CHAPTER 16: HABITATS REGULATIONS APPRAISAL

INTRODUCTION

16.1. 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. The optimised design also introduces monopiles as a foundation option.

16.2. 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 for adverse effects on the integrity of European sites, as defined by the Conservation of Offshore Marine Habitats and Species Regulations 2017, throughout the construction, operation and decommissioning phases of the optimised Seagreen Project.

16.3. The optimised Seagreen Project comprises the Seagreen Alpha Offshore Wind Farm (OWF) (herein referred to as 'Project Alpha') and Seagreen Bravo OWF (herein referred to as 'Project Bravo'). It is noted that the Offshore Transmission Asset has been separately licensed, no changes are proposed and therefore those components have not been re-assessed. A full description of the optimised Seagreen Project is provided in Chapter 5 (Project Description) of this EIA Report.

16.4. This Habitats Regulations Appraisal (HRA) is undertaken in the context of the existing consents, which were issued by Scottish Ministers in 2014, following the completion of an Appropriate Assessment (AA). The AA completed was a regional assessment for the Forth and Tay OWFs (Seagreen Alpha, Seagreen Bravo, Neart na Gaoithe and Inch Cape). The AA concluded, subject to appropriate conditions being attached to the consents, that the Seagreen Alpha and Seagreen Bravo developments, both alone or in combination with other projects, would not adversely affect the integrity of any European site (Marine Scotland, 2014a). The legality of the decision to award consents for Seagreen Alpha OWF and Seagreen Bravo OWF was confirmed by the UK Supreme Court in November 2017, following legal challenge by the RSPB. Therefore a precedent is provided for development consent for an offshore wind farm comprising 150 WTGs in this location. The consents and licences received in 2014 and confirmed in 2017 are hereafter referred to as 'the original consents' and the original developments for which consent was sought (Seagreen Alpha OWF and Seagreen Bravo OWF), are hereafter referred to as 'the originally consented project'.

16.5. This HRA assesses the optimised Seagreen Project design, in accordance with guidance set out in the 2017 Scoping Opinion. The assessment is therefore based on the same development boundary as the originally consented projects but with fewer (maximum 120 WTGs across both sites), larger, higher capacity WTGs resulting in slower rotation speeds and a higher minimum blade tip clearance of 32.5m. The methodologies applied have been agreed with Marine Scotland and reflect developments in assessment methods since the original consents application in 2012. The assessment also incorporates updated baseline information as appropriate.

16.6. The Structure of this HRA 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 HRA 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 European marine sites;
- Description of The Project (Worst Case Scenario): confirms the project's relationship with the conservation management of European sites and confirms the design parameters to be assessed (the Worst Case Scenario [WCS]), the mitigation measures (both embedded and additional) and sets out any monitoring proposals, if required;
- Special Areas of Conservation (SACs) for marine mammals: presents the assessment of adverse effect on site integrity for SACs from construction, operation and decommissioning phases and assesses mitigation measures where adverse effects are concluded. The assessment is undertaken for the optimised Seagreen Project alone and where no adverse effects are identified, in combination with other plans or projects;
- Special Protection Areas (SPAs) for birds: presents the assessment of adverse effect on site integrity for SPAs from construction, operation and decommissioning phases and assesses mitigation measures where adverse effects are concluded. The assessment is undertaken for the optimised Seagreen Project alone and where no adverse effects are identified, in combination with other plans or projects; and
- Appropriate Assessment Report Matrices: provides a summary of the assessment undertaken.

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

16.8. This chapter was produced by NIRAS Consulting Limited and SMRU Consulting.

LEGISLATION, POLICY AND GUIDANCE

16.9. This HRA provides information to the competent authority in Scotland, to allow them to discharge the requirements of regulation 28 of the Conservation of Offshore Marine Habitats and Species Regulations 2017, in relation to the optimised Seagreen Project.

Policy Context

16.10. The consideration of policies is important when defining the scope of the assessment in order to ensure that the EIA Report/HRA has been prepared in the knowledge of what are the relevant policy issues.

16.11. 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 Scottish Ministers' policies for, amongst other things, sustainable development in the Scottish marine area.

16.12. The National Marine Plan (2015) policy 'Renewable 5' states that "*Projects must demonstrate compliance with Environmental Impact Assessment and Habitats Regulations Appraisal legislative requirements*".

16.13. It is also a general policy under the National Marine Plan (2015) that "*Authorities should afford the same level of protection to proposed SACs and SPAs (i.e. sites which have been approved by Scottish Ministers for formal consultation but which have not yet been designated) as they do to sites which have been designated*".

16.14. This HRA, undertaken in accordance with the legislative requirements, is therefore also presented in the EIA Report to ensure that the policy requirements of the National Marine Plan are met.

Legislative Requirements

16.15. The following European directives and national legislation are relevant to the aim of National Marine Plan policy 'Renewable 5'. These directives and statutory instruments are summarised in Table 16.1.

16.16. The key legislative measures providing for the protection of habitats and species are the European Parliament and Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the 'Habitats Directive') and the Council Directive 2009/147/EC on the conservation of wild birds (the 'Birds Directive').

16.17. The Habitats Directive satisfies the commitments of the European Community under the Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention). The Birds Directive satisfies the commitments of the European Community under the Convention on the Conservation of Migratory Species of Wild Animals (the Bonn Convention).

16.18. The Habitats Directive aims to maintain or restore natural habitat types and species of community interest listed in the Annexes at a favourable conservation status, whilst ensuring the strict protection of species listed on Annex IV. Similarly, the Birds Directive aims to preserve, maintain or re-establish a sufficient diversity and area of habitats for all the naturally occurring birds in a wild state in the European territory of the Member States; and avoid pollution or deterioration of habitats.

16.19. Together, the Habitats and Birds Directives establish the Natura 2000 network of protected sites which includes SAC and SPA designations.

16.20. 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. For plans and projects beyond 12 nautical miles from land (baseline), the requirement to undertake an appropriate assessment in accordance with the Habitat Directive is set out in the Offshore Marine Conservation Regulations.

16.21. The Offshore Marine Conservation Regulations collectively refers to SACs and SPAs as European sites. European sites located in the United Kingdom are identified by the following designations:

- Special Area of Conservation (SAC);
- Candidate SAC (cSAC);
- Special Protection Area (SPA); and
- Site of Community Importance (SCI).

16.22. In addition, in Scotland, a proposed Special Area of Conservation (pSAC) is a site that has been approved for consultation by the Scottish Government, but has yet to be submitted to the European Commission. A proposed SPA (pSPA) is a site that has been approved for consultation by the Scottish Government, but is not yet classified (Scottish Natural Heritage, 2017a).

16.23. In Scotland, Ramsar sites, designated under the Convention on Wetlands of International Importance especially as Waterfowl Habitat (the 'Ramsar Convention'), are also designated as European sites and/or Sites of Special Scientific Interest (Scottish Government, 2014). Where the interests of Ramsar sites correspond with those of overlapping European sites the Ramsar interests are not considered separately (Scottish Government, 2011).

Table 16.1 Legislation

Legislation	Description	Relevance to assessment
Habitats Directive	Requires EU Member States to take measures to maintain or restore natural habitats and wild species listed on the Annexes to the Directives at a favourable conservation status and introduce robust protection for those habitats and species of European importance.	Establishes the legal requirement for competent national authorities to agree to a plan or project with a likely significant effect on a European site only after having ascertained by means of an appropriate assessment that it will not adversely affect the integrity of a that site. For the optimised Seagreen Project MS-LOT have established a likely significant effect and the need for an appropriate assessment.
Birds Directive		
Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in Scotland)	Transposes the requirements of the Habitats and Birds Directives into Scottish law. Applies to land, land covered (continuously or intermittently) by tidal waters or any part of the sea in or adjacent to Great Britain up to the seaward limit of territorial waters.	Establishes the requirement for a person applying to a competent authority for any consent, permission or other authorisation for a plan or project to provide such information as the competent authority may reasonably require to undertake an appropriate assessment. For the optimised Seagreen Project this information is presented in this chapter of the EIA Report.
The Conservation of Offshore Marine Habitats and Species Regulations 2017	In respect of the offshore marine area, transposes the requirements of the Habitats and Birds Directives into UK law. Applies to the waters, sea bed and subsoil subjacent to those waters of the Scottish Zone (as defined by the Scotland Act 1998).	

Guidance

16.24. This HRA is undertaken in accordance with:

- 'Assessment of plans and projects significantly affecting Natura 2000 sites. Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC' (European Communities, 2002);
- 'EU Guidance on wind energy development in accordance with the EU nature legislation' (European Union, 2011);
- 'Communication from the Commission on the precautionary principle' (European Commission, 2000) and 'Managing Natura 2000 Sites;
- The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC' (European Communities, 2000); and
- 'Natura sites and the Habitats Regulations. How to consider proposals affecting SACs and SPAs in Scotland. The essential quick guide' (Scottish Natural Heritage, 2010a).

16.25. Guidance on the consideration of potential SACs and potential SPAs (Scottish Natural Heritage, 2017a) and when new marine Natura 2000 sites should be taken into account in offshore renewable energy consents and licences (Department of Energy and Climate Change (DECC), 2016) was also applied.

CONSULTATION

16.26. As part of the EIA process and to inform this HRA Seagreen has consulted with a number of statutory and non-statutory organisations to inform the approach to assessment on European sites.

16.27. 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 Scotland Licensing 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 this HRA.

16.28. Table 16.2 sets out a summary of the consultation undertaken to date, including the date and type of consultation, the issues raised in relation to the HRA and how these have been addressed within this EIA Report.

16.29. Consultation responses in relation to technical aspects of the ornithology and marine mammals impact assessments are detailed in Chapter 8 (Ornithology) and Chapter 10 (Marine Mammals).

Table 16.2 Summary of consultation

Consultee and Date	Summary of issues raised	How issues have been addressed (reference specific section of HRA Chapter)
Scoping Opinion 2017		
MS-LOT 15 September 2017	MS-LOT agreed that the assessment for marine mammals should only consider the effects from underwater noise.	The assessment is focused on underwater noise from wind turbine generator foundation piling.
	For bottlenose dolphin, an assessment of the impacts of the optimised Seagreen Project alone on the East Scotland management unit population as well as cumulatively with other developments that may impact on the same population is required. Seagreen should ensure that the information provided can be used for an Appropriate Assessment in relation to the Moray Firth SAC.	See Section Impact Prediction: Special Areas of Conservation
	The Scottish Ministers request that, where necessary, the information is provided in a form that means it can be used for the EPS process or, where needed, to inform the Appropriate Assessment as part of an HRA.	See Section Impact Prediction: Special Areas of Conservation
	For species where population level impact assessments are undertaken MSS recommend using the Interim Population Consequences of Disturbance (iPCoD) framework. As a minimum parameters must include: • The piling schedule; • The demographic parameters; • Starting population size; • Copy of the code used to run the model; and • Any quality assurance/quality control outputs that the software produces.	iPCoD modelling has been used in this EIA Report (see also Appendix 10D [iPCoD Results]).
	The Scottish Ministers advise that the results of the assessment using iPCoD should be presented using the metrics provided in the MSS guidance note.	See Appendix 10D (iPCoD Results).
	The Scottish Ministers consider the following projects should be considered for inclusion in the marine mammals cumulative impact assessment: • Worst case scenario of Neart na Gaoithe (2014 as consented) or Neart na Gaoithe (2017 scoping report); • Worst case scenario of Inch Cape (2014 as consented) or Inch Cape (2017 scoping report); • Worst case scenario of Moray Offshore East Development or Moray East Offshore Wind Farm – Alternative Design; • Beatrice Offshore Wind Farm; • Moray West Offshore Wind Farm; and • Aberdeen Harbour Expansion project. The list of projects to be included may be refined following initial results of the noise modelling.	These projects have been considered and the list updated in line with subsequent discussions which have also informed assumptions to be made in relation to other projects. See paragraph 16.43 and Table 16.5.
	Scoping Opinion should be regarded as HRA screening	Scope of assessment includes all European sites and qualifying interests included in the MS-LOT Scoping Opinion response.

Consultee and Date	Summary of issues raised	How issues have been addressed (reference specific section of HRA Chapter)
	It is the Scottish Ministers' opinion that the following SPAs/pSPA and qualifying features must be included in the assessment: • Forth Islands SPA – gannet, kittiwake, herring gull, puffin, guillemot, razorbill; • Fowlsheugh SPA – kittiwake, herring gull, guillemot, razorbill; • Buchan Ness to Collieston Coast SPA and St Abb's Head to Fast Castle SPA should be scoped in due to connectivity. PVAs for these SPAs are required unless the cumulative effects from the Forth and Tay projects are estimated to be less than a reduction in annual adult survival of 0.2%; • Firth of Forth and St Andrews Bay Complex pSPA - gannet, kittiwake, herring gull, puffin, guillemot, razorbill. The assessment carried out for these species at the breeding colony SPAs listed above should also be used for the assessment of the pSPA species.	Scope of assessment includes all European sites and qualifying interests included in the MS-LOT Scoping Opinion response.
	For the existing colony SPAs the conservation objective relating to the population of the species as a viable component of the site should be the focus of the assessment, although justification should be provided within the EIA Report/HRA Report as to why the other conservation objectives are less relevant or are addressed via this conservation objective.	This HRA considers all conservation objectives.
	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 provides a full breakdown of the apportioning process, which is based on the advice given in the scoping opinion.
	The scoping opinion sets out the requirements for Population Viability Analysis (PVA) including the populations for which it is required and the assumptions that should be made.	PVA modelling methods, assumptions and results are described in Appendix 8D (Population Viability Analysis)

Consultee and Date	Summary of issues raised	How issues have been addressed (reference specific section of HRA Chapter)
Meetings		
Ornithology meeting on assessment methods and HRA 22 November 2017 (MS-LOT, Marine Scotland Science and Scottish Natural Heritage)	Whether or not there is a requirement for inclusion of assessment of cable route within the Outer Firth of Forth pSPA within this HRA.	The Transmission Asset was previously licensed and no changes are proposed. Therefore re-assessment of the cable route is scoped out. However, the licensed Transmission Asset is considered as another project for the purposes of in combination assessment and information is presented to allow in combination effects to be assessed for subsequent applications involving the pSPA.
	Whether features of the Outer Firth of Forth pSPA have been assessed within existing SPA.	Features of the Outer Firth of Forth pSPA assessed in relation to the draft pSPA citation and conservation objectives.
	Confirmed that transboundary effects are scoped out.	Scoped out in relation to ornithology.
Marine mammals meeting on assessment methods and HRA 22 November 2017 (MS-LOT, Marine Scotland Science and Scottish Natural Heritage)	In combination assessment will be undertaken at species specific scales relating to management units and in the case of bottlenose dolphins and harbour seals, the scales are largely aligned with the SAC population scales. The HRA will only be addressing underwater noise effects and will not be considering indirect effects. Transboundary effects do not have to be considered in HRA.	In combination assessment within this chapter follows this approach.
Marine mammals baseline meeting 5 February 2018 (Marine Scotland Science and Scottish Natural Heritage)	No specific technical issues raised regarding HRA.	No action required
Ornithology approach to assessment meeting 6 March 2018	The 2014 HRA is considered to be the baseline and how the developments will be compared needs to be considered.	This HRA compares the impact predictions published in the appropriate assessment of the Scottish Ministers in 2014 with the impact predictions of the optimised Seagreen Project.
Marine Mammals approach to assessment meeting 6 March 2018	Scottish Natural Heritage stated that population modelling would not be expected on the basis of the figures presented, but there is a need to consider requirements for the in combination assessment to inform HRA.	Population modelling has been presented for bottlenose dolphins for the project alone assessment and bottlenose dolphins and grey seals for the in combination assessment.
MS-LOT, 17 May 2018 (Meeting)	It is expected that iPCoD will be used for bottlenose dolphin only.	iPCoD modelling undertaken for this EIA Report/HRA takes this into account (see also Appendix 10D [iPCoD Results]).
	Management unit/starting population for iPCoD to be 195 animals, as presented in Cheney *et al.* 2013 and to be confirmed in SNH's most recent site condition monitoring report (Cheney *et al.* 2018, in prep).	

Consultee and Date	Summary of issues raised	How issues have been addressed (reference specific section of HRA Chapter)
Other		
HRA Status Report Consultation 12th December 2017. (MS-LOT, Marine Scotland Science and Scottish Natural Heritage)	MS-LOT and MSS had no comments.	No action required
	Scottish Natural Heritage were content with no assessment of any Annex I (benthic habitats), Annex II fish or shellfish qualifying features of any European site.	Scoped out of this HRA.
	Scottish Natural Heritage were content that no assessment of grey or harbour seal at Isle of May SAC but assessment of Firth of Tay and Eden Estuary SAC and Berwickshire and North Northumberland Coast SAC will be required if the potential noise impacts are not less than, or there are increased effects from those assessed during the original application. Potential noise impacts on bottlenose dolphins from the Moray Firth SAC will be assessed.	Impact predictions are made for grey seal in relation to the Isle of May SAC and the Berwickshire and North Northumberland Coast SAC and for harbour seal in relation to the Firth of Tay and Eden Estuary SAC. Impact predictions are made for bottlenose dolphin in relation to the Moray Firth SAC.
	Scottish Natural Heritage were content with the sites and qualifying interests for the breeding season and that there is no requirement for a non-breeding season assessment for puffin.	Non-breeding season assessment for puffin not included in this HRA.
	No assessment is required related to the cable route through the Outer Firth of Forth pSPA but information should be represented or highlighted as to where it can be found in the originally consented project ES. This is to allow in combination effects to be assessed for subsequent applications involving the pSPA and to allow the (legally) required review of consents that will be due upon any classification of this pSPA.	The Transmission Asset was previously licensed and no changes are proposed. Therefore re-assessment of the cable route is scoped out. However, the licensed Transmission Asset is considered as another project for the purposes of in combination assessment and information is presented to allow in combination effects to be assessed for subsequent applications involving the pSPA. An assessment of the potential impacts of the Transmission Asset on ornithology was presented in in the 2012 Offshore ES Chapter 10 (Ornithology) (see paragraph 10.319 onwards).
Consultation on list of plans and projects for cumulative/in combination assessment (MS-LOT)	Requirement to include consideration of projects at Cromarty Firth, Port of Ardersier and Aberdeen Harbour for bottlenose dolphin in combination assessment. Requirement to consider wider UK windfarms in relation to in combination effects on non-breeding kittiwake and gannet.	Projects incorporated into list. Projects and species considered in relevant EIA Report chapters and in combination assessment within this HRA.

