortality of 0.49% (based on survival rate of 0.146 and baseline mortality of 11,339). Without considering the proportion of non-breeding adults that are part of the population assessed, it is considered that there is no prospect of any material impacts on the regional breeding population.

8.619. Without considering the likely age structure of the populations impacted, the impact is predicted to be of regional spatial extent for the project duration, continuous and of high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the kittiwake populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]). Therefore the impact magnitude is considered to be **low**.

Post-breeding Season

8.620. Using the same assumptions as for Project Alpha and Project Bravo alone (30% displacement rate recommended by MSS and SNH and 2% mortality) the predicted cumulative mortality of kittiwake due to the displacement predicted to arise from Project Alpha and Project Bravo combined, Inch Cape and Neart na Gaoithe offshore wind farms in the post-breeding season is 48 (Table 8.39).

8.621. Project Alpha and Project Bravo combined contribute 58% to the cumulative total impact on kittiwake in the post-breeding season. Assessed against the defined kittiwake regional post breeding population (829,937 birds; Furness, 2015) the predicted mortality from breeding season displacement represents an increase in baseline mortality of 0.04% (based on survival rate of 0.146 and baseline mortality of 121,171).

8.622. Without considering the proportion of non-breeding adults that are part of the populations assessed, the impact is predicted to be of regional spatial extent for the project duration, continuous and of high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the kittiwake populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]), therefore the impact magnitude is considered to be **low**.

Pre-breeding Season

8.623. Using the same assumptions as for Project Alpha and Project Bravo alone (30% displacement rate recommended by MSS and SNH and 2% mortality) the predicted cumulative mortality of kittiwake due to the displacement predicted to arise from Project Alpha and Project Bravo combined, Inch Cape and Neart na Gaoithe offshore wind farms in the pre-breeding season is 19 (Table 8.39).

8.624. Project Alpha and Project Bravo combined contribute 63% to the cumulative total impact on kittiwake in the pre-breeding season. Assessed against the defined kittiwake regional post-breeding population (627,816 birds; Furness, 2015) the predicted mortality from pre-breeding season displacement represents an increase in baseline mortality of 0.02% (based on survival rate of 0.146 and baseline mortality of 91,661). Without considering the proportion of non-breeding adults that are part of the population assessed, it is considered that there is no prospect of any material impacts on the regional pre-breeding population.

8.625. Without considering the proportion of non-breeding adults that are part of the populations assessed, the impact is predicted to be of regional spatial extent for the project duration, continuous and of high reversibility. In addition, the PVA outputs requested by the Scottish Ministers in the 2017 Scoping Opinion do not indicate, within the certainty that can be attached to probabilistic population modelling, an adverse consequence for the kittiwake populations of any of the SPAs assessed (see Appendix 8D [Population Viability Analysis]), therefore the impact magnitude is considered to be **low**.

Receptor Sensitivity

8.626. Kittiwake is considered to be of international conservation value as Project Alpha and Project Bravo lie within the mean maximum foraging range of SPA colonies that include this species as a qualifying feature. With regional and national population trends indicating declines, with low productivity rate, the species' recoverability is considered to be low. Behaviourally, kittiwake was considered to be of low vulnerability to displacement by Wade *et al.* (2016). In summary, kittiwake is deemed to be of low vulnerability, low recoverability and international value. The sensitivity of kittiwake is therefore, considered to be **medium**.

Impact Significance

8.627. Overall, the sensitivity of kittiwake is considered to be **medium** and the impact magnitude is deemed to be **low**. The impact will therefore be **Minor Adverse** which is **Not Significant** in EIA terms.

Collision

8.628. Direct comparison of the collision risks predicted by the wind farms in the wider area is problematic due to the differing assumptions made in the calculations used in the different studies, and the limited amount of species data presented in ES chapters (Maclean *et al.*, 2009). Nevertheless, a combined quantitative assessment of the cumulative impacts posed by the optimised Seagreen Project in conjunction with other projects has been undertaken where appropriate, based on the information presented in other projects' supporting documentation available to date. Due to a lack of compatible project information it has not, however, been possible to include a quantitative assessment for each project. All suitable quantitative data from relevant projects are presented in each species assessment below.

8.629. Cumulative impacts of the optimised Seagreen Project and other relevant projects during the breeding season have been based on the mean maximum foraging range given for each species (or other information e.g. tracking information) from colonies from which birds may interact with the optimised Seagreen project. However, it is also important to consider the populations of immature and non-breeding individuals that may be impacted by wind farms considered cumulatively with the Seagreen Offshore Wind Farm to which a proportion of collision impacts will be attributable.

8.630. For the purposes of this assessment, the definition of cumulative impacts is the impact of the optimised Seagreen Project, alongside the impacts of other offshore wind farm projects on a single species. Projects are only included if they contribute to collision mortality in colonies impacted by the optimised Seagreen Project.

8.631. During the non-breeding period, it is assumed that individuals present from each species will originate from a wider range of colonies, with mixing throughout the Firth of Forth and North Sea, and so the most appropriate reference populations (e.g. east coast or flyway) have been taken forward to assessment, based on literature evidence available (Furness, 2015). A greater range of projects are included, reflecting the wider movements of birds (i.e. all east coast UK offshore wind farm projects).

Confidence in Collision Risk Data Available from Other Projects

Collision Risk Modelling

8.632. The earliest collision risk assessments of offshore wind farms for Round 1 and 2 projects were generally undertaken by adapting the Band (2000) collision risk model (updated in Band *et al.*, 2007), developed on behalf of SNH to quantify mortality rates for birds at onshore wind farms. As flight data are collected in a fundamentally different way in the onshore and offshore environments, the boat survey data collected at these offshore sites required significant reinterpretation to become compatible with the model. This is a potential source of variability in interpretation and results between projects, particularly as a standard method of interpretation was not available at that time.

8.633. For these projects' models it was also assumed that for birds transiting through turbines at risk height, collision risk was distributed evenly within the rotor swept area (as per Option 1 or 2 of the Band model), which in the majority of cases overestimates the risk for most species which predominantly fly at lower altitudes (including some within the lower rotor swept area). As the probability of colliding with a rotor blade is lower at these lower altitudes, using the mean value instead will invariably overestimate risk, and therefore resultant mortality rates.

8.634. The most recent projects have run collision risk analyses using the Band model, updated for the offshore environment (Band, 2012; sometimes the draft version Band [2011]). The updates within Band (2012) mean that projects that have used the Band (2012) or Band (2011) models are likely to produce more realistic mortality rates than earlier projects that had to interpret the onshore Band models. This is particularly the case for those that undertook modelling using the Extended Option 3 or 4 variants.

8.635. In addition to the different models used to estimate collision mortality, different avoidance rates have been selected for impact assessment in different projects. This is the most sensitive parameter in the model, and so leads to a great deal of variability in results. Mortality estimates from other projects have been converted to a common currency in this assessment consistent with those avoidance rates recommended by JNCC *et al.* (2014) and Cook *et al.* (2014).

8.636. A process of caution is applied however when altering outputs (by updating prescribed avoidance rates) within projects considered within the cumulative assessment. This is particularly relevant for projects that have been consented, where values have already been accepted by decision-makers. In some other cases it is not clear in the collision modelling process, using different Band model versions, where precaution may have been built in. If this was at an earlier stage, then a higher avoidance rate may be acceptable, and so results should be converted to a "common currency", where possible.

Nocturnal Activity Factors

8.637. Collision risk modelling conducted for projects considered in-combination are considered to have most likely to have used the nocturnal activity factors from Garthe and Hüppop (2004) which are considered to overly conservative. It is therefore necessary to correct the collision risk estimates to account for this over-estimation based on updated evidence and advice from Marine Scotland and SNH (Marine Scotland, 2017).

8.638. A process to account for this overestimate was considered as part of the consent application for the Hornsea Three offshore wind farm utilising four generic offshore wind farms located offshore on the UK North Sea coast (Orsted, 2018). The four generic wind farms were located in areas that reflect the main areas of offshore wind farm development in the UK North Sea. The use of four generic wind farms was required in order to capture the differences in day time and nocturnal hours that occur at different latitudes which will influence the correction factor required.

8.639. Table 8.40 presents correction factors for four geographic areas from Ørsted (2018). Two correction factors are presented, a minimum representing the minimum monthly change that can be applied across all months and the total representing the total change in collision risk estimates in each area using a generic wind farm scenario. The effect both correction factors would have on the resulting cumulative collision risk total is considered in the assessment sections presented below. It is worth noting that the 'total' correction factor may potentially under or overestimate the collision risk for an individual project. The application of the 'minimum' correction factor is considered to be precautionary as this represents the minimum change that would occur across all months.

Table 8.40 Reductions in collision risk estimates for generic offshore wind farms in each geographic region

Geographic Region	Minimum % reduction in collision risk estimates	Total % reduction in collision risk estimates
East Anglia and English Channel	Gannet = 10.1 Gulls = 9.2	Gannet = 19.4 Gulls = 16.2
Southern North Sea	Gannet = 9.3 Gulls= 8.5	Gannet = 19.3 Gulls = 16.2
Firth of Forth	Gannet = 8.4 Gulls = 7.8	Gannet = 19.3 Gulls = 16.2
Moray Firth	Gannet = 7.6 Gulls = 7.1	Gannet = 19.2 Gulls = 16.1

Consented and As-Built Scenarios

8.640. In addition to the observation that different CRMs have been used for different projects, it is frequently the case that projects when constructed do not reflect the worst case design scenario assessed. In many cases, the as-built scenario will represent a significantly lower impact than that assessed as the worst case for the purpose of obtaining a consent.

8.641. In order to provide an appraisal of this likely over-estimation of the cumulative collision risk totals for each species, a simple exercise has been conducted comparing the turbine scenario used for CRM for projects considered cumulatively with the respective as-built turbine scenario. Table 8.41 identifies the assessed, consented and as-built or planned turbine scenarios for each of the projects considered cumulatively in addition to the possible change that may result if CRM was conducted utilising the as-built turbine scenario.

8.642. The exercise has identified considerable reductions in the number of turbines originally assessed for certain projects. A number of these projects are now operational or under construction and have (or will be) built out to the consented capacity. MacArthur Green (2017) presents an appraisal of the likely 'headroom' that exists in current cumulative collision risk estimates due to differences between assessed and as-built turbine scenarios. Table 8.41 presents the correction factor reported by MacArthur Green (2017) for these operational projects. The correction factors from MacArthur Green (2017) are only included in Table 8.41 if the turbine scenarios used match those presented in Table 8.35.

8.643. The exercise has identified the potential for reductions at nearly all projects considered in the cumulative assessment. The largest reductions, relevant to each species are discussed in the following assessment sections.