SCOPE OF ASSESSMENT

16.30. The HRA process is a step by step process which involves:

- Stage 1 – Screening: Determination of likely significant effect (LSE) on a European site (alone or in combination with other projects or plans).
- Stage 2 – Appropriate Assessment: Assessment of implications of LSE on the conservation objectives of a European site to ascertain whether the proposal will adversely affect the integrity (ecological functions) of a European site.
- Stage 3 – Assessment of Alternative Solutions: Determination that the conservation objectives and status of the European site will outweigh any consideration of costs, delays or other aspects of an alternative solution.
- Stage 4 – Assessment of Imperative Reasons of Overriding Public Interest (IROPI): Assessment of compensatory measures where there are human health or safety considerations or environmental benefits and where there are no alternative solutions and adverse impacts remain.

16.31. The 2017 Scoping Opinion represents Stage 1 Screening and this HRA represents the information relevant to the Stage 2 Appropriate Assessment.

16.32. With reference to the HRA screening in the 2017 Scoping Opinion and confirmation through further consultation, the scope of this HRA considers the following European sites and qualifying interests:

- Special Areas of Conservation (SACs)
  - Berwickshire and North Northumberland Coast SAC – grey seal *Halichoerus grypus*;
  - Isle of May SAC – grey seal;
  - Firth of Tay and Eden Estuary SAC – harbour seal *Phoca vitulina*; and
  - Moray Firth SAC – bottlenose dolphin *Tursiops truncatus*.
- Special Protection Areas (SPAs)
  - Buchan Ness to Collieston Coast SPA – herring gull *Larus argentatus*, guillemot *Uria aalge*, kittiwake *Rissa tridactyla*;
  - Forth Islands SPA – gannet *Morus bassanus*, , kittiwake, herring gull, puffin *Fratercula arctica*, guillemot and razorbill *Alca torda*;
  - Fowlsheugh SPA – kittiwake, herring gull, guillemot and, razorbill;
  - St Abb's Head to Fast Castle SPA – kittiwake, herring gull, guillemot and razorbill; and
  - Outer Firth of Forth and St Andrews Bay Complex pSPA – gannet, kittiwake, herring gull, puffin, guillemot and razorbill.

16.33. The Outer Firth of Forth and St Andrews Bay Complex pSPA is proposed for designation as a foraging area for breeding colonies already designated as SPAs and that are likely sources of individuals within the breeding and non-breeding seasons of species scoped into this HRA. The optimised Seagreen Project is located away from the pSPA and therefore the impact predictions for the qualifying interests of the pSPA are given in respect of the SPA colony only. Taking into account the predicted impacts, the determination of adverse effect on site integrity with respect to the conservation objectives of the pSPA is stated separately.

16.34. Population Viability Analysis (PVA) was requested for all SPAs and qualifying interests except Buchan Ness to Collieston Coast SPA, St Abb's Head to Fast Castle SPA and for herring gull at all sites. It is known that PVA is not suitable for populations where counts are infrequent and variable, an issue identified for Buchan Ness to Collieston Coast SPA by Jitlal *et al.* (2017).

16.35. With reference to the HRA screening in the 2017 Scoping Opinion, the scope of this HRA does not consider any Ramsar sites.

16.36. With reference to the 2017 Scoping Opinion and confirmed through further consultation including Appendix 16A (HRA Status Report), the scope of the HRA considers the following impacts:

- Underwater noise disturbance from pile driving — in respect of bottlenose dolphin, grey seal and harbour seal;
- Displacement — in respect of gannet, guillemot, razorbill, puffin, kittiwake and herring gull only;
- Barrier effect — in respect of puffin, guillemot, razorbill, kittiwake only; and
- Collision mortality — in respect of gannet, kittiwake (excluding Buchan Ness to Collieston Coast SPA) and herring gull only.

16.37. Chapter 8 (Ornithology) identified no significant effects in relation to any potential construction or decommissioning impacts or from operational disturbance and these sources of impact are scoped out of this HRA. Following the 2017 Scoping Opinion and the conclusions of the Chapter 8 (Ornithology), this HRA assesses the effects of operational displacement (including barrier effects) and collision mortality.

16.38. With reference to the 2017 Scoping Opinion no likely significant transboundary effects have been identified with regards to European sites. It should be noted however that projects located outside of Scotland have potential transboundary effects on the European sites scoped into this HRA. These other projects with transboundary effects are considered in the in combination assessment.

16.39. In this HRA the impacts are first assessed alone, i.e. consideration of Project Alpha alone, Project Bravo alone, and then for Project Alpha and Project Bravo combined. Where no adverse effect on site integrity is concluded for the assessment alone or combined, an in combination assessment predicts the potential cumulative impact of other plans and projects acting together with Project Alpha, Project Bravo and Project Alpha and Project Bravo combined.

16.40. This HRA is based on the optimised Seagreen Project design set out in Chapter 5 (Project Description) and with the assumption that consent conditions as set out in Chapter 7 (Scope of EIA Report) will be applied.

16.41. All other potential impacts on European sites have been scoped out of this HRA for the optimised Seagreen Project in line with the 2017 Scoping Opinion and are not assessed further within this HRA. Those impacts where no LSE were identified in the 2014 Appropriate Assessment (MS-LOT, 2014) were scoped out of this HRA in the 2017 Scoping Opinion, these include:

- Collision risk to lesser black-backed gull *Larus fuscus* of Forth Islands SPA;
- Collision risk and/or displacement to Northern fulmar *Fulmarus glacialis* of Buchan Ness to Collieston Coast, Forth Islands and Fowlsheugh SPAs; and
- Collision risk and/or displacement to common & Arctic tern *Sterna hirundo/S. paradisaea* of Forth Islands SPA.

16.42. Relative to the 2014 Appropriate Assessment (MS-LOT, 2014), the impacts and qualifying interests screened in or out of this HRA are summarised in Table 16.3 for marine mammals and Table 16.4 for birds.

Table 16.3 Summary of HRA screening for marine mammal features

Grey Seal	Harbour Seal	Bottlenose Dolphin
Berwickshire and North Northumberland Coast SAC		
U	x	x
Isle of May SAC		
U	x	x
Firth of Tay and Eden Estuary SAC		
x	U	x
Moray Firth SAC		
x	x	U

x = Not a qualifying interest; U = Screened in (underwater noise disturbance)

Table 16.4 Summary of HRA screening for bird features

Fulmar	Gannet	Guillemot	Razorbill	Puffin	Kittiwake	Herring Gull	Lesser Black-backed Gull	Great Black-backed Gull	Common Tern	Arctic Tern
Buchan Ness to Collieston Coast SPA										
x	x	D	x	x	C/D	C	x	x	x	x
Forth Islands SPA										
x	C	D	D	D	C/D	C	x	x	x	x
Fowlsheugh SPA										
x	x	D	D	x	C/D	C	x	x	x	x
St Abb's Head to Fast Castle SPA										
x	x	D	D	x	C/D	C	x	x	x	x
Outer Firth of Forth and St Andrews Bay Complex pSPA										
x	C	D	D	D	C/D	C	x	x	x	x

x = Screened out; C = Screened in (collision); D = Screened in (displacement)

16.43. Consultation was carried out with Marine Scotland and relevant local planning authorities to agree a list of other plans and projects for consideration in Cumulative Impact Assessment (CIA) and in combination assessment for the EIA Report and HRA. Details of this consultation and the complete list of plans and projects is provided at Appendix 6A (Plans and Projects for Consideration for Cumulative Impact Assessment). Following consideration of this list, those projects which have the potential to impact European sites cumulatively with either Project Alpha alone, Project Bravo alone or Project Alpha and Project Bravo combined are presented in Table 16.5. The justification for projects scoped into and scoped out of the CIA for Ornithology and Marine Mammals is presented in Chapter 8 (Impact Assessment: Cumulative) and Chapter 10 (Impact Assessment: Cumulative) respectively. Brief descriptions of each of the projects in Table 16.5 are provided in Appendix 6A.

16.44. No plans have been identified that have the potential to give rise to cumulative impacts on European sites.

Table 16.5 In Combination Assessment Projects (offshore wind farms unless otherwise stated)

Project Name		
1. European Offshore Wind Deployment Centre (EOWDC)	12. Hornsea Project Two	25. Neart na Gaoithe
2. Beatrice	13. Hornsea Three	26. Race Bank
3. Blyth Demo	14. Humber Gateway	27. Rampion
4. Dogger Bank Creyke Beck A and B	15. Hywind	28. Sheringham Shoal
5. Dogger Bank Teesside A and Sofia*	16. Inch Cape	29. Teesside
6. Dudgeon	17. Kentish Flats Extension	30. Triton Knoll
7. East Anglia One	18. Kincardine	31. Westermost Rough
8. East Anglia Three	19. Lincs	32. Seagreen Offshore Transmission Asset
9. Galloper	20. London Array	33. Aberdeen Harbour Expansion Project (AHEP)
10. Greater Gabbard	21. Methil	34. Port of Cromarty Firth Phase 4
11. Hornsea Project One	22. Moray East	35. Port of Ardersier
	23. Moray West	36. Forthwind Wind Farm
	24. Thanet	

*formerly Dogger Bank Teesside B

16.45. The 2017 Scoping Opinion advised that information is provided on the licensed Seagreen Transmission Asset project to inform the HRA with regards to in combination impacts and the Outer Firth of Forth and St Andrews Bay Complex pSPA. This information is provided in this chapter under Impact Prediction: Special Protection Areas: In combination.

METHODOLOGY

16.46. This section presents the methodology applied to determine if there are any adverse effects on site integrity associated with the construction, operation and decommissioning phases of the optimised Seagreen Project.

Study Area

16.47. In accordance with the Chartered Institute of Ecology and Environmental Management (CIEEM) (in prep.) the study area encapsulates all the areas, no matter how remote from the optimised Seagreen Project, that are likely to be affected by biophysical changes as a result of construction, operation and decommissioning ('the zone of influence').

16.48. It is often appropriate to identify different zones of influence for different features (CIEEM, in prep.). In this chapter zones of influence are 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 marine mammal populations and seabird breeding colonies where foraging ranges overlap with the optimised Seagreen Project these include, therefore:

- Marine Mammals (See Figure 10.1 in Volume II: Figures)
  - Immediate Study Area (ISA) - An area defined by the optimised Seagreen Project boundaries: Project specific boat based surveys were focused in the Firth of Forth Round 3 Zone (the Zone). FTOWDG data sharing and collaborative studies also provided data across the ISA. An updated review combined these previous studies with more recent data and this is presented in Appendix 10A (Marine Mammal Baseline);
  - Regional Study Area - European site populations remote from the optimised Seagreen Project where measurable population effects are likely to occur. The European sites included are defined in the 2017 Scoping Opinion (Marine Scotland, 2017) and include: Berwickshire and North Northumberland Coast SAC, Firth of Tay and Eden Estuary SAC, Isle of May SAC and Moray Firth SAC; and
  - Wider Study Area - An area used to define the reference population of each SAC feature under consideration: This is equivalent to the agreed management units for each population, as advised in the 2017 Scoping Opinion and defined in the marine mammal baseline, and agreed during consultation, as detailed in Appendix 10A (Marine Mammal Technical Baseline Report).
- Birds (See Figure 8.1 in Volume II: Figures)
  - An area of approximately 391km^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 of approximately 204.5km^2 surrounding Project Alpha and Project Bravo, where indirect impacts will occur out to 2km from the site boundary; and
  - Seabird breeding colonies remote from the optimised Seagreen Project where measurable population effects are likely to occur. The seabird colonies included are defined in the 2017 Scoping Opinion (Marine Scotland, 2017) and include: Buchan Ness to Collieston Coast SPA; St Abb's Head to Fast Castle SPA; Forth Islands SPA; Fowlsheugh SPA; and the Outer Firth of Forth and St Andrews Bay Complex pSPA.

Data Collection

16.49. 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 HRA. The 2012 Offshore ES includes a range of detailed project specific surveys and site characterisation studies to define baseline conditions.

16.50. Where data from the 2012 Offshore ES is used, this is set out below (Table 16.6) and data is provided as supporting information to this chapter (refer to Chapter 8 [Ornithology] and Chapter 10 [Marine Mammals]).

16.51. Baseline characterisation of the European sites has been undertaken using desk based research. Table 16.6 details the data sources used to inform this assessment.

Table 16.6 Data sources

Data	Source	Location
European site description	Scottish Natural Heritage	Site Link <https://gateway.Scottish Natural Heritage.gov.uk/sitelink>
European site qualifying interest population size		
European site management		
European site qualifying interest conservation status		
European site conservation objectives		
Boat based marine mammal surveys	Boat based surveys undertaken by ECON Ltd for marine mammals in the wider Seagreen Zone. Surveys were carried out from December 2009 to November 2011.	Chapter 10 (Marine Mammals) Appendix 10A (Marine Mammals Technical Baseline Report)
Boat based and aerial survey	Collection of survey data across the outer Firth of Forth and Firth of Tay provides spatially explicit densities to inform the baselines for harbour porpoise, minke whale and white-beaked dolphin.	
Review of data from aerial surveys	The Crown Estate commissioned a series of aerial surveys of offshore wind farm sites during 2009 and 2010 around the UK. SMRU Ltd was commissioned by FTOWDG to evaluate data collected at the STW and Round 3 Zones within the Firths of Forth and Tay.	
Collation of aerial and other data on seals	SMRU Ltd was commissioned in 2011 to collate all existing baseline information for seals in the relevant seal management areas, including aerial surveys at haul out sites, diet, and telemetry data and to generate at sea densities.	
Collation and summary of data on bottlenose dolphin between the Firths of Forth and Tay and the Moray Firth and usage in the Forth and Tay	Baseline information on bottlenose dolphin was also collated by SMRU Ltd in 2011 for the Forth and Tay Offshore Wind Developers Group (FTOWDG).	
Bottlenose dolphin photo-ID surveys	Mark-recapture methods have been used to assess the population using photo-ID data collected by the University of Aberdeen since 1989.	
Joint Cetacean Protocol (JCP) Phase III Analysis	The JCP Phase III analysis included datasets from 38 sources, totalling over 1.05 million km of survey effort between 1994 and 2010 from a variety of platforms (Paxton *et al.*, 2016). The JCP Phase III analysis was conducted to combine these data sources to estimate spatial and temporal patterns of abundance for a number of species of cetacean, including the following of direct relevance to the Seagreen project: harbour porpoise, minke whale, bottlenose dolphin, short-beaked common dolphin and white-beaked dolphin.	
JNCC Report 544: Harbour Porpoise Density	Heinänen and Skov (2015) conducted a detailed analysis of 18 years of survey data on harbour porpoise around the UK between 1994 and 2011 held in the JCP database. The goal of this analysis was to try to identify "discrete and persistent areas of high density" that might be considered important for harbour porpoise.	

Data	Source	Location
Special Committee on Seals (SCOS)	Under the Conservation of Seals Act 1970 and the Marine (Scotland) Act 2010, the Natural Environment Research Council (NERC) provides scientific advice to government on matters related to the management of seal populations through the advice provided by the SCOS. SMRU provides this advice to SCOS on an annual basis through meetings and an annual report. The most recent publically available SCOS report is SCOS (2017) which presents the data collected up to 2016.	
SMRU Seal Haul-out and Pup Production Surveys	SMRU carries out surveys of harbour and grey seals in Scotland and on the east coast of England to contribute to NERC's statutory obligation under the Conservation of Seals Act 1970 'to provide the (UK government) with scientific advice on matters related to the management of seal populations'. These include harbour seal moult surveys, which also include grey seal counts (August) and grey seal breeding season pup production surveys.	
Seal At-sea Usage Maps	Russell *et al.* (2017) have produced revised estimated at-sea distribution usage maps for both grey and harbour seals. The usage maps are based on telemetry data from 270 grey seals and 330 harbour seals tagged within the UK, based on data between 1996 and 2015.	
The East Coast Marine Mammal Acoustic Study (ECOMMAS)	The ECOMMAS began in 2013 and involved 30 PAM sites along the east coast of Scotland to collect data on the relative abundance of dolphins and porpoise.	
Study area bird densities	Site specific baseline data was collected by ECON Ltd from boat-based surveys from 23 monthly boat-based surveys that were completed between December 2009 and November 2011 inclusive. Six monthly boat-based surveys were undertaken between April 2017 and September 2017 inclusive.	Chapter 8 (Ornithology) Appendix 8A (Ornithology Technical Report)
Study area bird flight heights	Site specific flight height data was collected by ECON Ltd from boat-based surveys from 23 monthly boat-based surveys that were completed between December 2009 and November 2011 inclusive. Six monthly boat-based surveys were undertaken between April 2017 and September 2017.	Chapter 8 (Ornithology) Appendix 8A (Ornithology Technical Report)
Study area estimated bird collision	Collision rates were estimated through Collision Risk Modelling using the Band (2012) model using assumptions advised by MS-LOT.	Chapter 8 (Ornithology) Appendix 8B (Collision Risk Modelling)
Collision/displacement mortality predictions for in combination assessment	Project ES/HRA documents. For Scottish projects these are: Aberdeen Demo Environmental Statement (2012) Forthwind Environmental Statement (2015) Hywind Environmental Statement (2015) Inch Cape Environmental Statement (2014) Kincardine Environmental Statement (2016) Neart na Gaoithe EIA Report (2018)	Para. 16.568 to 16.643

Survey Work

Marine mammals

16.52. A full description of the boat-based survey methodology is provided in Appendix 10Ai (Seagreen Firth of Forth Round 3 Zone Marine Mammal Surveys); a brief summary follows.