Table 8.41 Assessed, consented and as-built/planned turbine scenarios for projects considered cumulatively for collision risk impacts

Offshore wind farm	Assessed turbine scenario	Assessed capacity (MW)	Consented capacity (MW)	Consented number of turbines	As-built turbine scenario/ turbine scenario currently being considered	As built/ currently planned capacity	Is there a difference between the assessed turbine scenario and either the consented of as-built/planned turbine scenarios (Yes/No)?	Implications for cumulative collision risk total
Operational								
Dudgeon	168 x 3 MW	504	560	77	67 x 6 MW	402	Yes – consented number of turbines (77) lower than that assessed (168). In addition, constructed number of turbines lower than consented	MacArthur Green (2017) reports a reduction of 54% for gannet. No change for kittiwake and herring gull as no collision risk estimates are available.
Greater Gabbard	140	Unavailable	-	-	140 x 3.6 MW	504	No – assessed scenario consistent with as-built scenario	-
Humber Gateway	83 x 3.6 MW	298.8	300	83	73 x 3 MW	219	Yes – as-built number of turbines (73) lower than assessed (83) however capacity of as-built turbines lower than assessed	MacArthur Green (2017) reports a reduction of 50% for gannet, 61% for kittiwake and 58% for herring gull
Kentish Flats Extension	17 x 3 MW	51	-	-	15 x 3.3 MW	49.5	Yes – as-built scenario has fewer turbines than assessed scenario	MacArthur Green (2017) reports a reduction of 20% for gannet, 28% for kittiwake and 29% for herring gull
Lincs	83 x 3 MW	249	250	83	75 x 3.6 MW	270	Yes – as-built scenario has fewer turbines than assessed scenario	MacArthur Green (2017) reports no change for gannet and a 4% increase for kittiwake No change for herring gull as no collision risk estimates are available.
London Array	271 x 3 MW	813	1000	341	175 x 3.6 MW	630	Yes – as-built scenario has fewer turbines than assessed scenario	Potential reduction of 35% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates
Sheringham Shoal	108 x 3 MW	324	316.8	108	88 x 3.6 MW	316.8	Yes – as-built scenario has fewer turbines than assessed scenario	MacArthur Green (2017) reports a reduction of 3% for gannet. No change for kittiwake or herring gull as no collision risk estimates are available.
Teesside	30	Unavailable	100	30	27 x 2.3 MW	62.1	Yes – as-built scenario has fewer turbines than assessed scenario	MacArthur Green (2017) reports a reduction of 32% for gannet and 33% for kittiwake and herring gull.

Offshore wind farm	Assessed turbine scenario	Assessed capacity (MW)	Consented capacity (MW)	Consented number of turbines	As-built turbine scenario/ turbine scenario currently being considered	As built/ currently planned capacity	Is there a difference between the assessed turbine scenario and either the consented of as-built/planned turbine scenarios (Yes/No)?	Implications for cumulative collision risk total
Thanet	60 x 5 MW	300	300	-	100 x 3 MW	300	Yes – as-built scenario has more turbines than assessed scenario	As-built scenario was assessed within the Environmental Statement but was not the worst case scenario. As this scenario has ultimately been built the collision risk estimates used for Thanet represent the 100 x 3 MW turbine scenario
Westermost Rough	50 x 3.6 MW	180	245	80	35 x 6 MW	210	Yes – as-built scenario has fewer turbines than assessed scenario	MacArthur Green (2017) reports a reduction of 17% for gannet and 18% for kittiwake and herring gull.
Under Construction								
Beatrice (gannet)	142 x 7 MW	994	750	125	84 x 7 MW	588	Yes – consented number of turbines (125) lower than that assessed (142). In addition, constructed number of turbines lower than consented	Potential reduction of 41% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates
Beatrice (other species)	277 x 3.6 MW	817.2	750	125	84d x 7 MW	588	Yes – consented number of turbines (125) lower than that assessed (277). In addition, constructed number of turbines lower than consented	Potential reduction of 70% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates
Blyth Demonstration Project	15 x 8 MW	120	-	-	5 x 8 MW	40	Yes – as-built scenario has fewer turbines than assessed scenario	Potential reduction of 67% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates
East Anglia ONE	325 x 3.6 MW	1,170	1,200	240	102 x 7 MW	714	Yes – consented number of turbines (240) lower than that assessed (325). In addition, project has committed to building only 102 turbines but using a different turbine scenario	Potential reduction of 26%–assessed vs consented number of turbines Potential additional 42% reduction if as built scenario vs assessed scenario taken into account
Galloper	140 x 3.6 MW	504	504	140	56 x 6.3 MW	352.8	Yes – as-built scenario has fewer turbines than assessed scenario	MacArthur Green (2017) reports a reduction of 57% for gannet and herring gull and 58% for kittiwake.
Hornsea Project One	240 x 5 MW	1,200	1,200	-	174 x 7 MW	1,218	Yes – as-built scenario has fewer turbines than assessed scenario	Potential reduction of 28% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates

Offshore wind farm	Assessed turbine scenario	Assessed capacity (MW)	Consented capacity (MW)	Consented number of turbines	As-built turbine scenario/ turbine scenario currently being considered	As built/ currently planned capacity	Is there a difference between the assessed turbine scenario and either the consented of as-built/planned turbine scenarios (Yes/No)?	Implications for cumulative collision risk total
Hywind	5 x 6 MW	30	30	-	5 x 6 MW	30	No – assessed scenario consistent with as-built scenario	-
Race Bank	206	Unavailable	580	-	91	-	Yes–as-built scenario has fewer turbines than assessed scenario	MacArthur Green (2017) reports a reduction of 47% for gannet and 41% for kittiwake. No change for herring gull as no collision risk estimates are available.
Rampion	175	700	700	175	116 x 3.45 MW	400.2	Yes – as-built scenario has fewer turbines than assessed/consented scenario	MacArthur Green (2017) reports a reduction of 31% for gannet. No change for kittiwake or herring gull as no collision risk estimates are available.
Consented and awarded CfD								
Aberdeen European Offshore Wind Deployment Centre	11 x 7 MW	77	100	-	11 x 8.4 MW	92.4	Yes – same number of turbines, however capacity of turbines higher for as-built scenario	Potential for a minor change in collision risk due to change in turbine scenario
Hornsea Project Two	300 x 5 MW	1,500	1,800	300	92-231	1,368	Yes – planned turbine scenario has fewer turbines than assessed scenario	Potential reduction of 23-69% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates
Moray EDA (Moray East)	339 (139 x 3.6, 100 x 5 and 100 x 5 MW)	1,500.4	1,116	186[A]	100 x 9.5 MW	950	Yes – consented number of turbines (186) lower than that assessed (339). In addition, planned turbine scenario is lower than consented	Potential reduction of 71% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates
Neart na Gaoithe	128 x 3.6 MW	460.8	450	75	56 x 8 MW	450	Yes – consented number of turbines (75) lower than that assessed (128). In addition, proposed 2018 turbine scenario is lower than consented	Revised numbers presented in addition to consented (2014) numbers in parentheses.
Triton Knoll	288 x 3.6 MW	1,036.8	1,200	288	90 x 9.5 MW	855	Yes – planned turbine scenario has fewer turbines than assessed scenario	Potential reduction of 69% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates

Offshore wind farm	Assessed turbine scenario	Assessed capacity (MW)	Consented capacity (MW)	Consented number of turbines	As-built turbine scenario/ turbine scenario currently being considered	As built/ currently planned capacity	Is there a difference between the assessed turbine scenario and either the consented of as-built/planned turbine scenarios (Yes/No)?	Implications for cumulative collision risk total
Consented – no CfD								
Dogger Bank Creyke Beck A and B	400 x 6 MW	2,400	2,400	400	-	-	No	Project was consented in 2015 and it is likely that a larger capacity turbine scenario, resulting in fewer turbines, will be constructed
Dogger Bank Teesside A and Sofia (formerly Dogger Bank Teesside B)	400 x 6 MW	2,400	2,400	400	240-400	Unavailable	No	Project was consented in 2015 and it is likely that a larger capacity turbine scenario, resulting in fewer turbines, will be constructed
East Anglia Three	172 x 7 MW	1,204	-	-	172 x 7 MW	1,204	No	-
Inch Cape	213	784	-	-	72	Unavailable	Yes – planned turbine scenario has fewer turbines than assessed scenario. Scoping report (2017) details revised and reduced turbine scenario	Revised numbers (see Appendix 8B [Collision Risk Modelling]) presented in addition to consented (2014) numbers in parentheses.
Kincardine	8 x 6 MW	6 to 8	Up to 50MW	-	7	Unavailable	Yes–planned turbine scenario has fewer turbines than assessed scenario	Potential reduction of 13% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates
Methil	1	Unavailable	-	-	2	Unavailable	Yes–planned turbine scenario has more turbines than assessed scenario	Increase of 100% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates

[A]Consent is for 186 turbines based 6 MW turbines. With respect to birds worst case within the envelope is 159 turbines for 7-10 MW turbine

Gannet

8.644. Table 8.42 presents a seasonal breakdown of predicted cumulative collision mortality for gannet.

Impact Magnitude

Breeding Season

8.645. The combined breeding season mortality is estimated to be 584 gannets when including the revised applications for Inch Cape and Neart na Gaoithe. Project Alpha and Project Bravo combined contribute approximately 61% when Option 1 results are applied. The mortality of these additional birds in the breeding season is equal to an increase in baseline mortality of 4.6% of the regional breeding population (158,212 individuals) using a baseline mortality rate of 0.081 (Horswill and Robinson, 2015). When the 2014 consented values are included from Inch Cape and Neart na Gaoithe an additional annual adult mortality of 996 individuals is concluded. This would account for a 7.7% increase in baseline mortality of the regional breeding population.

8.646. Of those projects considered cumulatively in the breeding season, there are likely to be reductions in the collision risk estimates presented in Table 8.42 for EOWDC and Hywind due to the over-estimation of nocturnal activity of gannet as part of the collision risk modelling conducted for these projects. The collision risk estimates for these projects would reduce by at least 7.6 to 8.4% and possibly up to 19.2 to 19.3% (Table 8.41).

8.647. There is unlikely to be a significant change in the collision risk estimates predicted for projects considered in the breeding season as a result of differences between assessed and as-built/planned turbine scenarios (Table 8.41).

8.648. It is, however, considered likely that a proportion of all birds recorded in the breeding season are immature individuals with older immatures indistinguishable from adult birds. In addition, a further proportion are likely to be non-breeding adult birds. Data from the breeding season at Seagreen collected through the baseline boat-based surveys indicates that 2.7% were aged as being non-adults. A further 10% of adult birds are considered to be on 'sabbatical' from breeding each year (Marine Scotland, 2017).

8.649. The impact of collision on gannet during the breeding season is predicted to be of regional spatial extent, to occur throughout the duration of the project and to be of low to medium reversibility. As has been illustrated the cumulative collision risk estimate is likely to be an overestimate for the breeding season due to factors including the age structure of the regional population. Nevertheless, the mortality predicted is substantial and represents a potential change in baseline mortality (7.7%) that could be categorised as having the potential to affect gannet abundance and distribution within the given geographical area assessed.