16.53. Site specific baseline data was collected from boat-based surveys from 23 monthly boat-based surveys that were completed between December 2009 and November 2011 inclusive.

16.54. These surveys broadly followed the recommendations set out by Diederichs *et al.* (2008) for ship-based transect line distance sampling. One dedicated JNCC-trained observer continuously scanned the area between the boat and the horizon, 90 degrees to each side of the front of the vessel (total range of 180 degrees) with binoculars and naked eye.

16.55. Every effort was made to ensure that the marine mammal survey was carried out in the most optimal sea conditions available in any single month. Whilst it was not possible to ensure that all days were of sea state 3 or below, the minimum visibility was always over 200m. In accordance with the JNCC standard methods, each sighting was recorded with location (latitude and longitude), time when first observed and time when sighting ended, species, number of animals observed, number of calves/pups, distance from the boat, and bearing and direction of movement. In addition, every sighting record includes identification features, behaviour and other observations (e.g. sex of seals, associations with seabirds etc.).

16.56. Location of the boat and time during the sighting was recorded instantly using a GPS device. Range was estimated using a range-finder stick and bearing was read from a compass in-built into the GPS device.

16.57. Field identification of marine mammals was based on the appearance (e.g. dorsal fin, tail fluke, sequence of body parts visible when surfacing, general shape, size and proportions and body markings in cetaceans; shape of head and snout, proportions of facial features in seals) and the behaviour of animals.

16.58. During further surveys undertaken between May and October 2017 primarily for birds (see below), incidental observations of marine mammals were also obtained.

Ornithology

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

16.60. Site specific ornithological baseline data were collected from 23 monthly boat-based surveys of the original Phase 1 Development Area of the Zone completed between December 2009 and November 2011 inclusive. Six monthly boat-based surveys of the original Phase 1 Development Area of the Zone plus a 2km buffer were undertaken between May 2017 and October 2017 inclusive.

16.61. 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).

16.62. 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).

16.63. Both sides of the vessel were surveyed continuously, with all birds recorded by three skilled surveyors, with one for each side of the boat supported by one dedicated recorder. Snapshot counts were recorded at 500m intervals with flying birds recorded in radial distance bands resulting in a 180 degree arc extending 300m from the vessel (Appendix 8A [Ornithology Technical Report]).

16.64. 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.

16.65. The direction of travel and height (1: <20m, 2: 20 to 120m and 3: >120m) was recorded for flying birds and details of age, plumage and behaviour were recorded where applicable.

16.66. The 2017 survey methodology followed that of the 2009–2011 surveys of Project Alpha and Project Bravo, and including Scalp Bank, with the following exceptions:

- The 2009 to 2011 survey area was surveyed with the addition of a 2km buffer zone;
- 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]);
- The October survey concentrated on achieving flight height measurements;
- Three survey transect routes were surveyed with greater separation between transect routes and lower overall spatial coverage (*c.f.* four transect routes surveyed in 2009 to 2011);
- Bird flight height was recorded in 5m height bands (cf. 1: <20m, 2: 20 to 120m and 3: >120m in 2009 to 2011); and
- A fourth surveyor was employed on all surveys to undertake a dedicated, simultaneous survey of flight heights using a Nikon Forestry Pro laser rangefinder.

Data Analysis

Ornithology

Population Baseline

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

16.68. 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 described above).

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

16.70. 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 300m divided by the total area surveyed by snapshot counts, i.e. the number of snapshot counts multiplied by the radial snapshot count area of 0.141km^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 300m x 300m box by dividing the snapshot count by the total area of the box (0.18km^2).

16.71. 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.

Impact Assessment

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

16.73. The ornithological impacts in this HRA reflect changes in baseline data and changes in impact assessment approach. As described in Chapter 8 (Ornithology) and Appendix 8A (Ornithology Technical Report), an influx, potentially of failed breeders from elsewhere, perhaps more northerly Scottish colonies, resulted in unusually high survey counts of kittiwake and auk species in July 2017. These exceptional counts were the result of birds apparently attracted by abundant prey resources. For the assessment of displacement two baseline datasets are used, one containing this outlier data from July 2017 and the second with the outlier removed and replaced by a mean of peak counts. The baseline data used in the cumulative assessment excludes the unusually high numbers of birds present in July 2017 as this is seen to represent a more realistic baseline scenario when taking into account the precaution (see para. 16.570 to 16.572) built into the assessment.

16.74. The determination of an adverse effect on site integrity (ecological functions) is based on the conservation objectives and the conservation status of a European site (European Communities, 2000; European Communities, 2002).

16.75. From the baseline information gathered and the construction, operation or decommissioning impact predictions, an assessment of whether or not an adverse effect on site integrity will occur was made by:

- Qualitatively predicting the magnitude of impacts on the features of European sites that are screened into this assessment;
- Determining the effect(s) on the qualifying interest population; and
- Identifying where such an effect prevents the conservation objectives from being achieved or progress towards them delayed such that the conservation status of a European site is adversely affected.

16.76. Where, in the absence of evidence, no adverse effect on the integrity of a European site can be objectively demonstrated, under the precautionary principle adverse effects must be assumed (European Commission, 2000; European Communities, 2002).

16.77. The determination of adverse effect on site integrity is made within the context outlined in the 2017 Scoping Opinion.

16.78. In accordance with the 2017 Scoping Opinion, PVA is used to determine the population-level consequences of predicted impacts. For marine mammals, PVA is used within the interim Population Consequences of Disturbance (iPCoD) framework and using the metrics as set out in relation to the assessment for birds, below. These are regarded by Marine Scotland Science (MSS) as the most useful metrics to test PVA outputs, thus enabling more robust assessment of offshore renewables effects, following research undertaken by MSS (Jitlal *et al.*, 2017).

16.79. For birds, the determination of population-level consequences also refers to the specific outputs requested in the 2017 Scoping Opinion, as supporting a robust assessment of offshore renewables effects. The requested outputs are:

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

16.80. Together these PVA outputs provide a suite of indicators of the probability for population-level consequences arising from the impacts scoped into this HRA, in particular to determine whether the feature will remain a viable component of the SPA or (p)SPA for which it forms a feature in the long term, as required by the 2017 Scoping Opinion.

16.81. For the purposes of this HRA, the population of a bird interest feature scoped into the HRA that is already in favourable condition is considered to remain a viable component of a (p)SPA if the PVA model outputs indicate that the impacted population will be maintained at or above the population at the time of designation. For populations that have already declined, are declining, and/or are in unfavourable condition, the test is whether the PVA model indicates that the predicted impacts will prevent the population from being restored to favourable condition. Where adverse effects on site integrity are identified then mitigation measures are assessed using the following tasks:

- List each of the measures to be introduced;
- Explain how the measures will avoid the adverse impacts on the site; and
- Explain how the measures will reduce the adverse impacts on the site.

Developments in Assessment Methods

16.82. Relevant technical developments in the assessment approach from the originally consented project 2012 Offshore ES are described in Chapter 8 (Ornithology) and Chapter 10 (Marine Mammals). There are no key developments related to the 'Methodological guidance on the provisions of Article 6(3) and (4) Directive 92/43/EEC' (European Communities, 2002) that are relevant to this HRA.

Marine Mammals

16.83. Changes in the marine mammal assessment approach are detailed in Chapter 10 (Marine Mammals) and briefly summarised below.

16.84. In the 2012 Offshore ES, criteria developed by Southall *et al.* (2007) were used to evaluate injury risk. Since the 2012 Offshore ES was completed new guidelines have been issued by the US National Oceanic and Atmospheric Administration (NOAA) (National Marine Fisheries Service, 2016) which have been used in the marine mammal assessment to define injury risk. The risk of injury was based on both of the dual criteria: cumulative sound exposure level (SELcum) and peak sound pressure level (peak SPL).

16.85. The 2012 Offshore ES relied on the 'dBht(species)' metric (Nedwell *et al.*, 2007) to assess behavioural effects on marine mammals. Instead of using the dB_{ht} metric, in the current assessment, the risk of behavioural effects (disturbance leading to displacement) was assessed using dose response curves from species specific empirical studies wherever possible. The dose-response curve adopted in this assessment for all cetaceans was developed by Graham *et al.* (2017a) based on data collected during the construction of the Beatrice Offshore Wind Farm. For seals, a dose response curve was derived from the data collected and analysed by Russell *et al.* (2016) from tagged harbour seals during pile driving at the Lincs Offshore Wind Farm in the Wash.

Ornithology

16.86. Changes in the ornithological assessment approach between the previous HRA examined in 2014 and this HRA, which is based on the advice of the Scottish Ministers contained in the 2017 Scoping Opinion, are discussed in detail in Chapter 8 (Ornithology) and summarised in Table 16.7. A key part of that advice from Scottish Minister included the approach to be taken for apportioning impacts on breeding seabird populations at SPAs with potential connectivity to the optimised Seagreen Project site. Connectivity refers to the known or likely occurrence of bird features originating from SPAs at the Project Alpha and Project Bravo sites or 2 km buffer. It is also considered likely that a proportion of all birds recorded in the breeding season are immature individuals with older immatures for some species indistinguishable from adult birds. In addition, a further proportion are likely to be non-breeding adult birds. The methodology and results for calculating apportioning values used within this HRA is outlined in the Appendix 16B (Seabird Apportioning). An overview follows of what the apportioning achieves in this HRA based on the advice of the Scottish Ministers.

Connectivity between SPA seabird features and the optimised Seagreen Project in the breeding season

16.87. During the breeding season foraging seabirds may travel some distance from their breeding colonies. Scottish Minsters in the 2017 Scoping Opinion suggested the most applicable foraging range criterion for use in assessment was the mean maximum foraging range as derived by Thaxter *et al.* (2012). For apportioning breeding season impacts associated with an offshore wind farm, Scottish Ministers have advised that the two-step approach advocated by SNH (2017 Scoping Opinion) is to be used. This is the approach that has been followed in the assessment of impacts on seabirds from the optimised Seagreen Project. However, not all of the SPAs that Scottish Ministers advise must be included in the assessment lie within mean maximum foraging range alone. Therefore the apportioning calculations use the mean maximum foraging range plus one standard deviation (Thaxter *et al.* 2012) so that the qualifying features of the four SPAs the Scottish Minsters requested are incorporated in apportioning calculations.

Apportioning non-breeding seasons effect from the optimised Seagreen Project

16.88. When apportioning non-breeding season effects from the optimised Seagreen Project between relevant SPAs for gannet and kittiwake, the contribution of adult birds from an individual SPA as a proportion of the relevant Biologically Defined Minimum Population Scale (BDMPS) is used; BDMPS as estimated by Furness (2015). An alternative approach is used for herring gull to identifying a non-breeding season population for the Forth and Tay and the contribution to it from regional SPA populations. For guillemot and razorbill, the only two auks that Scottish Ministers advise must be assessed in the non-breeding season, the non-breeding season effects was assigned to relevant SPAs within, when breeding, a species' foraging range of the proposed development.

Age composition during the breeding season

16.89. For features of the SPAs with potential connectivity in the breeding season, the proportion of adult and immature birds present at the optimised Seagreen Project site has been identified from age class data, where available from site-specific surveys. For species where age composition survey data is not available e.g. the auk species (puffin, razorbill and guillemot), the numbers of birds in each age class estimated by Furness (2015) using a stable (equilibrium) model population for the relevant species has been be applied. These approaches follow recommendations on assigning impacts between age classes as advised by Scottish Minsters in the 2017 Scoping Opinion.

Age composition during the non-breeding season

16.90. With the exception of herring gull, the age class composition of a seabird species present at the optimised Seagreen Project site during non-breeding seasons has been derived using proportions from PVA stable age structure. When apportioning non-breeding season effects from the optimised Seagreen Project between relevant SPAs for herring gull, this is done in respect of adult breeding birds only. Given that herring gull is only a breeding feature of the four SPAs that are being assessed by the HRA, there is no requirement to consider age composition for this species within this section.

Sabbaticals

16.91. A proportion of adults in a population skip breeding in any given year; this is referred to as a sabbatical. Including sabbatical birds in the impact prediction would likely overestimate the effects to the populations, as breeding colony population size estimates do not include these sabbatical birds. Scottish Ministers have in the 2017 Scoping Opinion recommended the proportion of adults to assign as taking sabbaticals from breeding in a given year. Using these sabbatical rates (see Table 16.7), the impacts assigned to sabbaticals are scoped out of the assessment.

Table 16.7 Ornithological impact assessment approach comparison

Parameter	Gannet		Puffin		Guillemot		Razorbill		Kittiwake		Herring Gull	
	2014	2018	2014	2018	2014	2018	2014	2018	2014	2018	2014	2018
Band collision risk model (option)	3	1 & 2							3	1 & 2	3	2
Collision risk model avoidance rate (%)	98	98.9							98	98.9	98	99.5
Displacement rate (%)	60		60	50, 60 & 70		50 & 60	60	50 & 60	30	30		
Displacement mortality (%)[1]	CEH model		CEH model	2		1	CEH model	1	CEH model	2		
Apportioning (adult birds in breeding season) (%)	?	97.3	?	51.0	?	57.5	?	57.1	?	94.16	?	28.6
Sabbaticals (%)		10		7		7		7		10		35
Non-breeding season[2]		C				D		D		C/D		C
Population model type[3]	ABC & ruABC	PVA	ABC & ruABC	PVA	ABC & ruABC	PVA	ABC & ruABC	PVA	ABC & ruABC	PVA	ABC & ruABC	PVA

[1] CEH model = CEH Displacement Model (Searle *et al.*, 2014); [2] C = assessment of collision; D = Displacement; [3]ABC & ruABC = Acceptable Biological Change & reduced uncertainty ABC; PVA = Population Viability Analysis; ? = not stated in 2014 Appropriate Assessment (Marine Scotland Licensing Operations Team, 2014)

Displacement Analysis

16.92. During the consultation phase that informed the 2014 Appropriate Assessment (MS-LOT, 2014) the statutory nature conservation bodies (SNCBs) advised that there was potential for the proposed Forth and Tay offshore wind developments to have a significant effect on guillemot, razorbill, puffin and kittiwake in relation to displacement and the Forth Islands SPA (guillemot, razorbill, puffin and kittiwake), Fowlsheugh SPA (guillemot, razorbill and kittiwake), Buchan Ness to Collieston Coast SPA (guillemot and kittiwake) and St Abb's Head to Fast Castle SPA (guillemot, razorbill and kittiwake). This section provides an overview of displacement and analysis undertaken for this assessment as detailed in Appendix 8C (Analysis of Displacements Impacts on Seabirds) with the basis for the mortality and displacement rates applied discussed. It concludes with consideration of the applicability to the displacement analysis of two models focused on the proposed Forth/Tay offshore wind farm developments and displacement; the "CEH displacement model" (Searle *et al.* 2014) looking at the population consequences of displacement and a second model estimating at-sea turnover of breeding seabirds (Searle *et al.* 2015).

Overview

16.93. 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.

16.94. Seabird species vary in their reactions to the presence of operational infrastructure (e.g. wind turbines and offshore substation platforms (OSPs)) and to the associated maintenance activities (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.

16.95. Following recently published joint SNCB interim guidance (JNCC *et al.*, 2017), displacement impacts for each relevant species are presented and, where appropriate, using a range of potential displacement rates. These have been presented in this assessment for each of the seasons being assessed as applicable (e.g. 'breeding', 'post-breeding', 'non-breeding' and 'pre-breeding'). The 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.

16.96. 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.

16.97. 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.

16.98. 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 optimised Seagreen Project.

16.99. 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).

16.100. 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.

16.101. A study at Tuno Knob, in Denmark, reported effects on nocturnal flights of eiders out to 1,500m 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).

Spatial Scales

16.102. 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.

16.103. 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 at either Project Alpha, Project Bravo or Project Alpha and Project Bravo combined plus 2 km 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).

16.104. 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. 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. In respect of the optimised Seagreen Project, all estimates of displacement mortality are therefore likely to be overestimated as a result of the in-built precaution, i.e., no gradient of impact in the buffer zone and the use of mean peak number.

Displacement Rates

16.105. 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.

16.106. 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.

16.107. 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.

16.108. 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

16.109. 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.

16.110. 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 500m). 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).

16.111. 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).

16.112. 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.