8.650. In the 2017 Scoping Opinion the consultation responses received were taken into account in adopting the opinion including SNH advice that it *"does not require any assessment against regional populations – our focus remains on the individual breeding colonies, particularly SPAs"*. For gannet, the relevant breeding colony of interest to SNH is Bass Rock as part of the Forth Islands SPA.

8.651. The magnitude of this cumulative impact is relatively low in comparison to the size of the gannet population which is currently reported as 75,259 pairs and growing and which far exceeds the gannet population for which the SPA was designated (21,600 pairs). Nevertheless, the predicted mortality exceeds 1% of the baseline mortality within this population (951 individuals cf. 122 individuals) and further work has been undertaken to understand the consequences of this level of cumulative impact through PVA (Appendix 8D [Population Viability Analysis]).

8.652. The outputs of the PVA modelling over the 25 year operational life time of the optimised Seagreen Project (see Chapter 16) indicate that:

- The impacted population will continue to grow at a similar, but lower, rate to that predicted by the PVA for the un-impacted population. The predicted median population growth rate (1.00) (although as the end population slightly declines over 25 years, this value is probably very slightly less than 1) for the impacted population is essentially indistinguishable from that of the un-impacted population (counterfactual of the median population growth rate ≈ 1); and
- The lower growth rate leads to a smaller predicted population after 25 years than would otherwise arise in the absence of the impact. The model predicts a median end population size (in the impacted scenario) of 73,599 pairs which is about 83% of that which would arise in the absence of the impact (the ratio of the counterfactual of population size is 0.83 and the centile of un-impacted population that is equivalent to the 50th centile for the impacted population is 0.88). This population is only slightly lower (by about 2.2%) than that which is currently present (73,599 pairs cf. 75,259 pairs). Given the precautionary nature of the assessment, which is compounded additively across multiple wind farms, and the simplistic nature of the PVA model which is being used to make predictions over a 25 year period, it is considered that, in practice it is likely that the population will be at least no lower than the current population.

8.653. The current gannet population far exceeds the population for which the SPA was designated. The PVA modelling indicates that this population is likely to continue to be maintained at least at this level at the predicted level of cumulative collision mortality arising from the optimised Seagreen Project in combination with other projects. At this level of cumulative impact there is no indication that the population would decline to a level at which it would no longer be considered to be a viable component of the SPA.

8.654. On the basis of the above assessment of potential impact overestimation and the PVA, the impact magnitude is therefore considered to be **low**.

Post-breeding Season

8.655. The post-breeding season total for gannet accounts for approximately 38% of annual collisions from Project Alpha and Project Bravo combined plus projects considered cumulatively. A total of 458 collisions is predicted which represents a 1.2% increase in baseline mortality (36,960 individuals) of the post-breeding BDMPS population of gannet (456,298 individuals). When considering the 2014 consented scenarios from Inch Cape and Neart na Gaoithe a small increase to 471 collisions (representing a 1.3% change in baseline mortality) is observed. However, there are a number of additional factors that suggest the magnitude of the impact would be lower.

Table 8.42 Cumulative collision impacts for gannet

Project	Status	Collision risk model [Option]	Annual collisions	Breeding	Post-breeding	Pre-breeding
Breeding and non-breeding seasons						
Neart na GaoitheA	Consented and awarded CfD	Band (2012) [2]	108 (296)	93 (259)	7 (19)	7 (18)
Inch CapeB	Consented – no CfD	Band (2012) [1]	117 (365)	108 (354)	7 (8)	2 (3)
Project Alpha and Project Bravo combined	Consented – no CfD	Band (2012) [1]	407	354	25	27
EOWDC	Consented and awarded CfD	Band (2012) [2]	9	5	4	0
Hywind	Under construction	Band (2012) [1]	7	4	1	2
Kincardine	Consented – no CfD	Band (2012) [1]	21	20	1	0
Non-breeding seasons						
Beatrice	Under construction	Band (2012) [1]	57	-	14	6
Blyth Demo	Under construction	Band et al. (2007) [1]	8	-	1	2
Dogger Bank Creyke Beck A and B	Consented – no CfD	Band (2012) [2]	33	-	12	6
Dogger Bank Teesside A and Sofia (formerly Dogger Bank Teesside B)	Consented – no CfD	Band (2012) [2]	36	-	7	7
Dudgeon	Operational	Band (2000) [1]	37	-	30	11
East Anglia One	Under construction	Band (2012) [2]	56	-	164	8
East Anglia Three	Consented – no CfD	Band (2012) [1]	56	-	35	10
Galloper	Under construction	Band et al. (2007) [1]	56	-	24	10
Greater Gabbard	Operational	Band (2000) [1]	28	-	7	8
Hornsea Project One	Under construction	Band (2012) [1]	66	-	22	17
Hornsea Project Two	Consented and awarded CfD	Band (2012) [2]	27	-	11	5
Hornsea Project Three	Application submitted	Band (2012) [2]	37	-	9	7
Humber Gateway	Operational	Not available [1]	4	-	1	1
Kentish Flats Extension	Operational	Band (2012) [1]	0	-	0	0

Project	Status	Collision risk model [Option]	Annual collisions	Breeding	Post-breeding	Pre-breeding
Lincs	Operational	Band (2000) [1]	5	-	1	1
London Array	Operational	Band (2000) [1]	6	-	2	0
Methil	Consented – no CfD	Band (2011/12) [1]	1	-	0	0
Moray East	Consented and awarded CfD	Band (2012) [1]	56	-	6	3
Race Bank	Under construction	Band (2000) [1]	50	-	6	4
Rampion	Under construction	Band (2011) [1]	102	-	9	2
Sheringham Shoal	Operational	Band (2000) [1]	18	-	2	0
Teesside	Operational	Band (2000) [1]	7	-	0	0
Thanet	Operational	Band (2000) [1]	1	-	0	0
Triton Knoll	Consented and awarded CfD	Band (2000) [1]	122	-	50	25
Westermost Rough	Operational	Band *et al.* (2007) [1]	0	-	0	0
Total				**584 (996)**	**458 (471)**	**171 (183)**

[A]Neart na Gaoithe figures show updated (2018) figures plus consented (2014) figures in parentheses.

[B]Inch Cape numbers worst case potential 2018 application as calculated in Appendix 8B (Collision Risk Modelling) plus consented (2014) values in parentheses.

NB. Projects highlighted are those that have less certainty of being built.

8.656. For those projects that are considered in the post- and pre-breeding seasons only, there are likely to be reductions in the collision risk estimates presented in Table 8.42 due to the over-estimation of nocturnal activity of gannet as part of the collision risk modelling conducted for these projects. Table 8.41 suggests that the collision risk estimates for these projects would reduce by at least 7.6 to 10.1% and possibly up to 19.2 to 19.4%. For some of these projects (e.g. Dudgeon, East Anglia One, East Anglia Three, Galloper, Hornsea Project One and Triton Knoll) these differences would represent a material difference in the number of collisions contributed to the overall total.

8.657. The information presented in Table 8.41 in relation to differences between assessed and as-built scenarios indicates that there is potential for considerable reductions in the collision risk estimates for many projects for which estimates are included in Table 8.42. This is especially applicable to East Anglia One (42% reduction), Galloper (37% reduction) and Triton Knoll (69% reduction) which all contribute a material proportion of the cumulative collision risk total.

8.658. The cumulative impact of collision on gannet during the post-breeding season is, when factoring the evidence presented above, predicted to be of regional spatial extent, to occur throughout the duration of the project and of low to medium reversibility. The cumulative collision risk estimate presented below takes into account the likely overestimation for the post-breeding season due to factors including the age structure of the regional population, and assessed turbine scenarios that overestimate results.

8.659. On the basis of the above assessment of potential impact overestimation and the PVA, the impact is therefore considered to be **low**.

Pre-breeding Season

8.660. There are estimated to be 171 collisions during the pre-breeding season with Project Alpha and Project Bravo combined contributing 16% of these collisions (Table 8.42). This total represents an increase of 0.85% in the baseline mortality (20,119 individuals) of the pre-breeding BDMPS population of gannet (248,385 individuals). When considering the 2014 consented scenarios from Inch Cape and Neart na Gaoithe a small increase to 183 collisions (representing a 0.91% change in baseline mortality) is observed. However, there are a number of additional factors that suggest the magnitude of the impact would be lower.

8.661. Paragraphs 8.637 and 8.639 outline the potential reductions that may occur when changes to nocturnal activity factors and differences between assessed and as-built/planned turbine scenarios are considered for those projects that make a material contribution to the cumulative collision risk total.

8.662. The impact of collision mortality on gannet during the pre-breeding season is predicted to be of regional spatial extent, to occur throughout the duration of the project and of low to medium reversibility. The cumulative collision risk estimate presented in Table 8.42 is likely to be a considerable overestimate for the pre-breeding season due to factors including the age structure of the regional population and differences between as-built, consented and assessed turbine scenarios that overestimate results.

8.663. On the basis of the above assessment of potential impact overestimation and the PVA, the impact is therefore considered to be **low**.

Sensitivity of the Receptor

8.664. As a qualifying feature of regional SPAs, gannet is afforded international conservation value. It was ranked high in terms of vulnerability to collisions by Wade *et al.* (2016) although moderate vulnerability by Langston (2010). High vulnerability is considered appropriate within this assessment.

8.665. Gannet is deemed to be of high vulnerability, high recoverability and international value. The sensitivity of gannet is therefore, considered to be **high**.

Impact Significance

8.666. Overall, the sensitivity of gannet is considered to be high and the impact magnitude is deemed to be low. The impact will therefore be **Moderate adverse**. The 2017 Scoping Opinion says, however, that "*The Scottish Ministers advise that the conservation objective relating to the population of species as a viable component of the site should be the focus of the assessment*". Consequently further analysis of the effects of the predicted impacts on specific breeding populations has been undertaken (see Chapter 16). This analysis does not indicate that there is a risk that the breeding gannet population at Bass Rock will reduce to the level at which it would no longer be considered to be viable component of the Forth Islands SPA, and on this basis, the predicted impact is considered **not significant** in EIA terms. This determination of significance also reflects the differing potential for projects to ultimately make a material contribution to a cumulative impact alongside Project Alpha, Project Bravo and Project Alpha and Project Bravo combined.

Kittiwake

8.667. Table 8.43 presents a seasonal breakdown of predicted cumulative collision mortality using results from the Basic Band model, for kittiwake.

Impact Magnitude

Breeding Season

8.668. When considering all projects which are within foraging range, the combined breeding season mortality is estimated to be 207 kittiwakes, of which Project Alpha and Project Bravo combined contribute approximately 60%. The mortality of these additional birds in the breeding season is equal to an increase in baseline mortality (11,339 individuals; 1% = 113) of 1.9% on the regional breeding population (77,664 individuals) using a baseline mortality rate of 0.146 (Horswill and Robinson, 2015). When the 2014 consented values are included from Inch Cape and Neart na Gaoithe a total of 324 is concluded. This would account for a 3.6% increase in baseline mortality of the regional breeding population.

8.669. As the cumulative collision risk estimate in the breeding season is over 1% baseline mortality there is potential for the impact magnitude to be of a moderate level. However, there are a number of additional factors that suggest the level of impact may be lower. It is considered likely that a proportion of all birds recorded in the breeding season are immature individuals (see Appendix 16B [Seabird Apportioning]). In addition, a further proportion are likely to be non-breeding adult birds. Analyses undertaken in Appendix 8A (Ornithology Technical Report) suggests that around 14% of birds at Project Alpha and Project Bravo combined in the breeding season will be immature birds or breeding adults on 'sabbatical'.

8.670. There is likely to be reductions in the collision risk estimates presented in Table 8.43 for EOWDC and Hywind due to the over-estimation of nocturnal activity of kittiwake as part of the collision risk modelling conducted for these projects. Table 8.41 suggests that the collision risk estimates for these projects would reduce by at least 7.1 to 7.8% and possibly up to 16.1 to 16.2%.

Table 8.43 Cumulative collision impacts for kittiwake

Project	Project status	Collision risk model [Option]	Annual collisions	Breeding	Post-breeding	Pre-breeding
Breeding and non-breeding seasons						
Neart na Gaoithe[A]	Consented and awarded CfD	Band (2012) [2]	28 (70)	9 (23)	17 (42)	2 (5)
Inch Cape[B]	Consented – no CfD	Band (2012) [1]	72 (241)	40 (143)	16 (45)	16 (44)
Project Alpha and Project Bravo combined	Consented – no CfD	Band (2012) [1]	266	130	88	48
EOWDC	Consented and awarded CfD	Band (2012) [2]	19	14	3	1
Kincardine	Under construction	Band (2012) [2]	21	14	6	1
Non-breeding seasons						
Beatrice	Under construction	Band (2012) [1]	87	-	7	17
Blyth Demo	Under construction	Band *et al.* (2007) [1]	5	-	2	2
Dogger Bank Creyke Beck A and B	Consented – no CfD	Band (2012) [2]	719	-	107	329
Dogger Bank Teesside A and Sofia (formerly Dogger Bank Teesside B)	Consented – no CfD	Band (2012) [2]	445	-	79	237
East Anglia One	Under construction	Band (2012) [2]	581	-	396	142
East Anglia Three	Consented – no CfD	Band (2012) [1]	102	-	64	34
Galloper	Under construction	Band *et al.* (2007) [1]	66	-	27	29
Greater Gabbard	Operational	Band (2000) [1]	28	-	6	18
Hornsea Project One	Under construction	Band (2012) [1]	123	-	43	25
Hornsea Project Two	Consented and awarded CfD	Band (2012) [1]	27	-	7	4
Hornsea Project Three	Application submitted	Band (2012) [2]	238	-	61	57
Humber Gateway	Operational	Not available [1]	7	-	2	2

Project	Project status	Collision risk model [Option]	Annual collisions	Breeding	Post-breeding	Pre-breeding
Hywind	Under construction	Band (2012) [1]	18	-	1	2
Kentish Flats Extension	Operational	Band (2012) [1]	3	-	1	1
Lincs	Operational	Band (2000) [1]	3	-	1	1
London Array	Operational	Band (2000) [1]	6	-	2	3
Methil	Consented – no CfD	Band (2011/12) [Unknown]	1	-	0	0
Moray East	Consented and awarded CfD	Band (2012) [1]	37	-	1	10
Race Bank	Under construction	Band (2000) [1]	31	-	17	6
Teesside	Operational	Band (2000) [1]	81	-	13	9
Thanet	Operational	Band (2000) [1]	0	-	0	0
Triton Knoll	Consented and awarded CfD	Band (2000) [1]	209	-	99	69
Westermost Rough	Operational	Band *et al.* (2007) [1]	0	-	0	0
Total				**207 (324)**	**1067 (1121)**	**1065 (1096)**

[A]Neart na Gaoithe figures show updated (2018) figures plus consented (2014) figures in parentheses.

[B]Inch Cape numbers worst case potential 2018 application as calculated in Appendix 8B (Collision Risk Modelling) plus consented (2014) values in parentheses.

NB. Projects highlighted are those that have less certainty of being built.

8.671. Table 8.41 indicates that there is unlikely to be a significant change in the collision risk estimates predicted for projects considered in the breeding season as a result of differences between assessed and as-built/planned turbine scenarios.

8.672. The impact of collision on kittiwake during the breeding season is predicted to be of regional spatial extent, to occur throughout the duration of the project and to be of low to medium reversibility. As has been illustrated the cumulative collision risk estimate is likely to be an overestimate for the breeding season due to factors including the age structure of the regional population. Nevertheless, the mortality predicted is substantial and represents a potential change in baseline mortality (7.7%) that could be categorised as having the potential to affect kittiwake abundance and distribution within the given geographical area assessed.

8.673. In the 2017 Scoping Opinion the consultation responses received were taken into account in adopting the opinion including SNH advice that it *"does not require any assessment against regional populations – our focus remains on the individual breeding colonies, particularly SPAs"*. For kittiwake, the relevant breeding colony of interest to SNH are the Forth Islands SPA and Fowlsheugh SPA.

8.674. Further work has been undertaken to understand the consequences of cumulative collision mortality on the Forth Islands SPA kittiwake population through PVA (Appendix 8D (Population Viability Analysis)). The outputs of the PVA modelling over the 25 year operational life time of the optimised Seagreen Project (see Chapter 16) indicates that:

- The impacted population will continue to grow at a very similar rate to that predicted by the PVA for the un-impacted population. The predicted median population growth rate (1.03) for the impacted population is essentially indistinguishable from that of the un-impacted population (counterfactual of the median population growth rate ≈ 1); and
- The similarity of the predicted growth rates leads to similar population outcomes. The model predicts a median end population size (in the impacted scenario) of 9,461 pairs. This is similar to the predicted population in the absence of any impact as indicated by the moderately high ratio of the counterfactual of population size (0.89) and the centile of un-impacted population that is equivalent to the 50th centile for the impacted population (0.64).

8.675. The outputs of the PVA modelling over the 25 year operational life time of the optimised Seagreen Project indicates that the impacted population will continue to grow at a very similar rate to that predicted by the PVA for the un-impacted population. Recent monitoring data from the colony (see Chapter 16) also indicate that the population is stable or growing. The predicted median population growth rate (1.03) for the impacted population is essentially indistinguishable from that predicted for collision alone and of the un-impacted population (counterfactual of the median population growth rate ≈ 1).

8.676. The current kittiwake population for the Forth Islands SPA is lower than that for which it is designated, however, there is no indication that the cumulative impact of the optimised Seagreen Project would prevent the population from maintaining itself or from growing further. In fact PVA modelling predicts that the population will grow over the project lifetime even with the additional mortality that the operation of the wind farm is predicted to lead to. Consequently, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that kittiwake will remain a viable a component of the site.

8.677. The Fowlsheugh SPA assessment is made in the context of a population decline since the designation of the Site of Special Scientific Interest (SSSI) that underpins the Fowlsheugh SPA. The decline is considered to be "consistent with national trends, thought to be linked to changes in food supply outside the designated site" (Scottish Natural Heritage, 2011). The current Fowlsheugh SPA population of 9,655 is lower than the population of 36,650 pairs cited at the time of the marine extension designation in 2009 (Scottish Natural Heritage, 2009). More recent counts indicate a more stable population, albeit at a reduced level from that which was designated (see Chapter 16).

8.678. The outputs of the PVA modelling, using the metrics advised by Marine Scotland, over the 25 year operational life time of the optimised Seagreen Project (see Chapter 16) predict that the un-impacted population will grow slowly and this is not considered to be inconsistent with the recent monitoring data for Fowlsheugh (see Chapter 16).

8.679. The effect of including the predicted cumulative additional annual mortality on the population has been tested using this PVA model and it indicates:

- The impacted population will continue to grow at a similar rate to that predicted by the PVA for the un-impacted population. The predicted median population growth rate (1.03) for the impacted population is similar to that of the un-impacted population (counterfactual of the median population growth rate = 0.99); and
- The model predicts a median end population size (in the impacted scenario) of 18,515 pairs. This is somewhat lower than the predicted population in the absence of any impact as indicated by the ratio of the counterfactual of population size (0.83) and the ratio of the centile of un-impacted population that is equivalent to the 50th centile for the impacted population (0.72).

8.680. Whilst the PVA model indicates the kittiwake population would continue to grow, there would be a lower kittiwake population at Fowlsheugh SPA after the optimised Seagreen Project has operated for 25 years than there would be in the absence of the wind farm, this prediction includes significant precaution, including:

- Over-estimation of the magnitude of the predicted impact.
- Over-estimation of the proportion of this impact that is likely to affect the breeding kittiwake interest feature of Fowlsheugh SPA.
- Over-estimation of the population response to the apportioned impact due to the simplistic nature of the PVA model used.

8.681. In light of the precaution included in the assessment, it is considered that the impacted population would be closer to the un-impacted population than is currently predicted. For example, empirical based flight speed estimates such as those defined by Skov *et al*. (2018) when used in the CRM for kittiwake could equate to a ~19% reduction in collision estimates. Based on the predictions that the kittiwake population will maintain its current capacity for growth and the population trajectory remains positive, albeit at a lower overall population size, the long term viability of kittiwake as a component of Fowlsheugh SPA will be maintained.

8.682. On this basis, although the predicted level of mortality is relatively high, the risk to the population and its continued viability as a breeding interest feature of the Forth Islands SPA and Fowlsheugh SPA that can be attributed to the optimised Seagreen Project, is **low**.

Post-breeding Season

8.683. In the post-breeding season a total of 1,067 collisions are estimated to occur with Project Alpha and Project Bravo combined contributing a small proportion of this total (8.2%). This level of additional mortality represents an increase of 0.88% in baseline mortality (121,171 individuals) of the post-breeding BDMPS population of kittiwake (829,937 individuals). When considering the 2014 consented scenarios from Inch Cape and Neart na Gaoithe a small increase to 1121 collisions (representing a 0.93% change in baseline mortality) is observed.

8.684. As an impact that would affect the receptor directly, has a regional spatial extent, is long term in duration, is continuous and of low to medium reversibility it is predicted that the cumulative collision risk estimate in the post-breeding season would be of low or moderate magnitude. However, there are a number of additional factors that suggest the magnitude of the impact would be at the lower end of this scale.

8.685. For those projects that are considered in the post- and pre-breeding seasons only, there is likely to be reductions in the collision risk estimates presented in Table 8.43 due to the over-estimation of nocturnal activity of kittiwake as part of the collision risk modelling conducted for these projects. Table 8.41 suggests that the collision risk estimates for these projects would reduce by at least 7.1 to 9.2% and possibly up to 16.1 to 16.2%. For some of these projects (e.g. the Dogger Bank projects, East Anglia One, East Anglia Three, Galloper, Hornsea Project One and Triton Knoll) this would represent a material difference in the number of collisions contributed to the overall total.