16.113. 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 500m buffer area) with these decreases significant within the wind farm plus 500m buffer area. Although decreases were also noted in the buffer area (500m to 3km) 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 (Vanermen *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) (Vanermen *et al.*, 2016). Evidence from Westermost Rough offshore wind farm, which has similar turbine spacing to the minimum proposed for the optimised Seagreen Project (1,000m), indicates that there was no statistically significant evidence of displacement for kittiwakes, guillemot or razorbill based on comparative mean densities in the wind farm and in a surrounding 8km buffer zone (APEM, 2017).

16.114. 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.

16.115. 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 Vanermen *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).

16.116. 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 (Vanermen *et al.* 2017), Blighbank (Vanermen *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). The intermediate displacement rate of 50% is also presented for razorbill.

16.117. 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).

16.118. In respect of the optimised Seagreen Project, all estimates of displacement mortality are therefore likely to be suitably precautionary. Displacement mortality based on worst case displacement rates is likely to represent an overestimation because previously high displacement rates recorded elsewhere did not take into account a buffer zone. When displacement is considered for the wind farm area plus a buffer zone significant displacement is typically not reported.

Kittiwake

16.119. 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).

16.120. A 30% rate was advised for kittiwake for Forth and Tay projects by Marine Scotland (2017 Scoping Opinion) and is used in this HRA. In respect of the optimised Seagreen Project, all estimates of displacement mortality are therefore likely to be precautionary.

Mortality Rates

16.121. 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 that 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.

16.122. 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.

16.123. 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). In respect of the optimised Seagreen Project, all estimates of displacement mortality are therefore likely to be suitably precautionary.

Population Consequences of Displacement/Barrier Effects

16.124. 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 generalised 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.

16.125. 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.

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

16.127. 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.

16.128. Whilst there was a large degree of uncertainty related to the magnitude of the predicted effects and considerable variation in adult survival and breeding success, the greatest effects were predicted in relation to kittiwake (Forth Island SPA and Fowlsheugh SPA) and puffin (Forth Island SPA) (Searle *et al.*, 2014). However, the 2014 Appropriate Assessment (Marine Scotland, 2014a) concluded that there would be no adverse effect on the integrity of these SPAs.

At-Sea Turnover of Breeding Seabirds

16.129. 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.

16.130. 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 Modelling

16.131. Collision risk modelling (CRM) 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 model for predicting collision rates 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).

16.132. 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 the optimised Seagreen Project.

16.133. 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.

16.134. 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).

16.135. 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.

16.136. 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.

16.137. The flight height data collected as part of site-specific boat-based surveys at the optimised Seagreen Project 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).

16.138. As agreed with Marine Scotland and SNH, 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 (paragraph 16.70).

16.139. 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 alone, 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 with rotor speeds of 5.9 to 6.8 revolutions per minute (rpm). It should be noted that the CRM is based on rotor speeds (8.0 to 10.6rpm) for a rotor diameters at the lower end of the Design Envelope (i.e., 164m). Hub height was calculated based on an assumed air gap of 30.18m 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).

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

- Gannet;
- Kittiwake; and
- Herring gull.

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

16.142. 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.

16.143. 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 16.8 taking into account the recommendations in JNCC *et al.* (2014) and the scoping opinion (Marine Scotland, 2017).

Table 16.8 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)

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

16.145. In respect of the optimised Seagreen Project the use of the Basic CRM model options means that all estimates of collision risk are precautionary because the CRM does not take into account the variability in the 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.

Assumptions and Precaution in Collision Risk Modelling Parameters

16.146. 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".

16.147. 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, models will become more refined and more accurately account for bird movement and behaviour.

16.148. 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 reductions 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.

16.149. 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 observational dataset 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).

16.150. This section considers precaution embedded in the CRM and the bird movement and behaviour evidence that supports this view. Moreover MacArthur Green (2017) calculated collision mortality based on actual wind farm design that is/was built out and highlighted the ornithological 'headroom' that exists, i.e. the difference between the consented project design and the project design that was built out. In respect of the optimised Seagreen Project CRM model, all estimates of collision risk are likely to be precautionary because the CRM is based on known design parameters but cannot predict future as-built scenarios for those projects yet to be built out.

Bird Flight Speed

16.151. 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 influences the estimation of the number of birds passing through an imaginary window in the modelled airspace as birds/sec or birds/sec per m². 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. The resulting impact magnitude calculated from the CRM is therefore considered to be precautionary in this respect.

16.152. 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 two (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.

16.153. Table 16.9 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).

16.154. 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 16.9 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); **Alerstam *et al.* (2007); ***Estimated with data for all large gulls combined

16.155. In respect of the optimised Seagreen Project CRM model, all estimates of collision risk are precautionary because the CRM takes into account the bird flight speeds commonly applied in CRM. Recent evidence published after the optimised Seagreen Project CRM was modelled demonstrates a likely decrease in bird flight speed which would result in a reduction in collision estimates.

Avoidance Rates

16.156. The generic species specific avoidance rates currently used are mostly based on mortality rates observed at onshore wind farms with no consideration of actual avoidance behaviour.

16.157. 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 than are currently advised for use in collision risk assessment in the UK. The rates used should be closer to those indicated by the EARs derived by Skov *et al.* (2018).

16.158. 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 in Table 16.10 with standard deviation to reflect both variability and uncertainty.

16.159. In respect of the optimised Seagreen Project CRM model, all estimates of collision risk are precautionary because the CRM applies generic avoidance rates. Recent empirical evidence published after the CRM was completed advocates the use of higher avoid rates that would result in a lower collision risk.

Table 16.10 The EAR highlight that the avoidance rates advised by the Scottish Ministers in the 2017 Scoping Opinion for gannet and kittiwake are precautionary. Comparison of relevant empirical and generic avoidance rates

Species	Empirical AR (Skov *et al.*, 2018)	Generic AR (2017 Scoping Opinion)
Gannet	0.999 ± 0.003 SD	0.989 (Option 2)
Kittiwake	0.998 ± 0.006 SD	0.989 (Option 2)
Herring gull	0.999 ± 0.005 SD	0.995 (Option 2) 0.990 (Option 3)*

* For this assessment Option 3 was used for herring gull.

Nocturnal Flight Activity

16.160. There is considerable uncertainty about levels of bird flight activity by night and 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).

16.161. 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.

16.162. In respect of the optimised Seagreen Project CRM model, all estimates of collision risk for kittiwake and herring gull are precautionary because the CRM applies generic nocturnal activity rates (25%) advised by the Scottish Ministers. Recent empirical evidence published after the CRM was completed advocates the use of lower nocturnal activity rates (<5%) that would result in a lower estimated collision risk. For gannet the generic nocturnal activity rates (0%) advised by the Scottish Ministers is not likely to be unrealistic.

Assessment Limitations and Uncertainty

16.163. Baseline boat-based surveys undertaken between 2009 and 2011 did not include the 2km buffer zone surveyed in the 2017 surveys. The 2017 surveys were seasonally restricted to the key seabird species in the breeding season identified in the 2012 Offshore ES.

16.164. Some sea areas surveyed in 2017 therefore have no corresponding data from 2009 to 2011 in the non-breeding season. To correct for this uncertainty bird density was extrapolated using the method described in Appendix 8A (Ornithology Technical Report). The difference in spatial and temporal coverage does not adversely affect the impact predictions within this HRA because the extrapolation uses site specific data.

16.165. There are uncertainties relating to the ability to predict the exposure of marine mammals to underwater noise, as well as in predicting the response to that exposure. These uncertainties relate to a number of factors: the ability to predict the level of noise that animals are exposed to, particularly over long periods of time; the ability to predict the numbers of animals affected, and the ability to predict the individual and ultimately population consequences of exposure to noise. These are explored in detail in Chapter 10 (see paragraph 10.52 *et seq.*).

Implications of developments in assessment methodology

16.166. The updated design for the optimised Seagreen Project entails the construction of fewer, larger turbines with increased blade tip clearance above sea level than the originally consented Project. The development area is unchanged although turbines are likely to be more widely separated.

16.167. The collision risk for key species arising from these larger turbines is considered to be lower than that of the turbine design included in the 2012 application.

16.168. These reductions are predicted notwithstanding the precaution inherent in the current assessment methodology, for example, the inclusion of non-breeding season impacts and the inclusion of data from further bird surveys undertaken during 2017. These surveys coincided with a period during which seabird densities were higher than those recorded during the surveys undertaken from 2009 to 2011 for the originally consented project. In one case, the survey conducted in July 2017, the bird densities were exceptionally high. These figures are an outlier caused by an exceptional foraging event. While they have been included in the displacement assessment for completeness, the assessments which omit this outlying data are a better representation of a realistic worst case and should be preferred.

16.169. For displacement, the development areas of the optimised Seagreen Project is the same as that of the originally consented Project, although, as fewer turbines are now proposed, the separation of those turbines is potentially greater. On this basis the displacement impacts of the optimised Seagreen Project should be no greater than those of the originally consented Project.

16.170. The inclusion of a 2km buffer in displacement calculations, however, increases the apparent magnitude of the impact because it is now assumed that birds over an area approximately 50% greater than the development area are potentially displaced, even though the development area is no larger than originally proposed and would contain fewer turbines overall. The actual area of any displacement effect will be also be smaller than provided by including this buffer where turbines are not sited close to the development area boundary.

16.171. Despite these changes the predicted impact magnitudes are, for key species, comparable to or lower than those predicted for the originally consented Project.

DESCRIPTION OF THE PROJECT (WORST CASE SCENARIO)

Management of the European site(s)

16.172. The optimised Seagreen Project is not directly connected with or necessary to the conservation management of any European site.

Worst Case Scenario

16.173. To inform the impact assessment on European sites, a WCS has been defined using the information contained within the optimised design envelope for the Seagreen Project, as presented in Chapter 5 (Project Description). The WCS refers to the impacts screened into this assessment in accordance with the 2017 Scoping Opinion, i.e. underwater noise in relation to marine mammals and collision and displacement in relation to birds.

16.174. The worst case represents, for any given effect, the scenario within the range of options in the design envelope that would result in the greatest potential for change to the receptors assessed.

16.175. Table 16.11 identifies, the WCS in relation to those European sites and qualifying interests scoped into the assessment and provides justification as to why no other scenario would result in a greater impact on the receptors considered. It should be noted that, whilst the WCS is defined for each impact for Project Alpha and Project Bravo alone, the WCS considers the projects combined (the optimised Seagreen Project). The impact assessment undertaken therefore considers the impacts of each project alone and the projects combined.

16.176. The selection of worst case parameters for the marine mammal assessment has been informed by the outcomes of Chapter 10 (Marine Mammals), which considered multiple sequential and concurrent scenarios for both projects alone and the projects combined. This assessment concluded that the worst case impact on both seals and bottlenose dolphin would result from the scenario involving construction of Project Alpha followed by the construction of Project Bravo, with monopile foundations installed in Project Alpha and jacket foundations with pin piles installed in Project Bravo.

Table 16.11 Worst Case Scenario Justification

Type of Impact	Worst Case Scenario	Justification/Rationale of Selected Design Envelope Parameter
Construction		
Underwater noise disturbance to bottlenose dolphin and grey and harbour seals from pile driving	**Project Alpha alone** The temporal WCS for Project Alpha is the sequential installation of piled Jacket foundations – this results in the greatest number of piling days (140) The spatial WCS for Project Alpha is the installation of monopile and pin pile foundations concurrently– this results in the largest area of impact and the largest number of individuals affected during piling activity, but this would be for a lower number of days (105) **Project Bravo alone** The temporal WCS for Project Bravo was the sequential installation of piled Jacket foundations – this resulted in the greatest number of piling days (140) The spatial WCS for Project Bravo is the installation of monopile and pin pile foundations concurrently – this results in the largest area of impact and the largest number of individuals affected during piling activity, but this would be for a lower number of days (70) **Project Alpha and Project Bravo combined** The overall WCS for the optimised Seagreen Project was determined by population modelling (detailed in Chapter 10) and is the sequential construction of Project Alpha and then Project Bravo, with the installation of monopiles at Project Alpha followed by jackets with pin piles at Project Bravo. This scenario would result in a total of 170 piling days. The WCS pile driving parameters for each foundation type were: 10m diameter monopiles: • Maximum hammer energy = 3000kJ.	Multiple sequential and concurrent scenarios have been assessed for each pile type and both types together for each project alone and for both projects together. Chapter 10 (Marine Mammals) also concluded that the sequential build of Project Alpha and then Project Bravo would represent the worst case impact overall when considering the optimised Seagreen Project. WCS for each pile type assessed includes maximum energy and frequency of occurrence with minimum ramp up durations. For auditory injury assessment, the maximum number of pin piles installed within 24 hours is the WCS. For disturbance, due to the additional days of disturbance occurring, the worst case is a lower number installed per day (average).

Type of Impact	Worst Case Scenario	Justification/Rationale of Selected Design Envelope Parameter
	• Minimum ramp up duration (minutes) = 20 • Duration per pile (hrs) = 4. • Number of events within 24hr = 1 2m jackets (pin piles): • Maximum hammer energy = 1800kJ. • Minimum ramp up duration (minutes) = 45. • Duration per pile (hrs) = 2.25. • Maximum number of events within 24hr = 4 • Average number within 24 hr = 2	
Operation		
Displacement impacts on guillemot, razorbill, puffin and kittiwake	Operation of maximum number of turbines (up to 70 WTGs), within the total area of the Project Alpha site (197km²), with a minimum turbine separation distance of 1,000m. Operation of maximum number of turbines (up to 70 WTGs), within the total area of the Project Bravo site (194km²), with a minimum turbine separation distance of 1,000m. Operation of maximum number of turbines (up to 120 WTGs), within the combined site for Project Alpha and Project Bravo (391 km²), with a minimum turbine separation distance of 1,000m.	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.
Barrier effects on puffin, guillemot, razorbill, kittiwake		
Collision mortality of gannet, kittiwake and herring gull	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 = 170m (LAT) and lowest rotor tip height of 32.5m (LAT).	Maximum turbine dimensions and operational speeds
Decommissioning		
A decommissioning plan will consider the latest technological developments, legislation and environmental requirements at the time that the work is due to be carried out. Decommissioning will likely involve the removal of monopiles by reverse vibration and therefore the potential effects during this phase have been assumed to be similar to (and not worse than) those predicted during the construction.		
In Combination		
Construction underwater noise disturbance of marine mammals and operational mortality of seabirds arising from displacement, barrier effect and collision impacts are assessed using the as-built and worst case scenarios for other existing and planned wind farm developments that are likely to have a significant effect on the European sites impacted by the optimised Seagreen Project.		

Environmental Measures Incorporated into the Project

16.177. The European Court of Justice has recently ruled that "*in order to determine whether it is necessary to carry out, subsequently, an appropriate assessment of the implications, for a site concerned, of a plan or project, it is not appropriate, at the screening stage, to take account of the measures intended to avoid or reduce the harmful effects of the plan or project on that site*" (People Over Wind and Sweetman [ECU, Case C-323/17]).

16.178. The HRA screening in the 2017 Scoping Opinion was based on the Scoping Report (Seagreen, 2017) which describes the optimised Seagreen Project without reference to detailed mitigation proposals. It is considered therefore that the HRA screening is compliant with the court ruling in that it did not consider mitigation in determining whether it is necessary to carry out an appropriate assessment.

16.179. 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. Mitigation measures that are incorporated into the design of the project are referred to as 'environmental measures incorporated into the Project' and are presented in Chapter 7 (Scope of EIA Report). These measures are intended to avoid or reduce any significant adverse impacts on the environment. These measures are effectively 'built in' to the impact predictions and as such, the assessment of adverse effect on site integrity includes consideration of these measures.

16.180. Environmental measures incorporated into the Project that are relevant to this assessment of European sites include:

- The development of a Piling Strategy that will be agreed with statutory consultees. The Piling Strategy will detail further (post-consent) ground conditions survey information that will allow the minimisation and optimisation of hammer energies. This will also include the details of soft start piling operations and other agreed mitigation methods to further reduce potential risk of auditory injury to marine mammals;
- Commitment to the use of best practice guidance and development of a vessel management plan (VMP) to determine vessel routing and therefore reduce disturbance impacts to avoid areas of high risk (rafting and feeding aggregations);
- Compared to the project design assessed in the 2012 Offshore ES, minimum blade tip clearance has been increased to 32.5m above lowest astronomical tide (LAT) in order to reduce predicted collision impacts for gannet and kittiwake;
- Reduction in the number of Wind Turbine Generators (WTGs) from 150 in the 2012 Offshore ES to 120 for the optimised Seagreen Project. The reduced turbine numbers were proposed to reduce the risk of collision impacts on birds; and
- Increase in minimum WTG separation from 610m in the 2012 Offshore ES, to 1000m in the 2014 consents and the optimised Seagreen Project, to reduce potential displacement impacts.

16.181. Development activities are also controlled through legislative compliance and standard good practice. In relation to the impacts assessed in this HRA these include:

- Article 6(2) of the EU Habitats Directive: "*Member States shall take appropriate steps to avoid, in the special areas of conservation, the deterioration of natural habitats and the habitats of species as well as disturbance of the species for which the areas have been designated, in so far as such disturbance could be significant in relation to the objectives of this Directive;*"
- Article 12(1b) of the EU Habitats Directive: "*Member States shall take the requisite measures to establish a system of strict protection for the animal species listed in Annex IV (a) in their natural range, prohibiting…deliberate disturbance of these species, particularly during the period of breeding, rearing, hibernation and migration;*".
- Article 2 of the EU Birds Directive: "*Member States shall take the requisite measures to maintain the population of [wild birds] at a level which corresponds in particular to ecological, scientific and cultural requirements, while taking account of economic and recreational requirements, or to adapt the population of these species to that level;*"
- The above listed articles of the EU Habitats and Birds Directives as transposed into the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in Scotland) and The Conservation of Offshore Marine Habitats and Species Regulations 2017; and
- The protection of Marine European Protected Species from injury and disturbance. Guidance for Scottish Inshore Waters (Marine Scotland, 2014b).