8.686. The information presented in Table 8.41 in relation to differences between assessed and as-built scenarios indicates that there is potential for considerable reductions in the collision risk estimates for many projects for which collision risk estimates are included in Table 8.43. This is especially applicable to East Anglia One (42% reduction), Galloper (37% reduction) and Triton Knoll (69% reduction) which all contribute a material proportion of the cumulative collision risk total.

8.687. The impact of collision on kittiwake during the pre-breeding season is predicted to be of regional spatial extent, continuous, to occur throughout project duration and to be of low to medium reversibility. As has been illustrated, the cumulative collision risk estimate presented is likely to be a considerable overestimate for the post-breeding season due to factors including the age structure of the regional population, differences between as-built, consented and assessed turbine scenarios. When these factors are taken into account the impact magnitude is therefore, considered to be **low**.

Pre-breeding Season

8.688. There are estimated to be 1,065 collisions from projects considered cumulatively during the pre-breeding season with the Project Alpha and Project Bravo combined contributing 4.5% of these collisions. The total represents a 1.16% increase in the baseline mortality (91,661 individuals) of the pre-breeding BDMPS population of kittiwake (627,816 individuals). When considering the 2014 consented scenarios from Inch Cape and Neart na Gaoithe a small increase to 1,096 collisions (representing a 1.20% change in baseline mortality) is observed.

8.689. As an impact that would affect the receptor directly, is long term in duration, is continuous and of low to medium reversibility it is predicted that the cumulative collision risk estimate in the pre-breeding season would be of low or moderate magnitude. However, there are a number of additional factors that suggest the magnitude of the impact would be lower.

8.690. Paragraphs 8.637 and 8.639 outline the potential reductions that may occur when changes to nocturnal activity factors and differences between assessed and as-built/planned turbine scenarios are considered for those projects that make a material contribution to the cumulative collision risk total.

8.691. The impact of collision on kittiwake during the pre-breeding season is predicted to be of regional spatial extent, continuous, to occur throughout project duration and to be of low to medium reversibility. As has been illustrated, the cumulative collision risk estimate presented is likely to be a considerable overestimate for the pre-breeding season due to factors including the age structure of the regional population, differences between as-built, consented and assessed turbine scenarios. When these factors are taken into account the impact magnitude is therefore, considered to be **low**.

Sensitivity of the Receptor

8.692. Kittiwake was rated as being relatively high vulnerability to collision impacts by Wade *et al.* (2016), due to the proportion of flights likely to occur at potential risk height and percentage of time in flight, including at night. From previous studies in Flanders that have recorded mortality rates and collision rates, estimated micro-avoidance rates were, however, high for smaller gulls (Everaert, 2006; 2008; 2011; Everaert *et al.*, 2002; Everaert and Kuijken, 2007). Studies have also shown that rates are consistently above 98% for flights at rotor height (GWFL, 2011).

8.693. Kittiwake is deemed to be of high vulnerability, low recoverability and international value. The sensitivity of kittiwake is therefore, considered to be **medium**.

Impact Significance

8.694. Overall, the sensitivity of kittiwake is considered to be **medium** and the impact magnitude is deemed to be **low.** The impact will therefore be **Minor adverse**. The 2017 Scoping Opinion says, however, that "*The Scottish Ministers advise that the conservation objective relating to the population of species as a viable component of the site should be the focus of the assessment*". Consequently further analysis of the effects of the predicted impacts on specific breeding populations has been undertaken (see Chapter 16). This analysis does not indicate that there is a risk that the breeding kittiwake populations at any of the SPAs assessed will reduce to the level at which it would no longer be considered to be viable component of the sites, and on this basis, the predicted impact is considered **not significant** in EIA terms. This determination arises because, in the context of the regional drivers of population decline, the risk that the Forth Islands SPA or Fowlsheugh SPA kittiwake populations will not remain viable due to the optimised Seagreen Project, is considered to be low. This determination of significance also reflects the differing potential for projects to ultimately make a material contribution to a cumulative impact alongside Project Alpha, Project Bravo and Project Alpha and Project Bravo combined.

Herring Gull

8.695. Table 8.44 presents a seasonal breakdown of predicted cumulative collision mortality using results from the Extended Band model, where available, for herring gull.

Impact Magnitude

Breeding Season

8.696. When considering all projects which are within foraging range, the combined breeding season mortality is estimated to be 13 herring gulls, of which Project Alpha and Project Bravo combined contribute 23%. The mortality of these additional birds in the breeding season is equal to an increase in baseline mortality (5,919 individuals) of approximately 0.22% on the regional breeding population (35,658 individuals) using a baseline mortality rate of 0.166 (Horswill and Robinson, 2015). When considering the 2014 consented scenarios from Inch Cape and Neart na Gaoithe, a small increase to 18 collisions (representing a 0.35% change in baseline mortality) is observed.

8.697. It is considered likely that a substantial proportion of all birds recorded in the breeding season are immature individuals. In addition, a further proportion are likely to be non-breeding adult birds. Therefore, the impact on the regional breeding population is likely to be an overestimate. In addition, a proportion of adults every breeding season skip breeding and take a sabbatical from breeding. To include any impacts occurring on any sabbatical birds would seem likely to overestimate the effects to these species/populations (Marine Scotland 2017a,b). Therefore, in accordance with Marine Scotland guidance (Marine Scotland 2017a,b), the impacts assigned to sabbaticals should be removed from the assessment. For herring gull the proportion of adults taking a sabbatical is 35% (See Chapter 16 [HRA] Appendix 16B [Seabird Apportioning]).

Table 8.44 Cumulative collision impacts for herring gull

Project	Collision risk model	Option	Annual collisions	Breeding	Non-breeding
Breeding and non-breeding seasons					
Neart na Gaoithe[1]	Band (2012)	2	6 (11)	2 (4)	4 (7)
Inch Cape[6]	Band (2012)	1	4 (11)	1 (4)	2 (6)
Project Alpha and Project Bravo combined	Band (2012)	3	12	3	8
EOWDC	Band (2012)	2	5	3	2
Hywind	Band (2012)	1	8	4	5
Kincardine	Band (2012)	1	1	0	1
Non-breeding seasons					
Beatrice	Band (2012)	1	326		265
Blyth Demo	Band *et al.* (2007)	1	11		6
East Anglia One	Band (2012)	2	42		36
East Anglia Three	Band (2012)	1	19		19
Galloper	Band *et al.* (2007)	1	20		17
Hornsea Project One	Band (2012)	1	14		13
Humber Gateway	Not available	1	2		1
Kentish Flats Extension	Band (2012)	1	2		1
Moray East	Band (2012)	1	51		46
Teesside	Band (2000)	1	43		25
Thanet	Band (2000)	1	9		6
Westermost Rough	Band *et al.* (2007)	1	0		0
Total		**13 (18)**		**458 (465)**	

Neart na Gaoithe figures show updated (2018) figures plus consented (2014) figures in parentheses.

[6] Inch Cape numbers worst case potential 2018 application as calculated in Appendix 8B [Collision Risk Modelling] plus consented (2014) values in parentheses

8.698. Of those projects considered cumulatively in the breeding season, there is likely to be reductions in the collision risk estimates presented in Table 8.44 for EOWDC and Hywind due to the over-estimation of nocturnal activity of herring gull as part of the collision risk modelling conducted for these projects. Table 8.41 suggests that the collision risk estimates for these projects would reduce by at least 7.1 to 7.8% and possibly up to 16.1 to 16.2%.

8.699. Taking into account sources of overestimation, the impact is predicted to be of regional spatial extent, to occur throughout the duration of the project and to be of low to medium reversibility. The predicted impact in relation to the SPA populations is negligible in real terms and therefore population consequences are not certain to arise for any of the SPAs assessed. The impact magnitude is therefore, considered to be **negligible**.

Non-breeding Season

8.700. There are estimated to be 458 collisions from projects considered cumulatively during the non-breeding season with Project Alpha and Project Bravo combined contributing 1.7% of these collisions. The total represents a 0.59% increase in the baseline mortality (77,441 individuals) of the pre-breeding BDMPS population of herring gull (466,511 individuals). When considering the 2014 consented scenarios from Inch Cape and Neart na Gaoithe a small increase to 465 collisions (representing a 0.60% change in baseline mortality) is observed.

8.701. For those projects that are considered in the non-breeding seasons only, there is likely to be reductions in the collision risk estimates presented in Table 8.44 due to the over-estimation of nocturnal activity of herring gull as part of the collision risk modelling conducted for these projects. Table 8.41 suggests that the collision risk estimates for these projects would reduce by at least 7.1 to 9.2% and possibly up to 16.1 to 16.2%. For some of these projects (e.g. the Beatrice, East Anglia One, Galloper, Hornsea Project One, Moray East and Teesside) these differences would represent a material difference in the number of collisions contributed to the overall total.

8.702. The information presented in Table 8.41 in relation to differences between assessed and as-built scenarios indicates that there is potential for considerable reductions in the collision risk estimates for many projects for which collision risk estimates are included in Table 8.44. This is especially applicable to Beatrice (70% reduction), East Anglia One (42% reduction), Galloper (37% reduction) and Triton Knoll (69% reduction) which all contribute a material proportion of the cumulative collision risk total.

8.703. Taking into account sources of overestimation, the impact is predicted to be of regional spatial extent, to occur throughout the duration of the project and to be of low to medium reversibility. The predicted impact in relation to the SPA populations is negligible in real terms and therefore population consequences are not certain to arise for any of the SPAs assessed. The impact magnitude is therefore, considered to be **negligible**.

Sensitivity of the Receptor

8.704. Herring gull was rated as being very highly vulnerable to collision impacts by Wade *et al.* (2016), due to the proportion of flights likely to occur at potential risk height and percentage of time in flight, including at night.

8.705. Herring gull is deemed to be of very high vulnerability, low recoverability and international value. The sensitivity of herring gull is therefore, considered to be **high**.

Impact Significance

8.706. Overall, the sensitivity of herring gull is considered to be **high** and the impact magnitude is deemed to be **negligible**. On this basis it is judged that the impact is of **Minor Adverse**, which is **Not Significant** in EIA terms.

INTERRELATIONSHIPS

8.707. Interrelationships describe the potential interaction of multiple project impacts upon one receptor and have a spatial and/or temporal component. Impacts may occur throughout different phases of the project (construction, operation or decommissioning) and/or different project impacts may have spatial overlap and may interact to create a more significant impact on a receptor than when considered in isolation. Interrelated impacts may be short term, temporary or longer term over the lifetime of the Project.

8.708. With respect to offshore ornithology there is the potential for an interrelated impact related to impacts on prey availability which could arise due to impacts on fish and shellfish ecology (Chapter 9 [Natural Fish and Shellfish Resource]) and/or commercial fisheries (Chapter 11 [Commercial Fisheries]). In both cases no potential significant impacts are predicted and no significant indirect impacts on seabirds are anticipated as a consequence of impacts on prey availability.

8.709. No other interrelated impacts are anticipated.

TRANSBOUNDARY IMPACTS

8.710. The Seagreen Scoping Report concluded that given the location of the Project and the likely key receptors, potential transboundary impacts are considered unlikely (Seagreen, 2017). Based on the location of the Project and the likely key receptors, it was considered that there will be no significant transboundary impacts on birds. In the breeding season, there are no non-UK seabird colonies within mean-maximum foraging range of the Project, therefore there will not be any transboundary impacts.

8.711. In the non-breeding season, although it is possible that birds from non-UK seabird colonies may pass through the optimised Seagreen Project, there will be minimal impact from displacement or barrier effects, as foraging birds would be able to find food outside of the optimised Seagreen Project, and so would not be affected if they avoided the optimised Seagreen Project due to the presence of turbines. Although it is possible that birds from non-UK seabird colonies may collide with the turbines, it is considered very unlikely that this would represent significant numbers of a species from non-UK colonies.

MITIGATION AND MONITORING

8.712. The assessment of impacts on birds, both in isolation and cumulatively, as a result of the construction, operation and decommissioning of the Project are predicted to be not significant in EIA terms. Based on the predicted impacts it is concluded that no specific mitigation is required beyond the designed embedded mitigation.

8.713. Following consent, a Project Environmental Monitoring Plan (PEMP) will be developed and agreed with MS-LOT, in discussion with the Forth and Tay Regional Advisory Group (FTRAG). Monitoring will be required to validate the findings of the EIA.

8.714. To date, there have been some high level discussions regarding future monitoring requirements for Neart na Gaoithe OWF. An ornithology sub-group for the FTRAG has been established, comprising representatives from Seagreen, NnG, Inch Cape, Marine Scotland, SNH, JNCC and RSPB. Initial discussions considered where monitoring should focus, in terms of research questions, key species, SPAs and impacts to be addressed.

IMPACT ASSESSMENT SUMMARY – THE OPTIMISED SEAGREEN PROJECT

8.715. This chapter has assessed the potential impacts on offshore ornithology of the construction, operation and decommissioning phases of the optimised Seagreen Project, both in isolation and cumulatively. Where significant impacts have been identified, additional mitigation has been considered and incorporated into the assessment. Table 8.45 summarises the impact assessment undertaken and the conclusion of residual impact significance, following the application of additional mitigation.

8.716. The significance of potential impacts due to disturbance and displacement from the optimised Project Alpha and optimised Project Bravo remain the same as those previously assessed, despite the calculation of those effects over a larger area than was previously assumed, due to the addition of the 2km buffer surveyed. No significant displacement impacts are predicted for kittiwake, guillemot, razorbill and puffin due to the effects of those projects, either alone or combined or cumulatively with other relevant projects.

8.717. The significance of potential impacts due to collision mortality from Project Alpha and Project Bravo are generally lower than those previously assessed. The use of fewer, larger turbines typically reduces the risk of collision for seabirds, notwithstanding changes in assessment methodology, which now includes consideration of non-breeding season effects, for example. For gannet, kittiwake and herring gull no significant impacts are predicted due to collision mortality arising from these projects, either alone or combined, or cumulatively with other relevant projects and therefore no additional mitigation measures are proposed.

Table 8.45 Summary of Predicted Impacts for the optimised Seagreen Project

Receptor	Potential Impact	Phase (C, O or D)	Impact Significance	Additional Mitigation Measures	Residual Impact Significance
Project Alpha					
Guillemot	Disturbance and displacement	C, O, D	Negligible to Minor adverse (Not Significant)	n/a	Negligible to Minor
Razorbill	Disturbance and displacement	C, O, D	Negligible to Minor adverse (Not Significant)	n/a	Negligible to Minor
Puffin	Disturbance and displacement	C, O, D	Minor adverse (Not Significant)	n/a	Minor
Kittiwake	Displacement	O	Minor adverse (Not Significant)	n/a	Minor
Gannet	Collision	O	Minor to Moderate adverse (Not Significant)	n/a	Minor to Moderate
Kittiwake	Collision	O	Minor adverse (Not Significant)	n/a	Minor
Herring gull	Collision	O	Minor adverse (Not Significant)	n/a	Minor
Project Bravo					
Guillemot	Disturbance and displacement	C, O, D	Negligible to Minor adverse (Not Significant)	n/a	Negligible to Minor
Razorbill	Disturbance and displacement	C, O, D	Negligible to Minor adverse (Not Significant)	n/a	Negligible to Minor
Puffin	Disturbance and displacement	C, O, D	Minor adverse (Not Significant)	n/a	Minor
Kittiwake	Displacement	O	Minor adverse (Not Significant)	n/a	Minor
Kittiwake	Collision	O	Minor adverse (Not Significant)	n/a	Minor
Gannet	Collision	O	Moderate adverse (Not Significant)	n/a	Moderate
Herring gull	Collision	O	Minor adverse (Not Significant)	n/a	Minor

Receptor	Potential Impact	Phase (C, O or D)	Impact Significance	Additional Mitigation Measures	Residual Impact Significance
Project Alpha and Project Bravo Combined					
Guillemot	Disturbance and displacement	C, O, D	Negligible to Minor adverse (Not Significant)	n/a	Negligible to Minor
Razorbill	Disturbance and displacement	C, O, D	Negligible to Minor adverse (Not Significant)	n/a	Negligible to Minor
Puffin	Disturbance and displacement	C, O, D	Minor adverse (Not Significant)	n/a	Minor
Kittiwake	Displacement	O	Minor adverse (Not Significant)	n/a	Minor
Gannet	Collision	O	Moderate adverse (Not Significant)	n/a	Moderate
Kittiwake	Collision	O	Minor adverse (Not Significant)	n/a	Minor
Herring gull	Collision	O	Minor adverse (Not Significant)	n/a	Minor
Cumulative Impact Assessment					
Guillemot	Disturbance and displacement	C, O, D	Minor adverse (Not Significant)	n/a	Minor
Razorbill	Disturbance and displacement	C, O, D	Minor adverse (Not Significant)	n/a	Minor
Puffin	Disturbance and displacement	C, O, D	Minor adverse (Not Significant)	n/a	Minor
Kittiwake	Displacement	O	Minor adverse (Not Significant)	n/a	Minor
Gannet	Collision	O	Moderate adverse (Not Significant)	n/a	Moderate
Kittiwake	Collision	O	Minor adverse (Not Significant)	n/a	Minor
Herring gull	Collision	O	Minor adverse (Not Significant)	n/a	Minor
Key: C = Construction, O = Operational, D = Decommissioning					

REFERENCES

Band, B. (2011). *Using a collision risk model to assess bird collision risks for offshore wind farms*. The Crown Estate Strategic Ornithological Support Services (SOSS) report SOSS-02. Norfolk, British Trust for Ornithology.

Band, B. (2012). *Using a collision risk model to assess bird collision risks for offshore wind farms*. The Crown Estate Strategic Ornithological Support Services (SOSS) report SOSS-02. Norfolk, British Trust for Ornithology.

Band, W. (2000). *Wind farms and Birds: calculating a theoretical collision risk assuming no avoiding action*. Scottish Natural Heritage Guidance Note.

Band, W., Madders, M., and Whitfield, D.P. (2007). Developing field and analytical methods to assess avian collision risk at wind farms. In: de Lucas, M., Janss, G.F.E. and Ferrer, M. (eds.) Birds *and Wind Farms: Risk Assessment and Mitigation*. Madrid, Quercus. p. 259-275.

Barrow Offshore Wind Ltd. (2009). Post *Construction Monitoring Report for Barrow Offshore Wind Farm*. Barrow Offshore Wind Ltd., Copenhagen.

Beatrice Offshore Wind Farm Limited. (2012). *Ornithological HRA Technical Report*. RPS report to BOWL.

BirdLife International (2017) BirdLife International Species Factsheets. [online] Available at: <http://www.birdlife.org/datazone> [Accessed December 2017].

Bradbury, G., Trinder, M., Furness, B., Banks, A.N., Caldow, R.W.G. and Hume, D. (2014). Mapping Seabird Sensitivity to Offshore Wind Farms. *PLOS ONE*, 12 (1), pp. 1-17.

Burton, N.H.K., Banks, A.N., Calladine, J.R. and Austin, G.E. (2013). The importance of the United Kingdom for wintering gulls: population estimates and conservation requirements. *Bird Study*, 60 (1), 87-101.

Cabot, D. (2009). *Wildfowl*. Harper Collins, London.

Camphuysen, C.J., Fox, T., Leopold, M.F. and Petersen, I.K. (2004). *Towards standardised seabirds at sea census techniques in connection with environmental impact assessments for offshore wind farms in the UK*. A report for COWRIE.

IEEM (2010). *Guidelines for Ecological Impact Assessment in Britain and Ireland: Marine and Coastal*. Winchester, Institute of Ecology and Environmental Management.

CIEEM (in prep). Guidelines for Ecological Impact Assessment in The UK and Ireland. Terrestrial, Freshwater, Coastal and Marine. Winchester, Chartered Institute of Ecology and Environmental Management.

Cook, A.S.C.P., Humphreys, E.M., Masden, E.A. and Burton, N.H.K. (2014). The *avoidance rates of collision between birds and offshore turbines.* Thetford, British Trust for Ornithology.

Coulson, J. (2011). The Kittiwake. Poyser monographs series.

Coulson, J. C., Monaghan, P., Butterfield, J. E. L., Duncan, N., Ensor, K., Shedden, C. and Thomas, C. 1984. Scandinavian Herring Gulls wintering in Britain. *Ornis Scand*. 15: 79-88

Cramp, S. and Perrins, C.M. (1977–1994). *Handbook of the birds of Europe, the Middle East and Africa. The birds of the western Palearctic*. Oxford, Oxford University Press.

DECC (2011). *Department of Energy and Climate Change–Offshore Energy Strategic Environmental Assessment: OESEA2 Environmental Report–Future Leasing/Licensing for Offshore Renewable Energy, Offshore Oil and Gas, Hydrocarbon Gas and Carbon Dioxide Storage and Associated Infrastructure*. Department for Energy and Climate Change, February 2011. URN 10D/1024.

del Hoyo, J.; Elliott, A. and Sargatal, J. (1996). *Handbook of the Birds of the World, vol. 3: Hoatzin to Auks*. Barcelona, Lynx Edicions.

Desholm, M. (2005). *TADS investigations of avian collision risk at Nysted Offshore Wind Farm*. Denmark, National Environmental Research Institute.

Dierschke, V. and Garthe, S. (2006). Literature review of offshore wind farms with regards to seabirds. In: Zucco, C., Wende, W., Merck, T., Köchling, I. and Köppel, J. (eds.): *Ecological research on offshore wind farms: international exchange of experiences. Part B: literature review of ecological impacts*. BfN-Skripten 186: 131–198.

Dierschke, V., Garthe, S. and Mendel, B. (2006). *Possible conflicts between offshore wind farms and seabirds in the German sectors of North Sea and Baltic Sea*. In: Köller, J., Köppel, H. and Peters, W. (Eds.): Offshore wind energy. Research on environ mental impacts. Berlin, Springer. p 121-143.

Drewitt, A.L. and Langston, R.H.W. (2006). Assessing the impacts of wind farms on birds. *Ibis*, 148. 29-42.