16.182. A number of consent conditions were attached to the original consents received for the Seagreen Project in 2014. These were defined to manage the environmental risk of the Project. Any future consents issued to Seagreen may include similar conditions to manage the risk to European sites, where necessary. Consent conditions applied to the originally consented project (and relevant to the management of environmental risk) are provided within Chapter 7 (Scope of EIA Report). Consent conditions relevant to the impacts assessed in this HRA include:

- Decommission any turbine that fails to produce electricity on a commercial basis to the National Grid in a continuous 12 month period within the period of 24 months from the date of the deeming decision by the Scottish Ministers;
- Submit a Construction Method Statement (CMS) that details how the construction related mitigation steps proposed in the EIA Report are to be delivered;
- Submit an Environmental Management Plan (EMP) that sets out the roles, responsibilities and chain of command in respect of environmental management for the protection of environmental interests during the construction and operation;
- Submit a Piling Strategy (PS) to manage the potential underwater noise impacts arising from piling activity; and
- Prior to the commencement of the development, appoint an Ecological Clerk of Works (ECoW) to ensure that appropriate and effective monitoring of the impacts is undertaken.

CHARACTERISTICS OF THE EUROPEAN SITE(S)

16.183. Whilst impacts have been identified in the HRA screening in the 2017 Scoping Opinion, it is necessary to characterise the European site(s) as a whole or of the areas where impacts are most likely to fall (EC, 2002). The characteristics of each European site considered in this HRA are summarised below.

Berwickshire and North Northumberland Coast SAC

16.184. The Berwickshire and North Northumberland Coast SAC includes 115km of coastline, is 7.4km at its widest point and encompasses including the Farne Islands and Holy Island (Hedley, 2016). The SAC is located 64.5km from the optimised Seagreen Project.

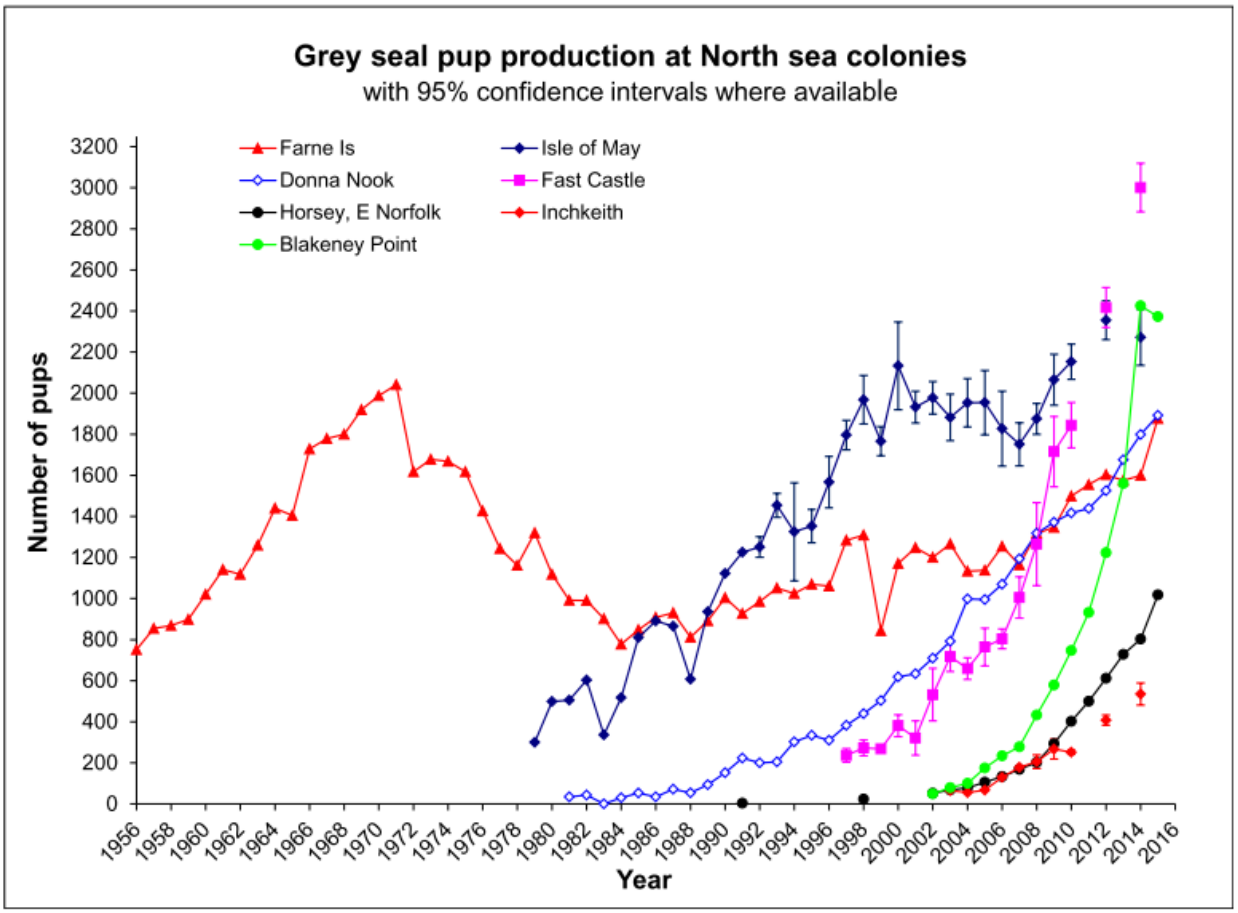
16.185. The SAC regularly supports a population of 501 to 1000 grey seals (JNCC, 2015), with a number of breeding colonies. Recent pup production surveys, however, suggest that a larger number may be breeding within the SAC, with pup production estimates from monitored colonies at approximately 4600 in 2014 (see Plate 16.1 and SCOS, 2017). Aerial surveys carried out monthly between April and September 2008 indicated that numbers of grey seals hauled out at the Farne Islands varied between 2000 and 4000 (Appendix 10Aiv). It is the most south-easterly site selected for the species and supports around 2.5% of annual UK pup production. Pup production at the breeding colonies within the SAC was estimated at 1600 at the Farne Islands, and 3000 at Fast Castle in 2014 (see Plate 16.1 and SCOS, 2017). Between 2010 and 2014 there was little change in the pup production estimate at the Farne Islands, however, between 2014 and 2016 the pup production estimate increased by 28% (SCOS, 2017). The pup production estimates at Fast Castle have shown significant increases since 2000 and in 2014 the breeding colony at Fast Castle became the biggest grey seal breeding colony in the North Sea (SCOS, 2017).

16.186. The SAC is located in both the East Coast Scotland Management Area (MA) and Northeast England MA for grey seals. The population estimate for the East Coast Scotland MA is 10,891, based on August 2016 haul-out counts scaled to account for the proportion of seals at sea at the time of the survey. The population estimate for the Northeast England MA is 19,851, based on August 2016 haul-out counts scaled to account for the proportion of seals at sea at the time of the survey. The 2017 Scoping Opinion advised that, for grey seals, the population present in the East Coast Scotland seal management unit should be used as the reference population for assessment. However, no specific advice was given in relation to the Berwickshire and North Northumberland Coast SAC in the HRA. Given that the Berwickshire and North Northumberland Coast SAC sits across both MAs, it was considered appropriate to use a combined estimate in the HRA for this site.

16.187. Of the qualifying interests screened into this assessment, grey seal has maintained a 'Favourable' conservation status (Scottish Natural Heritage, 2018a).

16.188. A Management Scheme to facilitate effective management of the SAC has been developed by the Berwickshire and Northumberland Marine Nature Partnership (Hedley, 2016). The management plan seeks to manage activities within the marine and coastal environment of the SAC. A total of 28 types of potentially damaging human activities occur within or close to the SAC. There are no management actions related to offshore renewable energy development projects.

Plate 16.1 Grey seal pup production at the North Sea colonies (SCOS 2016).



16.189. The conservation objectives for the European site are, subject to natural change, to ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its qualifying interests (grey seal). This will be achieved by maintaining or restoring:

- The extent and distribution of qualifying natural habitats and habitats of qualifying species;
- The structure and function (including typical species) of qualifying natural habitats;
- The structure and function of the habitats of qualifying species;
- The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely;
- The populations of qualifying interests; and
- The distribution of qualifying interests within the site.

Firth of Tay and Eden Estuary SAC

16.190. The Firth of Tay & Eden Estuary SAC is a large estuary comprised of sandy beaches and sandbanks with a largely sheltered inner estuary and an outer estuary exposed to strong tidal currents (Scottish Natural Heritage, 2006a). The SAC is located approx. 47km from the optimised Seagreen Project.

16.191. When designated (2005), the SAC regularly supported a population of 600 harbour seals, which was deemed to be important in maintaining the overall population size, and was considered significant as sources of emigration to smaller or newly established groups (Scottish Natural Heritage, 2006a). However, since then, counts of harbour seals within the SAC have declined. Annual August moult counts in the Firth of Tay and Eden Estuary SAC between 1990 and 2002 were 641 animals, which declined to only 51 animals in the 2016 count, representing a 90% decrease (SCOS, 2017). Population modelling work conducted for the Firth of Tay and Eden Estuary SAC population has concluded that if this declining trend continues, the population will effectively become extinct within the next 20 years (Hanson *et al.*, 2015).

16.192. In accordance with advice in the 2017 Scoping Opinion, for harbour seals, the population present in the East Coast Scotland seal management unit was used as the reference population for assessment and was taken as equivalent to the SAC population.

16.193. Of the qualifying interests screened into this assessment, harbour seal is in 'Unfavourable' conservation status and is declining (Scottish Natural Heritage, 2018b).

16.194. There is no known site management in relation to the SAC, although recreational disturbance is known to be a threat (Scottish Natural Heritage, 2018b). Given the concerning low numbers of harbour seals in the SAC, Marine Scotland has not issued any licences to shoot harbour seals within the East Scotland Management Area since 2010 (SCOS, 2017).

16.195. The conservation objectives of the European site are to avoid deterioration of the habitats of the qualifying interest (harbour seal) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for the qualifying interests.

16.196. To ensure for the qualifying interests that the following are maintained in the long term:

- Population of the species as a viable component of the site;
- Distribution of the species within site;
- Distribution and extent of habitats supporting the species;
- Structure, function and supporting processes of habitats supporting the species; and
- No significant disturbance of the species.

Isle of May SAC

16.197. The Isle of May SAC is 1.8km long and less than 500m wide with cliffs up to 60m high on the west coast with the landform sloping towards the sea to the east (Scottish Natural Heritage, 2011a). The SAC is located 52km from the optimised Seagreen Project.

16.198. The SAC supports the largest grey seal breeding colony on the east coast and the fourth largest in the UK (Scottish Natural Heritage, 2011a; 2015). The pup production estimate at the Isle of May increased from 936 in 1989 to 2,133 in 2000, after which it has remained relatively stable with annual pup production estimates between ~1,900 and ~2,300 (Plate 16.1). Pup production was estimated at 2,272 in 2014, which is slightly less than the estimate in 2012 of 2,355 (Plate 16.1) (SCOS, 2016).

16.199. In accordance with advice in the 2017 Scoping Opinion, for grey seals, the population present in the East Coast Scotland seal management unit was used as the reference population for assessment and was be taken as equivalent to the SAC population.

16.200. Of the qualifying interests screened into this assessment, grey seal has maintained 'Favourable' conservation status (Scottish Natural Heritage, 2018c).

16.201. The management of the SAC is included under the umbrella of the National Nature Reserve (NNR) management plan (Scottish Natural Heritage, 2015) which seeks to:

- Ensure the reserve continues to provide appropriate breeding habitat for grey seals;
- Manage the island to protect and where possible enhance habitats and species.

16.202. The conservation objectives of the European site are to avoid deterioration of the habitats of the qualifying interest (grey seal) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for the qualifying interests.

16.203. To ensure for the qualifying interests that the following are maintained in the long term:

- Population of the species as a viable component of the site;
- Distribution of the species within site;
- Distribution and extent of habitats supporting the species;
- Structure, function and supporting processes of habitats supporting the species; and
- No significant disturbance of the species.

Moray Firth SAC

16.204. The Moray Firth SAC encompasses the Beauly/Inverness Firth and the outer reaches of the Dornoch and Cromarty Firths (Scottish Natural Heritage, 2006b). The SAC is located 142km from the optimised Seagreen Project.

16.205. The SAC supported approximately 103 (95% CI: 93-115) bottlenose dolphins in 2016 (Cheney *et al.*, 2018) and due to its small size and relative isolation, the population is vulnerable to natural and human induced environmental change (Scottish Natural Heritage, 2006b). In line with the 2017 Scoping Opinion advice and due to the wide ranging nature of the bottlenose dolphins that use the SAC, the reference population for HRA is taken to be equivalent to the East Coast Scotland MU.

16.206. The current population estimate of bottlenose dolphin for the East Coast Scotland MU population is 195 individuals, based on photo-ID counts between 2006 and 2007 (Cheney *et al.*, 2013). The results of further surveys suggest that the East Coast Scotland population has continued to increase in size since 2007, therefore the current population size is likely to be larger than this (Cheney *et al.*, 2018). Between 1990 and 2015 the number of individuals using the SAC has remained stable, with some inter-annual variability (between 2011 and 2016 the estimated SAC abundance went from 108 to 103 animals with a minimum estimate of 85 in 2014 and a maximum estimate of 127 in 2012), whilst the population size has increased, suggesting the proportion of the population that uses the SAC has declined (Cheney *et al.*, 2018). Whilst the Moray Firth, including the SAC, is clearly an important area for this population, these animals are highly mobile, and have a large range that extends east

along the outer Moray Firth coastline and south to the Firth of Forth (Cheney *et al.* 2013). These data show that the East Coast Scotland bottlenose dolphin population has increased since 1990 and is currently considered a healthy population.

16.207. Of the qualifying interests screened into this assessment bottlenose dolphin are in 'Favourable Recovered' conservation status (Scottish Natural Heritage, 2018d).

16.208. A 'Management Scheme and Action Programme' to facilitate effective management of the SAC has been developed by the Moray Firth SAC Management Group (2016). The management plan includes that action to ensure the consenting regime for energy developments "*is informed by, and promotes the use of existing good practice guidelines for minimising the risk of disturbance and injury to dolphins as a result of underwater noise*" (Moray Firth SAC Management Group, 2016).

16.209. The conservation objectives of the European site are to avoid deterioration of the habitats of the qualifying interest (bottlenose dolphins), or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for the qualifying interests.

16.210. To ensure for the qualifying interests that the following are maintained in the long term:

- Population of the species as a viable component of the site;
- Distribution of the species within site;
- Distribution and extent of habitats supporting the species;
- Structure, function and supporting processes of habitats supporting the species; and
- No significant disturbance of the species.

Buchan Ness to Collieston Coast SPA

16.211. The Buchan Ness to Collieston Coast SPA comprises a 15km stretch of cliffs with a seaward extension of approximately 2km that includes the seabed, water column and surface (Scottish Natural Heritage, 2009a). The SPA is located 71.7km from the optimised Seagreen Project.

16.212. The SPA regularly supports in excess of 20,000 individual seabirds in the breeding season including the following qualifying interests screened into this assessment including guillemot (8,640 pairs), kittiwake (30,452 pairs) and herring gull (4,292 pairs) (Scottish Natural Heritage, 2009a).

16.213. Compared to population estimates at the time of designation the most recent colony counts (2017) (Scottish Natural Heritage, 2017b) for the qualifying interests screened into this assessment reflect their conservation status. Guillemot (45,067 pairs) have maintained 'Favourable' conservation status whereas there is no change in the Unfavourable' conservation status of kittiwake (11,482 pairs) and herring gull (3,115 pairs) (Scottish Natural Heritage, 2018e).

16.214. There is no site management in relation to the SPA (Scottish Natural Heritage, 2010b).

16.215. The conservation objectives for this European site (Scottish Natural Heritage 2006d) are to avoid deterioration of the habitats of the qualifying species (not relevant to the impacts assessed in this HRA) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained. To ensure for the qualifying species that the following are maintained in the long term:

- Population of the species as a viable component of the site;
- Distribution of the species within site;
- Distribution and extent of habitats supporting the species (not relevant to the impacts assessed in this HRA);
- Structure, function and supporting processes of habitats supporting the species (not relevant to the impacts assessed in this HRA); and
- No significant disturbance of the species.

Forth Islands SPA

16.216. The Forth Islands SPA comprises of a series of islands supporting the main seabird colonies in the Firth of Forth (Inchmickery, Isle of May, Fidra, The Lamb, Craigleith, Bass Rock and Long Craig) with the seaward extension of approximately 2km including the seabed, water column and surface (Scottish Natural Heritage, 2009b). The SPA is located 48.7km from the optimised Seagreen Project.

16.217. The SPA regularly supports in excess of 20,000 individual seabirds in the breeding season including the following qualifying interests screened into this assessment including gannet (21,600 pairs), puffin (14,000 pairs), guillemot (16,000 pairs), razorbill (1,400 pairs), kittiwake (8,400 pairs) and herring gull (6,600 pairs) (Scottish Natural Heritage, 2009b).