Eaton, M.A., Aebischer, N.J., Brown, A.F., Hearn, R., Lock, L., Musgrove, A.J., Noble, D., Stroud, D. and Gregory, R.D. (2015). *Birds of Conservation Concern 4: the population status of birds in the United Kingdom, Channel Islands and the Isle of Man*. *British Birds* 108, 708-746.

ECON (2012). *Boat-based ornithological monitoring at the Lynn and Inner Dowsing Wind Farms: Year 3 (2011) post-construction report*. Report for Centrica Renewable Energy Limited.

Everaert, J. (2006). Wind turbines and birds in Flanders: preliminary study results and recommendations. Natuur. *Oriolus*, 69(4), 145-155.

Everaert, J. (2008). *Effecten van windturbines op de fauna in Vlaanderen : onderzoeksresultaten, discussie en aanbevelingen. Effects of wind turbines on fauna in Flanders–Study results, discussions and recommendations*. Rapporten van het Instituut voor Natuur- en Bosonderzoek, 2008(44). Instituut voor Natuur- en Bosonderzoek: Brussel : Belgium.

Everaert, J., Devos, K. and Kuijken, E. (2002). *Windturbines en vogels in Vlaanderen. Voorlopige onderzoeksresultaten en buitenlandse bevindingen*. Report 2002.3, Instituut voor Natuurbehoud,Brussels. Available at http://publicaties.vlaanderen.be/docfolder/12563/Effecten_windturbines_op_de_fauna_Vlaanderen_2008.pdf.

Everaert, J. and Kuijken, E. (2007). *Wind turbines and birds in Flanders (Belgium): Preliminary summary of the mortality research results*. Belgian Research Institute for Nature and Forest.

Exo, K-M., Hüppop, O. and Garthe, S. (2003). *Offshore-Windenergieanlagen und Vogelschutz*. Seevögel 23, 83-95.

Forrester, R.W., Andrews, I.J., McInerny, C.J., Murray, R.D., McGowan, R.Y., Zonfrillo, B., Betts, M.W., Jardine, D.C. and Grundy, D.S. (eds) (2007). *The Birds of Scotland*. Aberlady, The Scottish Ornithologists' Club.

Frederiksen, M. *et al.* (2012). Multicolony tracking reveals the winter distribution of a pelagic seabird on an ocean basin scale. *Diversity Distrib*. 18, 530–542.

Frost, T.M., Austin, G.E., Calbrade, N.A., Mellan, H.J., Hearn, R.D., Stroud, D.A., Wotton, S.R. and Balmer, D.E.. (2018). *Waterbirds in the UK 2016/17: The Wetland Bird Survey. BTO, RSPB and JNCC, in association with WWT.* British Trust for Ornithology, Thetford.

Furness, R.W. (2015). Non-*breeding season populations of seabirds in UK waters. Population sizes for Biologically Defined Minimum Population Scales (BDMPS*). Natural England Commissioned Report NECR164.

Furness, R.W., Wade, H.M. and Masden, E.A. (2013). Assessing vulnerability of marine bird populations to offshore wind farms. *Journal of Environmental Management*, 119, 56-66.

Furness, R.W. and Todd, C.M. (1984). Diets and feeding of Fulmars *Fulmarus glacialis* during the breeding season:a comparison between St Kilda and Shetland colonies. *Ibis*, 126 (3), pp. 379-387.

Garthe, S. and Hüppop, O. (2004). Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index. *Journal of Applied Ecology*, 41, 724- 734.

Goodale W. and T. Divoll. (2009). *Birds, Bats and Coastal Wind Farm Development in Maine: A Literature Review*. Report BRI 2009-18. Gorham, Maine, BioDiversity Research Institute.

Guse, N., Garthe, S. & Schirmeister, B. (2009). Diet of red-throated divers *Gavia stellata* reflects the seasonal availability of Atlantic herring Clupea harengus in the southwestern Baltic sea. *Journal of Sea Research*, 62: 268-275.

GWFL (2011). *Galloper Wind Farm Project Environmental Statement–Chapter 11: Offshore Ornithology*.

Harris, M.P., Daunt, F., Newell, M., Phillips, R.A. and Wanless, S. (2010). Wintering areas of adult Atlantic puffins Fratercula arctica from a North Sea colony as revealed by geolocation technology. *Marine Biology*, 157(4), pp.827-836.

Horswill, C. & Robinson R. A. (2015). Review of seabird demographic rates and density dependence. *JNCC Report No. 552.* Joint Nature Conservation Committee, Peterborough

Hüppop, O., Dierschke, J., Exo, K-M., Fredrich, E. and Hill, R. (2006). Bird migration studies and potential collision risk with offshore wind turbines. *Ibis*, 148, 90-109.

ICES (2011). Effects of offshore wind farms on seabirds. p.12-17. *In*: *Report of the Working Group on Seabird Ecology (WGSE)* 1-4 November 2011. Madeira, Portugal. p. 73. CM2011/SSGEF:07. ICES, Copenhagen.

Institute of Environmental Management and Assessment (IEMA) (2004*) Guidelines for Environmental Impact Assessment.*

Jessopp, M.J., Cronin, M., Doyle, T.K., Wilson, M., McQuatters-Gollop, A., Newton, S. and Phillips, R.A. (2013). Transatlantic migration by post-breeding puffins: a strategy to exploit a temporarily abundant food resource?. *Marine biology*, 160(10), pp.2755-2762.

JNCC (2017). Seabird Monitoring Programme database. [Online]. Available at: http://jncc.defra.gov.uk/smp/ (Accessed March 2018).

JNCC (2016). Online species accounts for SPA species. [Online]. Available at http://www.jncc.gov.uk/page-1419 (Accessed March 2018).

JNCC (2014). *Joint Response from the Statutory Nature Conservation Bodies to the Marine Scotland Science Avoidance Rate Review*. Joint Nature Conservation Committee (JNCC), Natural England (NE), Natural Resource Wales (NRW), Northern Ireland Environment Agency (NIEA), Scottish Natural Heritage (SNH).

JNCC (2013). *Seabird Population Trends and Causes of Change: 1986-2015 Report*. [Online]. Available at: http://jncc.defra.gov.uk/page-3201 (Accessed March 2018).

JNCC, Natural England, Natural Resource Wales, Northern Ireland Environment Agency, Scottish Natural Heritage (2014). *Joint Response from the Statutory Nature Conservation Bodies to the Marine Scotland Science Avoidance Rate Review*. 25th November 2014.

JNCC, Natural Resources Wales, Department of Agriculture, Environment and Rural Affairs/Northern Ireland Environment Agency, Natural England and Scottish Natural Heritage, (2017). *Joint SNCB Interim Displacement Advice Note*. [Online]. Available at: http://jncc.defra.gov.uk/pdf/Joint_SNCB_Interim_Displacement_AdviceNote_2017.pdf (Accessed May 2017).

Johnston, A., Cook, A.S.C.P., Wright, L.J., Humphreys, E.M. and Burton, N.H.K. (2014). Modelling flight heights of marine birds to more accurately assess collision risk with offshore wind turbines. *Journal of Applied Ecology*, 51, 31-41.

Kaiser, M. Elliot, A,. Galanidi, M., Rees, E.I.S., Caldow, R., Stillman, R., Sutherland, W. & Showler, D. (2002). *Predicting the displacement of Common Scoter Melanitta nigra from benthic feeding areas due to offshore windfarms*. Report Cowrie-BEN-03-2002. University of Wales, Bangor.

Kerlinger, P. and Curry, R. (2002). *Desktop Avian Risk Assessment for the Long Island Power Authority Offshore Wind Energy Project*. Prepared for AWS Scientific Inc. and Long Island Power Authority.

King, S., Maclean, I.M.D., Norman, T., and Prior, A. (2009). *Developing Guidance on Ornithological Cumulative Impact Assessment for Offshore Wind Farm Developers*. COWRIE.

Kober. K., Webb. A., Win. I., Lewis. M., O'Brien. S., Wilson. L.J., Reid. J.B. (2010*). An analysis of the numbers and distribution of seabirds within the British Fishery Limit aimed at identifying areas that qualify as possible marine SPAs*. JNCC Report, No. 431.

Kotzerka. J., Garthe. S. and Hatch. S.A. (2010). GPS tracking devices reveal foraging strategies of Black-legged Kittiwakes. *Journal of Ornithology*. 151. 459-467.

Krijgsveld, K.L., Fijn, R.C., Heunks, C.P., van Horssen, W., de Fouw, J., Collier, M.P., Poot, M.J.M., Beuker, D. and Dirksen, S. (2010). *Effect Studies Offshore Wind Farm Egmond aan Zee. Progress report on fluxes and behaviour of flying birds covering 2007 and 2008*. Bureau Waardenburg report 09-023. Bureau Waardenburg, Culemborg.

Krijgsveld, K.L., Fijn, R.C., Japink, M., van Horssen, P.W., Heunks, C., Collier, M.P., Poot, M.J.M., Beuker, D. and Dirksen, S. (2011). *Effect studies Offshore Wind Farm Egmond aan Zee: Final report on fluxes, flight altitudes and behaviour of flying birds*. NoordzeeWind report nr OWEZ_R_231_T1_20111114_fluxandflight, Bureau Waardenburg report nr 10-219.

Lack, P. (Ed) (1986). *The atlas of wintering birds in Britain and Ireland*. T. and A.D. Poyser, Calton.

Langston, R.H.W. (2010). *Offshore wind farms and birds: Round 3 zones, extensions to Round 1 and 2 sites and Scottish Territorial Waters*. RSPB Research Report No. 39.

Leopold, M.F., Dijkman, E.M., Teal, L. and the OWEZ-team (2010). *Local birds in and around the Offshore Wind Farm Egmond aan Zee (OWEZ). NoordzeeWind rapport OWEZ_R_221_T1_20100731_local_birds*. Imares/NoordzeeWind, Wageningen/IJmuiden.

Leopold, M.F., Dukman, E.M., and Teal, L. (2011). *Local Birds in and around the Offshore Wind Farm Egmond aan Zee (OWEZ) (T-0 and T-1, 2002-2010)*. Texel, The Netherlands, Wageningen IMARES.

Longcore, T. and Rich, C. (2004). Ecological light pollution. Frontiers in Ecology and the Environment/Ecological Society of America, 2 (4), 191-198.

MacArthur Green Ltd. (2017). *Estimates of Ornithological Headroom in Offshore Wind Farm Collision Mortality*. Report to Crown Estate.

Maclean, I.M.D., Wright, L.J., Showler, D.A., and Rehfisch, M.M. (2009). A *review of assessment methodologies for offshore wind farms*. British Trust for Ornithology Report, commissioned by COWRIE Ltd.

Marine Scotland (2017). Marine Scotland Licensing Operations Team: Scoping Opinion for Seagreen Phase 1 Offshore Project. 15 September 2017. Scottish Government, Edinburgh.

Masden, E.A., Haydon, D.T., Fox, A.D. & Furness, R.W. (2010). Barriers to movement: modelling energetic costs of avoiding marine wind farms amongst breeding seabirds. *Marine Pollution Bulletin* 60: 1085-1091.

Masden, E.A. (2015). *Developing an avian collision risk model to incorporate variability and uncertainty*. Environmental Research Institute North Highland College – UHI University of the Highlands and Islands.

Mendel, B., Kotzerka, J., Commerfield, J., Schwemmer, H., Sonntag, N. and Garthe, S. (2014). *Effects of the* Alpha Ventus *offshore test site on distribution patterns, behaviour and flight heights of seabirds*. Federal Maritime and Hydrographic Agency

Mitchell, P.I., Newton, S.F., Ratcliffe, N. and Dunn, T.E. (2004). *Seabird populations of Britain and Ireland*. Poyser, London.

Moray Offshore Renewables Ltd. (2012) *Environmental Statement: Technical Appendix 4.5A – Ornithology Baseline and Impact Assessment.*

Musgrove, A.J., Aebicher, N.J., Eaton, M.A., Hearn, R.D., Newson, S.E., Noble, D.G., Parsons, M., Risely, K. and Stroud, D.A. (2013). Population estimates of birds in Great Britain and the United Kingdom. *British Birds*, 106, 64-100.

Nelson, E., Vallejo, G., Canning, S., Kerr, D., Caryl, F., McGregor, R., Rutherford, V. and Lancaster, J. (2015) *Analysis of Marine Ecology Monitoring Plan Data – Robin Rigg Offshore Wind Farm*. [Online]. Available at: http://www.gov.scot/Topics/marine/Licensing/marine/scoping/Robin-Rigg (Accessed March 2018).

nPower Renewables (2008). *North Hoyle Offshore Wind Farm FEPA Monitoring Final Report*.

Pennington M., Osborn K., Harvey P., Riddington R., Okill D., Ellis P. and Heubeck M. (2004). *Birds of Shetland*. Christopher Helm.

Percival, S.M. (2009). *Kentish Flats Offshore Wind Farm: Review of Monitoring of Red Throated Divers 2008-2009*. Ecology Consulting report to Vattenfall.

Percival, S.M. (2010). Kentish Flats Offshore Wind farm: Diver surveys 2009-2010. On behalf of Vattenfall Wind Power.

Petersen, I.K., Christensen, T.K., Kahlert, J., Desholm, M. and Fox, A.D. (2006). *Final results of bird studies at the offshore wind farms at Nysted and Horns Rev, Denmark*. NERI Report Commissioned by Ørsted and Vattenfall A/S 2006. National Environmental Research Institute Ministry of the Environment-Denmark, Denemarken.

Petersen, I.K. and Fox, A.D. (2007). *Changes in bird habitat utilization around the Horns Rev 1 offshore wind farm, with particular emphasis on Common Scoter*. National Environmental Research Institute, p. 36.

Reed, D.H., O'Grady, J.J., Brook, B.W., Ballou, J.D. and Frankham, R. (2003). *Estimates of minimum viable population sizes for vertebrates and factors influencing those estimates*. Biological Conservation, 113(1), 23–34.

Robinson, R.A. (2005). *BirdFacts: profiles of birds occurring in Britain and Ireland*. [Online]. Available at: http://www.bto.org/birdfacts (Accessed March 2018)

RPS (2012). *Lincs/LID6 Offshore Wind Farm – Boat-based Ornithological Monitoring: Construction Phase*. Report for CREL.

Ruddock, M. and Whitfield, D.P., (2007). *A Review of Disturbance Distances in Selected Bird Species.* [Online]. Available at: http://www.snh.org.uk/pdfs/strategy/renewables/birdsd.pdf (Accessed March 2013).

Seagreen Wind Energy (2012). Baseline Technical Report for Project Alpha & Project Bravo. Appendix F1. Environmental Statement Volume III: Appendices.

Schwemmer, P., Mendel, B., Sonntag, N., Dierschke, V. and Garthe, S. (2011). *Effects of ship traffic on seabirds in offshore waters: implications for marine conservation and spatial planning*. Ecological Applications 21: 1851-1860

Scottish Executive (2004). *Scotland's Biodiversity It's In Your Hands. A strategy for the conservation and enhancement of biodiversity in Scotland.* Scottish Executive, Edinburgh. [online] Available at: http://www.gov.scot/Resource/Doc/25954/0014583.pdf (Accessed June 2018)

Scottish Natural Heritage (2009). *Citation for Special Protection Area (SPA) St Abb's Head To Fast Castle (UK9004271) Including Marine Extension*. [online] Available at: https://gateway.snh.gov.uk/sitelink/documentview.jsp?p_pa_code=8579&p_Doc_Type_ID=16 (Accessed May 2018).

Scottish Natural Heritage (2011). *Conservation Objectives for Forth Islands Special Protection Area*. [online] Available at: <http://gateway.snh.gov.uk/sitelink/documentview.jsp?p_pa_code=8500&p_Doc_Type_ID=29> (Accessed May 2018)

Scottish Natural Heritage (2012). *Population trends of breeding seabirds colonies in Scottish SPAs*. SNH Report.

Scottish Natural Heritage (2013). *A handbook on environmental impact assessment*. 4th edition.

Scottish Natural Heritage (2017a). *2016-17 Marine bird proposed Special Protection Areas consultation (pSPAs)–consultation closed*. [online] Available at: <https://www.nature.scot/2016-17-marine-bird-proposed-special-protection-areas-consultation-pspas-consultation-closed> (Accessed March 2018).

Scottish Natural Heritage (2017b). Sitelink. [online] Available at: <https://gateway.snh.gov.uk/sitelink/> (Accessed March 2018).

Searle, K.R., Mobbs, D., Butler, A., Bogdanova, M., Freeman, S., Wanless, S. & Daunt, F. (2014). Population Consequences of Displacement from Proposed Offshore Wind Energy Developments for Seabirds Breeding at Scottish SPAs (CR/2012/03). Report to Marine Science Scotland. [online] Available at: http://www.gov.scot/Resource/0040/00404982.pdf (Accessed March 2018).

Searle, K.R., Butler, A., Mobbs, D., Bogdanova, M., Freeman, S., Wanless, S., Bolton, M., & Daunt, F. (2015). *At-sea turnover of breeding seabirds* (MSQ-0103). Report to Marine Science Scotland. [online] Available at: http://www.gov.scot/Publications/2015/06/2797

Skov, H., Heinanen, S., Norman, T., Ward, R.M., Mendez-Roldan, S. & Ellis, I. 2018. *ORJIP Bird Collision and Avoidance Study*. Final report – April 2018. The Carbon Trust. United Kingdom. 247 pp.

Stone, C.J., Webb, A., Barton, C., Ratcliffe, N., Redd, T.C., Tasker, M.L., Camphuysen, C.J. and Pienkowski, M.W. (1995). *An atlas of seabird distribution in north-west European waters*. Joint Nature Conservation Committee and Nederlands Institute voor Onderzoek der Zee, Peterborough.

Thaxter, C.B., Lascelles, B., Sugar, K., Cook, A.S.C.P., Roos, S., Bolton, M., Langton, R.H.W. and Burton, N.H.K. (2012). Seabird foraging ranges as a preliminary tool for identifying candidate Marine Protected Areas. *Biological Conservation* 156; 53-61.

The Scottish Government (2013). *2020 Challenge for Scotland's Biodiversity. A Strategy for the conservation and enhancement of biodiversity in Scotland.* The Scottish Government, Edinburgh. [online] Available at: http://www.gov.scot/Resource/0042/00425276.pdf (Accessed June 2018)

The Scottish Government (2015). *Scotland's National Marine Plan A Single Framework for Managing Our Seas.* The Scottish Government, Edinburgh. [online] Available at: http://www.gov.scot/Resource/0047/00475466.pdf (Accessed June 2018)

Trapp, J. L. (1998). *Bird kills at towers and other man–made structures: an annotated partial bibliography (1960–1998*). U S Fish and Wildlife Service, Office of Migratory Bird Management,Arlington, Virginia.

Tulp, I., Schekkerman H., Larsen J.K., van der Winden J., van de Haterd R.J.W., van Horssen P., Dirksen S., and Spaans A.L. (1999). *Nocturnal flight activity of sea ducks near the wind farm Tuno Knob in the Kattegat*. IBN-DLO Report No. 99.30.

Vanermen N., Stienen E.W.M., Courtens W., Onkelinx T., Van de walle M. and Verstraete H. (2013). *Bird monitoring at offshore wind farms in the Belgian part of the North Sea–Assessing seabird displacement effects*. Rapporten van het Instituut voor Natuur- en Bosonderzoek 2013 (INBO.R.2013.755887). Instituut voor Natuur- en Bosonderzoek, Brussel.

Vanerman, N., Courtens, W., Van de walle, M., Verstraete, H. and Stienen, E.W.M. (2016). *Seabird monitoring at offshore wind farms in the Belgian part of the North Sea Updated results for the Bligh Bank & first results for the Thorntonbank*. Brussels: Instituut voor Natuur- en Bosonderzoek.

Vanerman, N., Courtens, W., Van de walle, M., Verstraete, H. and Stienen, E.W.M. (2017). *Seabird monitoring at the Thorntonbank offshore wind farm. Updated seabird displacement results & an explorative assessment of large gull behavior inside the wind farm area.* Brussels: Instituut voor Natuur- en Bosonderzoek.

Wade H.M., Masden. E.A., Jackson, A.C. and Furness, R.W. (2016). Incorporating data uncertainty when estimating potential vulnerability of Scottish seabirds to marine renewable energy developments. *Marine Policy*, 70, 108–113.

Welcker, M., Liesenjohann, M., Blew, J., Nehls, G. & Grunkorn, T. (2017). Nocturnal migrants do not incur higher collision risk at wind turbines than diurnally active species. Ibis, 159, 366–373.

Wernham, C.V., Toms, M.P., Marchant, J.H., Clark, J.A., Sirwardena, G.M. and Baillie, S.R. (Eds). (2002). *The Migration Atlas: movement of the birds of Britain and Ireland*. Poyser.

Wetlands International (2017). "Waterbird Population Estimates". [online] Available at: wpe.wetlands.org (Accessed May 2017).

Williams, J.M., Tasker, M.L., Carter, I.C. and Webb, A. (1995). A method of assessing seabird vulnerability to surface pollutants. *Ibis*, 1137, S147-S152.

Winkleman, J.E. (1995). "Bird/wind turbine investigations in Europe." In Proceedings of National Avian–Wind Power Planning Meeting, Denver, Colorado, July 1994. RESOLVE Inc., Washington, D.C., and LGL Ltd., King City, Ontario. 145 pp.

Wright, L.J., Ross-Smith, V.H., Massimino, D., Dadam, D., Cook, A.S.C.P. and Burton, N.J.K. (2012). *Assessing the risk of offshore wind farm development to migratory birds designated as features of UK Special Protection Areas (and other Annex1 species)*. The Crown Estate Strategic Ornithological Support Services (SOSS) report SOSS-05. BTO and The Crown Estate. SOSS Website.