16.218. Recent colony counts (2017) for gannet (75,259 pairs), puffin (45,005 pairs), guillemot (45,067 pairs) and razorbill (7,792 pairs) (Scottish Natural Heritage, 2017b) reflect that all these qualifying interests have maintained a 'Favourable' conservation status. For kittiwake (4,663 pairs) this qualifying interest is in an 'Unfavourable' conservation status and declining (Scottish Natural Heritage, 2018f).

16.219. The conservation objectives for this European site (Scottish Natural Heritage 2011b) are to avoid deterioration of the habitats of the qualifying species (not relevant to the impacts assessed in this HRA) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained. To ensure for the qualifying species that the following are maintained in the long term:

- Population of the species as a viable component of the site;
- Distribution of the species within site;
- Distribution and extent of habitats supporting the species (not relevant to the impacts assessed in this HRA);
- Structure, function and supporting processes of habitats supporting the species (not relevant to the impacts assessed in this HRA); and
- No significant disturbance of the species.

16.220. Site management is currently restricted to the removal of tree mallow *Lavatera arborea* to allow puffins to get to their burrows (Scottish Natural Heritage, 2010c). Wider management issues outside the scope of site management include pollution, winter mortality rates of adult birds and the impacts of fisheries and climate change on the availability and suitability of food supplies in the breeding season (Scottish Natural Heritage, 2010c).

16.221. The management for the Isle of May, a component of the SPA, is included under the umbrella of the National Nature Reserve (NNR) Management Plan (Scottish Natural Heritage, 2015) which seeks to:

- Ensure the reserve continues to provide appropriate nesting habitat for the range and populations of breeding seabirds; and
- Manage the island to protect and where possible enhance habitats and species.

Fowlsheugh SPA

16.222. The Fowlsheugh SPA comprises a 10.15ha stretch of cliffs between 30m and 60m high with a 2km seaward extension including the seabed, water column and surface (Scottish Natural Heritage, 2009c). The SPA is located 27.5km from the optimised Seagreen Project.

16.223. The SPA regularly supports in excess of 20,000 individual seabirds in the breeding season including the following qualifying interests screened into this assessment; guillemot (56,450 individuals), razorbill (5,800 individuals), kittiwake (36,650 pairs) and herring gull (3,190 pairs) (Scottish Natural Heritage, 2009c).

16.224. Recent colony counts (2017) include guillemot (74,379 pairs), razorbill (7,426 pairs) and kittiwake (9,655 pairs) (Scottish Natural Heritage, 2017b). All of the qualifying interests have maintained 'Favourable' conservation status except herring gull (125 pairs) which is in an 'Unfavourable' and declining conservation status (Scottish Natural Heritage, 2018g). It is noted however that for kittiwake there has been an on-going population decline since the designation of the Site of Special Scientific Interest (SSSI) that underpins the 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, 2011b).

16.225. The site is managed under a management plan by the Royal Society for the Protection of Birds (RSPB) that includes the provision of visitor interpretation, measures to prevent disturbance to the birds on the cliffs and the management of the cliff top grassland (Scottish Natural Heritage, 2011c).

16.226. The conservation objectives for this European site (Scottish Natural Heritage 2006e) are to avoid deterioration of the habitats of the qualifying species (not relevant to the impacts assessed in this HRA) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained. To ensure for the qualifying species that the following are maintained in the long term:

- Population of the species as a viable component of the site;
- Distribution of the species within site;
- Distribution and extent of habitats supporting the species (not relevant to the impacts assessed in this HRA);
- Structure, function and supporting processes of habitats supporting the species (not relevant to the impacts assessed in this HRA); and
- No significant disturbance of the species.

St Abb's Head to Fast Castle SPA

16.227. The St Abb's Head to Fast Castle SPA comprises an area of sea cliffs and coastal strip stretching over 10km with a seaward extension extending approximately 1km into the sea that includes the seabed, water column and surface (Scottish Natural Heritage, 2009c). The SPA is located 65.7km from the optimised Seagreen Project.

16.228. The SPA regularly supports in excess of 20,000 individual seabirds in the breeding season including the following qualifying interests screened into this assessment; guillemot (31,750 individuals), razorbill (2,180 individuals), kittiwake (21,170 pairs) and herring gull (1,160 pairs) (Scottish Natural Heritage, 2009c).

16.229. Recent colony counts for guillemot (48,516 pairs), razorbill (2,214 pairs), kittiwake (4,803 pairs) and herring gull (325 pairs) (Scottish Natural Heritage, 2017b) reflect that guillemot and razorbill are in 'Favourable Maintained' conservation status and kittiwake and herring gull are in 'Unfavourable Declining' conservation status (Scottish Natural Heritage, 2018h).

16.230. There is no site management in relation to the SPA as it is thought that a widespread decline in the sandeel population is responsible for the unfavourable condition for kittiwake and herring gull (Scottish Natural Heritage, 2011d).

16.231. The conservation objectives for this European site (Scottish Natural Heritage 2006f) are to avoid deterioration of the habitats of the qualifying species (not relevant to the impacts assessed in this HRA), or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained. To ensure for the qualifying species that the following are maintained in the long term:

- Population of the species as a viable component of the site;
- Distribution of the species within site;
- Distribution and extent of habitats supporting the species (not relevant to the impacts assessed in this HRA);
- Structure, function and supporting processes of habitats supporting the species (not relevant to the impacts assessed in this HRA); and
- No significant disturbance of the species.

Outer Firth of Forth and St Andrews Bay Complex pSPA

16.232. The Outer Firth of Forth and St Andrews Bay Complex pSPA is a large estuarine and marine area encompassing two existing SPAs (St Abb's Head to Fast Castle SPA and Forth Islands SPA) that will protect the key structural and functional relationships that create and maintain the sites' integrity. The pSPA supports a wide range of seabird prey species throughout the year and the abundance of sandeels is of particular importance to breeding puffin, razorbill, guillemot, kittiwake and to a lesser extent gannet (Scottish Natural Heritage & JNCC, 2016a).

16.233. During the breeding season, the seabird qualifying interests have extensive marine foraging ranges extending far beyond the boundary of the pSPA. Outside of the breeding season the seabird qualifying interests disperse into the North Sea and further afield; the majority returning to their respective breeding colonies in successive seasons. The pSPA is located 29.3km from the optimised Seagreen project.

16.234. The qualifying interests screened into this assessment include gannet (10,945 individual [1980-2006]), puffin (61,086 individuals), guillemot (28,123 individuals), kittiwake (12,020 individuals) and herring gull (3,044 individuals) in the breeding season, as well as herring gull (12,313 individuals) guillemot (21,968 individual), kittiwake (3,191 individuals) and razorbill (5,481 individuals) in the non-breeding season (Scottish Natural Heritage & JNCC, 2016a).

16.235. The spatial distribution of qualifying interests within the pSPA varies between species. The distribution of gannet (7.0 birds/km^2) and kittiwake (5 to 10 birds/km^2, locally higher at 43.4 birds/km^2) are concentrated offshore, specifically in the outermost Firth of Forth for gannet and more generally the outer reaches of the pSPA for kittiwake. Puffin (locally up to 80 birds/km^2) is largely concentrated around the Isle of May extending west into the Firth of Forth, north to St Andrews Bay and east into the North Sea (Scottish Natural Heritage & JNCC, 2016). Non-breeding season guillemot and razorbill distribution is also centred around the Isle of May with a second concentration of guillemot in the inner Firth. In the breeding season guillemot are found throughout the pSPA. Herring gull is a ubiquitous species but the night time roosting distribution at sea within the pSPA is not known (Scottish Natural Heritage & JNCC, 2016a).

16.236. There is currently no specific data of substantial population changes over "*previous decades or even centuries*" for any of the qualifying interests (Scottish Natural Heritage & JNCC, 2016a).

16.237. Scottish Natural Heritage and JNCC's advice on management of the pSPA is detailed in Scottish Natural Heritage & JNCC's 'Advice to Support Management' (2016b). The aim of the advice is to ensure, where marine activities pose a risk of causing a significant effect, that the conservation objectives for each qualifying interests are achieved. The advice covers all marine activities that may cause an effect on a sensitive qualifying interest, but specifically includes:

- The use of mobile fishing gear;
- The use of static fishing gear;
- Harvesting intertidal shellfish and bait;
- Navigational dredging and disposal;
- Ports and Harbours activities;
- Development or expansion of ports and harbours;
- Recreational activities; and
- Renewable wind energy developments.

16.238. With respect to the originally consented project, providing that the mitigation measures as agreed by the Forth and Tay Regional Advisory Group (FTRAG) are deployed on a project specific basis, there are no additional management options (Scottish Natural Heritage & JNCC, 2016b).

16.239. The overarching conservation aim for the Outer Firth of Forth and St Andrews Bay Complex pSPA (Scottish Natural Heritage & JNCC, 2016b) is to:

- Avoid deterioration of the habitats of the qualifying species (not relevant to the impacts assessed in this HRA), or significant disturbance to the qualifying interests, subject to natural change, thus ensuring that the integrity of the site is maintained in the long-term and it continues to make an appropriate contribution to achieving the aims of the Birds Directive for each of the qualifying interests.

16.240. This contribution will be achieved through delivering the following objectives for each of the site's qualifying interests:

- Avoid significant mortality, injury and disturbance of the qualifying features, so that the distribution of the species and ability to use the site are maintained in the long-term.
- To maintain the habitats and food resources of the qualifying features in favourable condition (not relevant to the impacts assessed in this HRA).

IMPACT PREDICTION: SPECIAL AREAS OF CONSERVATION

Information required

16.241. In order to ensure that adequate information is available to complete the appropriate assessment for potential impacts to SACs, the checklist in Table 16.12 has been completed. Additional information is contained in the following chapters and appendices of this EIA Report:

- Chapter 10 (Marine Mammals);
- Appendix 10A (Marine Mammals Technical Baseline Report); and
- Appendix 10B (Underwater Noise Modelling Report).

Impact prediction for Project Alpha and Project Bravo combined

Construction noise impacts on marine mammals

Potential effects

16.242. With reference to the 2017 Scoping Opinion and confirmed through further consultation, this assessment considers underwater noise disturbance from pile driving in respect of bottlenose dolphin, grey seal and harbour seal. The potential effects arising from the underwater noise generated during pile driving during foundation installation include: injury, auditory injury and behavioural effects such as disturbance, leading to displacement.

16.243. The impact ranges for injury to marine mammals, including auditory injury such as Permanent Threshold Shift (PTS), are detailed in Appendix 10B (Underwater Noise Modelling Report) and in Chapter 10 (Marine Mammals). All ranges were within 50m for the SAC qualifying features. As a result there is negligible risk of injury to any individuals associated with SACs and no possibility of any adverse effect on site integrity. Therefore injury risk is not considered further within this Chapter.

16.244. Marine mammals may be displaced from the vicinity around pile driving operations as a result of underwater noise. A summary of the available evidence describing these effects on bottlenose dolphins and seals is presented in Chapter 10 (Marine Mammals). A summary has been provided here.

Table 16.12 Special Areas of Conservation Information Checklist for The Appropriate Assessment

Information about the project	Location of information			
	Berwickshire and North Northumberland Coast SAC	**Firth of Tay and Eden Estuary SAC**	**Isle of May SAC**	**Moray Firth SAC**
Full characteristics of the project which may affect the site	Chapter 5 (Project Description) Table 16.11			
Size and other specifications of the project				
The characteristics of existing, proposed or other approved projects or plans which may cause interactive or in combination impacts with the project being assessed and which may affect the site	Chapter 10 (Impact Assessment: Cumulative)			
Planned or contemplated nature conservation initiatives likely to affect the status of the site in the future	Para. 16.188	Para. 16.194	Para. 16.201	Para. 16.208
The relationship (e.g. key distances etc.) between the project and the Natura 2000 site	Para. 16.184	Para. 16.190	Para. 16.197	Para. 16.204
The information requirements (e.g. scoping opinion of the authorisation body or agency)	Para. 16.26 to Para.16.29 Table 16.2			
The reasons for the designation of the Natura 2000 site	Para. 16.185	Para. 16.191	Para. 16.198	Para. 16.205
The conservation objectives of the site and the factors that contribute to the conservation value of the site	Para. 16.189	Para. 16.195	Para. 16.202	Para. 16.210
The conservation status of the site (favourable or otherwise)	Para. 16.187 Appendix 10A (Marine Mammals Technical Baseline Report)	Para. 16.193 Appendix 10A (Marine Mammals Technical Baseline Report)	Para. 16.200 Appendix 10A (Marine Mammals Technical Baseline Report)	Para. 16.207 Appendix 10A (Marine Mammals Technical Baseline Report)
The existing baseline condition of the site				
The key attributes of any species on the site (e.g. population size)				
The dynamics of the habitats, species and their ecology (e.g. population trends)	Appendix 10A (Marine Mammals Technical Baseline Report)			
Those aspects of the site that are sensitive to change	Appendix 10A (Marine Mammals Technical Baseline Report)			
The key structural and functional relationships that create and maintain the site's integrity	The optimised Seagreen project is located outwith the site and no impacts related to structure of function have been identified			
The seasonal influences on the key species on the site	Chapter 10 Appendix 10A (Marine Mammals Technical Baseline Report)	The seasonal influences on the key species on the site	Chapter 10 Appendix 10A (Marine Mammals Technical Baseline Report)	The seasonal influences on the key species on the site
Other conservation issues relevant to the site, including likely future natural changes taking place	Appendix 10A (Marine Mammals Technical Baseline Report)	Other conservation issues relevant to the site, including likely future natural changes taking place	Appendix 10A (Marine Mammals Technical Baseline Report)	Other conservation issues relevant to the site, including likely future natural changes taking place

16.245. In a recent study on bottlenose dolphins in the Moray Firth (in relation to the construction of the Nigg Energy Park in the Cromarty Firth), some minimal behavioural effects of pile driving on dolphins have been observed. However, dolphins were not excluded from the vicinity of the piling activities (Graham *et al.*, 2017b). The pile driving resulted in a slight reduction of the presence, detection positive hours (number of hours that contain dolphin detections) and the encounter duration for dolphins within the Cromarty Firth. However, this response was only significant for the encounter durations. Encounter durations decreased within the Cromarty Firth (though only by a few minutes) and increased outside of the Cromarty Firth on days of piling activity. These data highlight a small spatial and temporal scale disturbance to bottlenose dolphins as a result of pile driving activities.

16.246. There is the potential for behavioural disturbance and displacement to result in a disruption in foraging and resting activities and an increase in travel and energetic costs. However, it has been previously shown that bottlenose dolphins have the ability to compensate for behavioural responses as a result of increased commercial vessel activity (New *et al.*, 2013). While there remains the potential for disturbance and displacement to affect individual behaviour, in a way that may affect an individual's ability to survive and reproduce, leading to population level effects, bottlenose dolphins do have some capability to adapt their behaviour and tolerate certain levels of disturbance.

16.247. A study of tagged harbour seals in the Wash has shown that they are also displaced from the vicinity of pile driving activities. Russell *et al.*, (2016) showed that seal abundance was significantly reduced within an area with a radius of 25km from piling activities, with a 19 to 83% decline in abundance across this range during piling compared to during breaks in pile driving. Seals returned to non-piling distributions within two hours after the end of a piling event. Both harbour and grey seals store energy in a thick layer of blubber, which means that they are tolerant of periods of fasting when hauled out and resting between foraging trips, and when hauled out during the breeding and moulting periods. Therefore, they are unlikely to be particularly sensitive to short-term displacement from foraging grounds during periods of active pile driving. Juvenile harbour seals may be more sensitive to displacement from foraging grounds due to a smaller body size and higher energetic needs. Harbour seals also need to continue feeding during lactation to support their pups, and therefore may be more sensitive at particular times of year.

16.248. Grey seals store energy throughout the year in the form of blubber and do not feed when provisioning pups during the breeding season, relying on this energy store for themselves and to feed their pups. During this time they are on land, fasting for several weeks and, therefore, are not sensitive to disturbance during the breeding season. Grey seals rely on foraging throughout the year to build up large blubber stores prior to breeding, so disturbance could still affect breeding success. However, the highly mobile and wide ranging nature of grey seals, in combination with their large body size, means that they are tolerant of periods of fasting as part of their normal life history. Grey seals are also highly adaptable to a changing environment and are capable of adjusting their metabolic rate and foraging tactics, to compensate for different periods of energy demand and supply (e.g. Sparling *et al.*, 2006, Beck *et al.*, 2003). Grey seals are also capable of moving large distances between different haul out and foraging regions (e.g. Russell *et al.*, 2013). Therefore, they are unlikely to be particularly sensitive to displacement from foraging grounds during periods of active pile driving.

16.249. Underwater noise caused by pile driving during the construction of the optimised Seagreen Project will not extend as far as the boundaries of any of the SAC sites scoped into this assessment. Therefore, there will be no effect on the distributions of qualifying species within each site. However, there is the potential for wider effects on the populations of qualifying species, as a result of disturbance leading to effective loss of supporting habitat for qualifying species.

16.250. The magnitude of potential disturbance effects of Project Alpha alone, Project Bravo alone and the optimised Seagreen Project are estimated and assessed in detail in Chapter 10 (Marine Mammals) and summarised below in Table 16.13. A summary of this assessment as it relates to the potential for adverse effect on the integrity of the scoped in SACs is presented here.

Table 16.13 Summary of Predicted Impacts for the optimised Seagreen Project in EIA terms

Receptor	Potential Impact	Impact Significance
Project Alpha		
Harbour seal	PTS Disturbance	Negligible (not significant) Negligible (not significant)
Grey seal	PTS Disturbance	Negligible (not significant) Negligible (not significant)
Bottlenose dolphin	PTS	Negligible (not significant)
	Disturbance	Minor (not significant)
Project Bravo		
Harbour seal	PTS Disturbance	Negligible (not significant) Negligible (not significant)
Grey seal	PTS Disturbance	Negligible (not significant) Negligible (not significant)
Bottlenose dolphin	PTS	Negligible (not significant)
	Disturbance	Minor (not significant)
Project Alpha and Project Bravo Combined		
Harbour seal	PTS Disturbance	Negligible (not significant) Negligible (not significant)
Grey seal	PTS Disturbance	Negligible (not significant) Negligible (not significant)
Bottlenose dolphin	PTS	Negligible (not significant)
	Disturbance	Minor (not significant)

Project Alpha

Firth of Tay and Eden Estuary SAC – Harbour seals

16.251. The total number of harbour seals predicted to be disturbed during the installation of pin pile jackets at Project Alpha is 0.13 (95% Confidence Interval [CI] 0.04 to 0.22), this is equivalent to 0.03% of the reference population which is also taken to be equivalent to the Firth of Tay and Eden Estuary SAC population. This level of disturbance under the pin pile jacket installation scenario would occur on a total of 140 days, spread over a period of 18 months.

16.252. The total number of harbour seals predicted to be disturbed during the concurrent installation of monopiles and pin pile jackets at Project Alpha is 0.29 (95% Confidence Interval (CI) 0.07-0.51), this is equivalent to 0.06% of the reference population which is also taken to be equivalent to the Firth of Tay and Eden Estuary SAC population. This level of disturbance under the concurrent monopile and pin pile jacket installation scenario would occur on a total of 35 days, with an additional 70 days of just pin pile installation (at the level of impact specified above), spread over a period of two years.

16.253. This level of disturbance is extremely low and therefore there is no likelihood of an adverse effect on the species as a qualifying feature of the Firth of Tay and Eden Estuary SAC, and **no adverse effect on the conservation objectives of the site** as a result of the construction of Project Alpha alone.

Isle of May SAC – Grey seals

16.254. The total number of grey seals predicted to be disturbed during the installation of pin pile jackets at Project Alpha is 27 (95% CI 8-46), this is equivalent to 0.25% of the Scottish east coast seal management area reference population which is also taken to be equivalent to the Isle of May SAC population. This level of disturbance under the pin pile jacket installation scenario would occur on a total of 140 days, spread over a period of 18 months.

16.255. The total number of harbour seals predicted to be disturbed during the concurrent installation of monopiles and pin pile jackets at Project Alpha is 42 (95% CI 14-70), this is equivalent to 0.38% of the Scottish east coast seal management area reference population which is also taken to be equivalent to the Isle of May SAC population. This level of disturbance under the concurrent monopile and pin pile jacket installation scenario would occur on a total of 35 days, with an additional 70 days of just pin pile installation (at the level of impact specified above), spread over a period of two years.

16.256. This level of disturbance is very low and will not affect animals present at the Isle of May SAC site during the breeding season. Therefore the construction of Project Alpha will have **no adverse effect on the conservation objectives** of the Isle of May SAC.

Berwickshire and North Northumberland SAC – Grey seals

16.257. The total number of grey seals predicted to be disturbed during the installation of pin pile jackets at Project Alpha is 27 (95% CI 8-46), this is equivalent to 0.09% of the combined Scottish east coast and north east England seal management area reference population which is taken to be equivalent to the Berwickshire and North Northumberland SAC population. Even adopting a more precautionary reference population, equivalent to the North England Management Unit (19,851), would result in an impact to an equivalent of only 0.14% of the reference population.

16.258. This level of disturbance under the pin pile jacket installation scenario would occur on a total of 140 days, spread over a period of 18 months.

16.259. The total number of grey seals predicted to be disturbed during the concurrent installation of monopiles and pin pile jackets at Project Alpha is 42 (95% CI 14-70), this is equivalent to 0.14% of the combined Scottish east coast and north east England seal management area reference population which is taken to be equivalent to the Berwickshire and North Northumberland SAC population. Even adopting a more precautionary reference population, equivalent to the North England Management Unit alone (19,851), would result in an impact to an equivalent of only 0.21% of the reference population.

16.260. This level of disturbance under the concurrent monopile and pin pile jacket installation scenario would occur on a total of 35 days, with an additional 70 days of just pin pile installation (at the level of impact specified above), spread over a period of two years.

16.261. This level of disturbance is very low and will not affect animals present at the SAC site during the breeding season. This, in combination with the low numbers of animals potentially disturbed outside of the SAC at other times of year, and the limited temporary duration of any disturbance, will not result in an adverse effect on the species as a qualifying feature. Therefore the construction of Project Alpha will have **no adverse effect on the conservation objectives** of the SAC.

Moray Firth SAC – Bottlenose dolphins

16.262. The total number of bottlenose dolphins predicted to be disturbed per piling day during the installation of monopiles at Project Alpha is 4.1, this is equivalent to 2.11% of the reference population which is also taken to be equivalent to the Moray Firth SAC population.

16.263. The total number of bottlenose dolphins predicted to be disturbed during the concurrent installation of monopiles and pin pile jackets at Project Alpha is 4.5, this is equivalent to 2.30% of the reference population which is also taken to be equivalent to the Moray Firth SAC population.

16.264. Population modelling carried out for Project Alpha and Project Bravo combined presented in Chapter 10, and summarised below, concludes that there would be no population level consequences as a result of the impacts of Project Alpha and Project Bravo combined, therefore the construction of Project Alpha alone will not result in a significant long term change to the population. Therefore there is no likelihood of an adverse effect on the species as a qualifying feature. The construction of Project Alpha will have **no adverse effect on the conservation objectives** of the SAC.

Appropriate Assessment Matrix

16.265. Table 16.14 summarises the assessment undertaken and the determination, prior to mitigation, of whether or not there is an adverse effect on site integrity for each European site.

Table 16.14 Appropriate Assessment Matrix (Project Alpha alone): Disturbance from construction piling noise

Conservation Objective	Berwickshire and North Northumberland Coast SAC	Firth of Tay and Eden Estuary SAC	Isle of May SAC	Moray Firth SAC
To ensure for the qualifying species that the following are maintained in the long term:				
Population of the species as a viable component of the site	*No Adverse Effect on Site Integrity* Level of temporary disturbance during construction of Project Alpha is very low and will not affect animals present in any European site. Disturbance outside of any European site at other times of year will potentially only affect a low numbers of animals and will not have any population consequences.			*No Adverse Effect on Site Integrity* Level of disturbance from construction of Project Alpha will have no population consequences.
Distribution of the species within site	*No Adverse Effect on Site Integrity* Project Alpha is located outwith the European site. The potential effect of displacement will therefore not impact the distribution of the qualifying interests within site.			
Distribution and extent of habitats supporting the species	*No Adverse Effect on Site Integrity* Project Alpha is located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
Structure, function and supporting processes of habitats supporting the species	*No Adverse Effect on Site Integrity* Project Alpha is located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
No significant disturbance of the species	*No Adverse Effect on Site Integrity* Level of temporary disturbance during construction of Project Alpha is very low and will not affect animals present in any European site. Disturbance outside of any European site at other times of year will potentially only affect a low numbers of animals.			*No Adverse Effect on Site Integrity* Level of disturbance from construction of Project Alpha will have no population consequences.
Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its qualifying interests	*No Adverse Effect on Site Integrity* Level of temporary disturbance during construction of Project Alpha is very low and will not affect animals present in any European site. Disturbance outside of any European site at other times of year will potentially only affect a low numbers of animals and will not have any population consequences.			
The extent and distribution of qualifying natural habitats and habitats of qualifying species	*No Adverse Effect on Site Integrity* Project Alpha is located outwith the European site and the impacts related to habitats were scoped out of this assessment.			
The structure and function (including typical species) of qualifying natural habitats	*No Adverse Effect on Site Integrity* Project Alpha is located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
The structure and function of the habitats of qualifying species	*No Adverse Effect on Site Integrity* Project Alpha is located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely	*No Adverse Effect on Site Integrity* Project Alpha is located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
The populations of qualifying interests	*No Adverse Effect on Site Integrity* Level of temporary disturbance during construction of Project Alpha is very low and will not affect animals present in any European site. Disturbance outside of any European site at other times of year will potentially only affect a low number of animals and will not have any population consequences.			
The distribution of qualifying interests within the site	*No Adverse Effect on Site Integrity* Project Alpha is located outwith the European site. The potential effect of disturbance will therefore not impact the distribution of the qualifying interests within site.			

Project Bravo

Firth of Tay and Eden Estuary SAC – harbour seals

16.266. The total number of harbour seals predicted to be disturbed during the installation of pin pile jackets at Project Bravo is 0.09 (95% CI 0.04-0.22), this is equivalent to 0.02% of the reference population which is also taken to be equivalent to the Firth of Tay and Eden Estuary SAC population. This level of disturbance under the pin pile jacket installation scenario would occur on a total of 140 days, spread over a period of 18 months.

16.267. The total number of harbour seals predicted to be disturbed during the concurrent installation of monopiles and pin pile jackets at Project Bravo is 0.21 (95% CI 0.05-0.38), this is equivalent to 0.04% of the reference population which is also taken to be equivalent to the Firth of Tay and Eden Estuary SAC population. This level of disturbance under the concurrent monopile and pin pile jacket installation scenario would occur on a total of 35 days, with an additional 70 days of just pin pile installation (at the level of impact specified above), spread over a period of two years.

16.268. This level of disturbance is extremely low and therefore there is very low likelihood of an adverse effect on the species as a qualifying feature of the Firth of Tay and Eden Estuary SAC, and **no adverse effect on the conservation objectives of the site** as a result of the construction of Project Bravo alone.

Isle of May SAC – Grey seals

16.269. The total number of grey seals predicted to be disturbed during the installation of pin pile jackets at Project Bravo is 14 (95% CI 6-21), this is equivalent to 0.13% of the Scottish east coast seal management area reference population which is also taken to be equivalent to the Isle of May SAC population. This level of disturbance under the pin pile jacket installation scenario would occur on a total of 140 days, spread over a period of 18 months.

16.270. The total number of grey seals predicted to be disturbed during the concurrent installation of monopiles and pin pile jackets at Project Bravo is 27 (95% CI 12-43), this is equivalent to 0.25% of the Scottish east coast seal management area reference population which is also taken to be equivalent to the Isle of May SAC population. This level of disturbance under the concurrent monopile and pin pile jacket installation scenario would occur on a total of 35 days, with an additional 70 days of just pin pile installation (at the level of impact specified above), spread over a period of two years.

16.271. This level of disturbance is very low and will not affect animals present at the Isle of May SAC site during the breeding season. Therefore the construction of Project Bravo will have **no adverse effect on the conservation objectives** of the Isle of May SAC.

Berwickshire and North Northumberland SAC – Grey seals

16.272. The total number of grey seals predicted to be disturbed during the installation of pin pile jackets at Project Bravo is 14 (95% CI 6-21), this is equivalent to 0.05% of the combined Scottish east coast and north east England seal management area reference population which is taken to be equivalent to the Berwickshire and North Northumberland SAC population. Even adopting a more precautionary reference population equivalent to the North England Management Unit (19,851) would result in an impact to an equivalent of 0.07% of the reference population.

16.273. This level of disturbance under the pin pile jacket installation scenario would occur on a total of 140 days, spread over a period of 18 months.

16.274. The total number of grey seals predicted to be disturbed during the concurrent installation of monopiles and pin pile jackets at Project Bravo is 27 (95% CI 12-43), this is equivalent to 0.09% of the combined Scottish east coast and north east England seal management area reference population, which is taken to be equivalent to the Berwickshire and North Northumberland SAC population. Even adopting a more precautionary reference population equivalent to the North England Management Unit alone (19,851) would result in an impact to an equivalent of 0.14% of the reference population.

16.275. This level of disturbance under the concurrent monopile and pin pile jacket installation scenario would occur on a total of 35 days, with an additional 70 days of just pin pile installation (at the level of impact specified above), spread over a period of two years.

16.276. This level of disturbance is very low and will not affect animals present at the SAC site during the breeding season. This, in combination with the low numbers of animals potentially disturbed outside of the SAC at other times of year, and the limited temporary duration of any disturbance, will not result in an adverse effect on the species as a qualifying feature. Therefore the construction of Project Bravo will have **no adverse effect on the conservation objectives** of the SAC.

Moray Firth SAC – Bottlenose dolphins

16.277. The total number of bottlenose dolphins predicted to be disturbed per piling day during the installation of monopiles at Project Bravo is 2, this is equivalent to 1.58% of the reference population which is also taken to be equivalent to the Moray Firth SAC population.

16.278. The total number of bottlenose dolphins predicted to be disturbed during the concurrent installation of monopiles and pin pile jackets at Project Alpha is 3.8, this is equivalent to 1.93% of the reference population which is also taken to be equivalent to the Moray Firth SAC population.

16.279. This is lower than the predicted impact of Project Alpha alone, furthermore population modelling carried out for Project Alpha and Project Bravo combined presented in Chapter 10 (Marine Mammals), and summarised below, concludes that there would be no population level consequences as a result of the impacts of Project Alpha and Project Bravo combined. Therefore the construction of Project Bravo alone will not result in a significant long term change to the population. Therefore there is no likelihood of an adverse effect on the species as a qualifying feature as a result of the construction of Project Bravo alone. The construction of Project Bravo will have **no adverse effect on the conservation objectives** of the SAC.

Appropriate Assessment Matrix

16.280. Table 16.15 summarises the assessment undertaken and the determination, prior to mitigation, of whether or not there is an adverse effect on site integrity for each European site.

Table 16.15 Appropriate Assessment Matrix (Project Bravo alone): Disturbance from construction piling noise

Conservation Objective	Berwickshire and North Northumberland Coast SAC	Firth of Tay and Eden Estuary SAC	Isle of May SAC	Moray Firth SAC
To ensure for the qualifying species that the following are maintained in the long term:				
Population of the species as a viable component of the site	*No Adverse Effect on Site Integrity* Level of temporary disturbance during construction of Project Bravo is very low and will not affect animals present in any European site. Disturbance outside of any European site at other times of year will potentially only affect a low numbers of animals and will not have any population consequences.			*No Adverse Effect on Site Integrity* Level of disturbance from construction of Project Bravo will have no population consequences.
Distribution of the species within site	*No Adverse Effect on Site Integrity* Project Bravo is located outwith the European site. The potential effect of displacement will therefore not impact the distribution of the qualifying interests within site.			
Distribution and extent of habitats supporting the species	*No Adverse Effect on Site Integrity* Project Bravo is located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
Structure, function and supporting processes of habitats supporting the species	*No Adverse Effect on Site Integrity* Project Bravo is located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
No significant disturbance of the species	*No Adverse Effect on Site Integrity* Level of temporary disturbance during construction of Project Bravo is very low and will not affect animals present in any European site. Disturbance outside of any European site at other times of year will potentially only affect a low numbers of animals and will not have any population consequences.			*No Adverse Effect on Site Integrity* Level of disturbance from construction of Project Bravo will have no population consequences.
Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its qualifying interests	*No Adverse Effect on Site Integrity* Level of temporary disturbance during construction of Project Bravo is very low and will not affect animals present in any European site. Disturbance outside of any European site at other times of year will potentially only affect a low number of animals and will not have any population consequences.			
The extent and distribution of qualifying natural habitats and habitats of qualifying species	*No Adverse Effect on Site Integrity* Project Bravo is located outwith the European site and the impacts related to habitats were scoped out of this assessment.			
The structure and function (including typical species) of qualifying natural habitats	*No Adverse Effect on Site Integrity* Project Bravo is located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
The structure and function of the habitats of qualifying species	*No Adverse Effect on Site Integrity* Project Bravo is located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely	*No Adverse Effect on Site Integrity* Project Bravo is located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
The populations of qualifying interests	*No Adverse Effect on Site Integrity* Level of temporary disturbance during construction of Project Bravo is very low and will not affect animals present in any European site in the breeding season. Disturbance outside of any European site at other times of year will potentially only affect a low numbers of animals.			
The distribution of qualifying interests within the site	*No Adverse Effect on Site Integrity* Project Bravo is located outwith the European site. The potential effect of disturbance will therefore not impact the distribution of the qualifying interests within site.			

Project Alpha and Project Bravo Combined

16.281. Based on the worst case scenario modelled in Chapter 10, (Marine Mammals) the total period of disturbance will be 70 days of disturbance resulting from the installation of driven monopiles at Project Alpha, followed by a total period of 100 days of disturbance resulting from the installation of driven pin pile jackets at Project Bravo. This disturbance is expected to occur over a total period of two years.

Firth of Tay and Eden Estuary SAC – Harbour seals

16.282. The total number of harbour seals predicted to be disturbed during the installation of monopiles at Project Alpha is 0.28 (95% CI 0.07-0.49), this is equivalent to 0.05% of the reference population which is also taken to be equivalent to the Firth of Tay and Eden Estuary SAC population.

16.283. The total number of harbour seals predicted to be disturbed during the installation of pin piles at Project Bravo is 0.09 (95% CI 0.00-0.19). This is equivalent to 0.02% of the reference population.

16.284. This level of disturbance is extremely low and therefore there is no chance of an adverse effect on the species as a qualifying feature of the Firth of Tay and Eden Estuary SAC. Therefore there will be **no adverse effect on the conservation objectives of the site** as a result of the construction of Project Alpha alone, Project Bravo alone or the optimised Seagreen Project.

16.285. Given that the potential for impact will affect <1 seal, harbour seals are not considered any further in this assessment.

Isle of May SAC – Grey seals

16.286. The total number of grey seals predicted to be disturbed during the installation of monopiles at Project Alpha is 51 (95% CI 16- 86), this is equivalent to 0.47% of the reference population which is also taken to be equivalent to the SAC population.

16.287. The total number of grey seals predicted to be disturbed during the installation of pin piles at Project Bravo is 14 (95% CI 6-21). This is equivalent to 0.13% of the reference population.

16.288. In summary it is predicted that a total of 51 grey seals may be disturbed on each day of piling over 70 days during monopile installation at Project Alpha, followed by a total of 14 grey seals being disturbed over 100 days during pin pile installation at Project Bravo. The level of disturbance is not expected to affect the ability of individual grey seals to meet their energy needs, to survive and reproduce.

16.289. Even considering the worst case of the same individual being disturbed each time, leading to individual reduction in fitness, this level of impact would be very unlikely to have any impact on the overall population trajectory or size, given the current size and increasing trend of the East Coast management area populations. Given the mobility of grey seals and the likely turnover of individuals it is highly unlikely that the same individuals would be repeatedly disturbed. It is important to note that while present at the breeding site, grey seals will be on land and therefore the potential to be exposed to disturbance from underwater noise will be limited to periods during transit to and from the site, should animals be passing through the impact area (restricted to a range of approximately 8.5km from the pile driving location at maximum hammer energies) and not while present at the SAC. Therefore the potential for any significant effect on the conservation objectives for the site is negligible.

16.290. This level of disturbance is very low and will not affect animals present at the Isle of May SAC site during the breeding season because seals are out of the water while breeding (Hewer, 1960). Therefore the optimised Seagreen Project will have **no adverse effect on the conservation objectives** of the Isle of May SAC as a result of the construction of Project Alpha alone, Project Bravo alone or the optimised Seagreen Project. This site is therefore not considered further in this HRA.

Berwickshire and North Northumberland SAC – Grey seals

16.291. The total number of grey seals predicted to be disturbed per day of pile driving during the installation of monopiles at Project Alpha is 51 (95% CI 16-86), this is equivalent to 0.17% of the combined reference population which is also taken to be equivalent to the SAC population. Even adopting a more precautionary reference population equivalent to the North England Management Unit (19,851) would result in an impact to an equivalent of 0.26% of the reference population.

16.292. The total number of grey seals predicted to be disturbed per day of pile driving during the installation of pin piles at Project Bravo is 14 (95% CI 6-21). This is equivalent to 0.05% of the combined reference population and 0.07% of a more precautionary North England Management Unit.

16.293. In summary it is predicted that a total of 51 grey seals may be disturbed on each day of piling over 70 days during monopile installation at Project Alpha, followed by a total of 14 grey seals being disturbed on each day of pile driving over 100 days during pin pile installation at Project Bravo. The level of disturbance is not expected to affect the ability of individual grey seals to meet their energy needs, to survive and reproduce.

16.294. Even considering the worst case of the same individual being disturbed each time, leading to individual reduction in fitness, and a worst case failure to breed in the year of disturbance, this level of impact would be very unlikely to have any influence on the population trajectory, or size, given the current large size and increasing trend of the grey seal population on the east coast of the UK. In addition, given the mobility of grey seals and the likely turnover rate of individuals it is highly unlikely that the same individuals would be repeatedly disturbed.

16.295. The predicted level of disturbance is very low and will not affect animals present at the SAC during the breeding season. As a result it is considered that the disturbance from pile driving at the optimised Seagreen Project will not result in an adverse effect on the species as a qualifying feature. Therefore the optimised Seagreen Project will have **no adverse effect on the conservation objectives** of the SAC.

16.296. However, given that the numbers of individuals affected are not <1, and the fact that the site is not solely designated for the breeding season, this SAC has been included in the in combination assessment.

Moray Firth SAC – Bottlenose dolphins

16.297. The total number of bottlenose dolphins predicted to be disturbed per day of pile driving during the installation of monopiles at Project Alpha is 4.1, this is equivalent to 2.11% of the reference population which is also taken to be equivalent to the Moray Firth SAC population.

16.298. The total number of bottlenose dolphins predicted to be disturbed per day of pile driving during the installation of pin piles at Project Bravo is 2. This is equivalent to 1.01% of the reference population. In summary, it is predicted that a total of 4.1 bottlenose dolphins may

be disturbed on each day of pile driving over 70 days during monopile installation at Project Alpha, followed by a total of 2 bottlenose dolphins disturbed per day of pile driving over 100 days during pin pile installation at Project Bravo. As advised in the 2017 Scoping Opinion and agreed during consultation discussions, quantitative population modelling using the interim Population Consequences of Disturbance (iPCoD) framework was used to determine the population level effect of this magnitude of disturbance. This population modelling is described in detail in Chapter 10 (Marine Mammals) and is summarised here to inform the assessment of potential impacts on the bottlenose dolphin population, as a qualifying feature of the Moray Firth SAC.

16.299. Harwood and King (2017) present suggested demographic parameters for bottlenose dolphin population management units in the UK, including specific demographic parameters for the East Coast Scotland MU. The East Coast Scotland MU population size of 195 and growth rate of 1.018 was obtained from Cheney *et al.* (2013) and the other demographic rates were obtained from the results of capture-recapture analysis of the dolphin photo-ID study (Lusseau, 2013).

16.300. The median predicted population size for the baseline population after 24 years was 274 (95% CI 182- 394). The median predicted population size for the impacted population after 24 years was 272 (95% CI 182-398) which is 99.3% of the size of the baseline population. This means that after a simulated 24 years the size difference between the median baseline and impacted population was 2 animals, with a large overlap in confidence intervals. Therefore, there was no significant difference between the predicted baseline (un-impacted) and impacted population sizes as a result of the predicted levels of disturbance.

16.301. When the ratios of population size between the paired baseline and impacted simulations were examined, the median ratio over the 1000 paired simulations was 1. Similarly the ratio of median growth rate between the 1000 paired simulations was 1.

16.302. The centile of the impacted population that matched the 50th centile of the baseline population was 42 after 1 year, 45 after 6 years, and remained 47 after 12, 18 and 24 years.

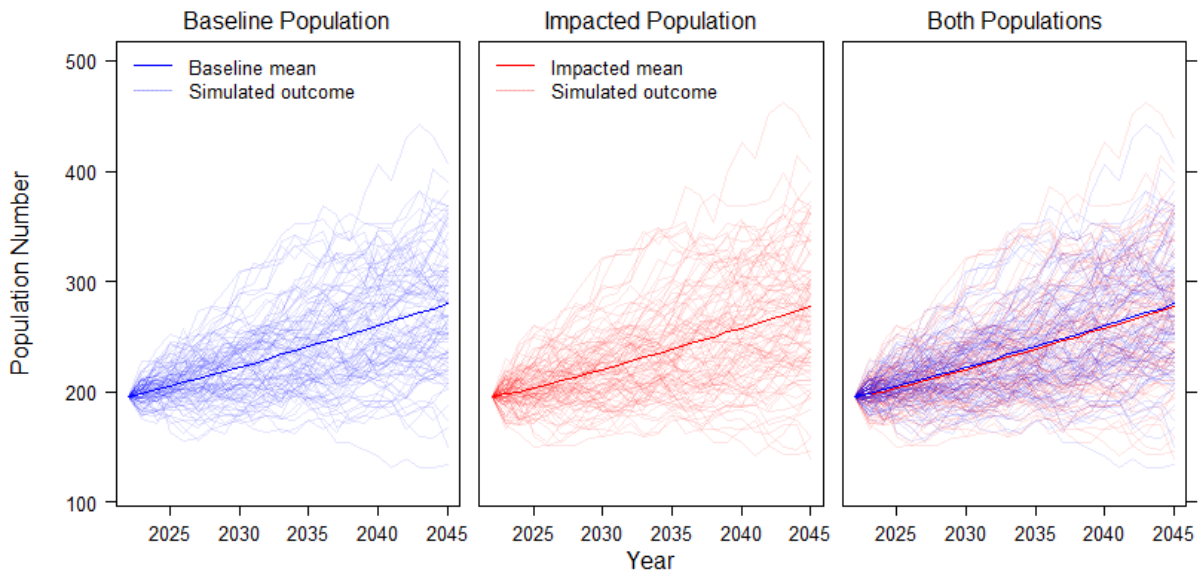
16.303. In probabilistic terms, as a result of the simulated impact, there was a 5.7% increase in the chance of a 1% annual decline after 1 year, a 3.5% increase in the chance of a 1% decline after 6 years, 0.7% after 12 years and 0.4% after 18 years.

16.304. In conclusion, the worst case bottlenose dolphin impact scenario did not result in a significant long term population effect. The population trajectory for both the baseline and the impacted populations (the mean and each individual 1,000 simulated outcomes) are presented in Plate 16.2. This demonstrates that the mean impacted population is predicted to experience an initial slight decline in growth rate relative to the baseline population, after which it then returns to the same growth rate as the baseline population and continues to increase at the same rate as the baseline population for the remainder of the simulations.

16.305. Therefore there is no likelihood of an adverse effect on the species as a qualifying feature. The construction of Project Alpha alone, Project Bravo alone or the optimised Seagreen Project will **have no adverse effect on the conservation objectives** of the Moray Firth SAC.

16.306. Because there is the potential for this level of impact to act in-combination with other plans and projects to result in an effect on the SAC, this SAC has been included in the in-combination assessment.

Plate 16.2 Simulated bottlenose dolphin population sizes for both the baseline and the impacted populations under the scenario of monopile installation at Project Alpha followed by pin pile installation at Project Bravo.



Appropriate Assessment Matrix

16.307. Table 16.16 summarises the assessment undertaken and the determination, prior to mitigation, of whether or not there is an adverse effect on site integrity for each European site.

Impact Prediction: In Combination

Construction noise impacts on marine mammals

16.308. Because the combined impact of Project Alpha and Project Bravo is considered to be the WCS for the optimised Seagreen Project, the in combination assessment focused on the worst case for the combined project. This is because if it is concluded the combined WCS did not have the potential for any adverse effects on site integrity then it can also be concluded that neither Project Alpha or Project Bravo would result in any adverse effects on site integrity when considered alone.

Project Alpha and Project Bravo Combined

16.309. Quantitative population modelling using the interim Population Consequences of Disturbance (iPCoD) framework was used to determine the population level effect of the optimised Seagreen Project for those SACs and qualifying features that were included in the in-combination assessment. These were grey seals (Berwickshire and North Northumberland Coast SAC) and bottlenose dolphins (Moray Firth SAC). Harbour seals and the Firth of Tay and Eden Estuary SAC were screened out because of the extremely low level of predicted disturbance from the optimised Seagreen project (<1 individual seal being disturbed per day of pile driving). The Isle of May SAC with grey seals as a qualifying feature was screened out based on the outcomes of the assessments for Project Alpha and Project Bravo alone.

Table 16.16 Appropriate Assessment Matrix (Project Alpha and Project Bravo combined): Disturbance from construction piling noise

Conservation Objective	Berwickshire & North Northumberland Coast SAC	Firth of Tay and Eden Estuary SAC	Isle of May SAC	Moray Firth SAC
To ensure for the qualifying species that the following are maintained in the long term:				
Population of the species as a viable component of the site	*No Adverse Effect on Site Integrity* Level of temporary disturbance during construction of Project Alpha and Project Bravo combined is very low and will not affect animals present in any European site. Disturbance outside of any European site at other times of year will potentially only affect a low numbers of animals and will not have any population consequences.			*No Adverse Effect on Site Integrity* Level of disturbance from construction of Project Alpha and Project Bravo combined will have no population consequences.
Distribution of the species within site	*No Adverse Effect on Site Integrity* Project Alpha and Project Bravo combined is located outwith the European site. The potential effect of displacement will therefore not impact the distribution of the qualifying interests within site.			
Distribution and extent of habitats supporting the species	*No Adverse Effect on Site Integrity* Project Alpha and Project Bravo combined is located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
Structure, function and supporting processes of habitats supporting the species	*No Adverse Effect on Site Integrity* Project Alpha and Project Bravo combined is located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
No significant disturbance of the species	*No Adverse Effect on Site Integrity* Level of temporary disturbance during construction of Project Alpha and Project Bravo combined is very low and will not affect animals present in any European site. Disturbance outside of any European site at other times of year will potentially only affect a low number of animals and will not have any population consequences.			*No Adverse Effect on Site Integrity* Level of disturbance from construction of Project Alpha and Project Bravo combined will have no population consequences.
Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its qualifying interests	*No Adverse Effect on Site Integrity* Level of temporary disturbance during construction of Project Alpha and Project Bravo combined is very low and will not affect animals present in any European site in the breeding season. Disturbance outside of any European site at other times of year will potentially only affect a low number of animals.			
The extent and distribution of qualifying natural habitats and habitats of qualifying species	*No Adverse Effect on Site Integrity* Project Alpha and Project Bravo combined is located outwith the European site and the impacts related to habitats were scoped out of this assessment.			
The structure and function (including typical species) of qualifying natural habitats	*No Adverse Effect on Site Integrity* Project Alpha and Project Bravo combined is located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
The structure and function of the habitats of qualifying species	*No Adverse Effect on Site Integrity* Project Alpha and Project Bravo combined is located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely	*No Adverse Effect on Site Integrity* Project Alpha and Project Bravo combined is located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
The populations of qualifying interests	*No Adverse Effect on Site Integrity* Level of temporary disturbance during construction of Project Alpha and Project Bravo combined is very low and will not affect animals present in any European site. Disturbance outside of any European site at other times of year will potentially only affect a low numbers of animals and will not have any population consequences.			
The distribution of qualifying interests within the site	*No Adverse Effect on Site Integrity* Project Alpha and Project Bravo combined is located outwith the European site. The potential effect of disturbance will therefore not impact the distribution of the qualifying interests within site.			

Grey Seals as a Qualifying Feature of the Berwickshire and North Northumberland Coast SAC in Combination Disturbance Assessment

16.310. Table 16.17 presents compiled information on the predicted effects from a range of projects included in the in combination assessment for grey seals as a qualifying feature of the Berwickshire and North Northumberland Coast SACs. For the other Forth and Tay projects which are currently undergoing assessment for revised project design envelopes (Inch Cape OWF and Neart na Gaoithe OWF), the worst case between the original and revised assessments was considered in the assessment. No other plans or projects within the East Coast Scotland and Northeast England Seal Management Area are expected to result in any significant disturbance to grey seals associated with the SAC.

16.311. Given uncertainties surrounding animal turnover and movements at this temporal and spatial scale, it is very challenging to predict a realistic overall level of disturbance. However, taking a precautionary approach, the total numbers summed across all projects (based on the maximum number of individuals from each project, and taking the maximum from either the consented or revised envelopes for the Forth and Tay offshore wind projects) is 2,209, which represents 20.3% of the total reference population (East Coast Scotland MU).

16.312. It should however, be highlighted that the use of the East Coast Scotland management area for grey seals is inappropriate as a reference population for the assessment of the Berwickshire and North Northumberland SAC given that a large portion of the SAC site sits within the Northeast England seal management area. Grey seals can range widely to forage and frequently travel over 100km between haul-out sites and telemetry data have shown grey seals foraging several hundred kilometres offshore and travelling regularly between distant haul out and breeding sites *(SCOS, 2017, Russell et al.*, 2013). The telemetry data presented in the baseline characterisation (Appendix 10A [Marine Mammals Technical Baseline Report]) has shown that there is considerable movement between the Forth and Tay area, the Farnes, The Lincolnshire and Norfolk coasts, Shetland and the Outer Hebrides. Acknowledging that the East Coast Scotland MU does not contain a discrete population and that connectivity is high with the adjacent Northeast England MU, it is more realistic to consider the two MUs as one population, particularly when considering impacts on the Berwickshire and North Northumberland Coast SAC, which straddles the line between the two management units.

16.313. The most recent August haul-out count for grey seals in the Northeast England MU is 6,948 (SCOS, 2017) which, scaled to account for the proportion of the population at sea at the time of the count, provides an estimated population size of 19,851 (CI: 18,284 to 21,713). When the East Scotland and Northeast England MU population estimates are summed the resulting population size is 30,743 grey seals. An impact of 2,209 grey seals therefore represents 7.2% of the combined East Scotland and Northeast England MUs.

16.314. In order to assess whether or not the in combination impacts of the optimised Seagreen Project, Inch Cape and Neart na Gaoithe had a population level effect, resulting in an adverse effect on the integrity of the SACs, population modelling was conducted for grey seals, using the scenarios from each project that resulted in the highest number of piling days (sequential rather than concurrent scenarios). Given that the population size numbers are based on 2016 counts, the modelling was conducted to start in 2017 and to run for 25 years.

Table 16.17 Grey seal in combination assessment – numbers predicted to be disturbed as a result of underwater noise from construction piling activities.

Project	Number of WTG	Number of Piles	Number of Piles/Day	Total Piling Days	Piling Period	Number of Seals Disturbed per Day	Years	Source
Inch Cape (consented)	213	852	2	426	Year round	526	2020 to 2021	Inch Cape (2013)
Neart na Gaoithe (consented)	125	500	2	250	Year round	113	2021 to 2022	NNG (2012)
Seagreen*	120	480	2	140	Year round (80% between Apr to Oct)	42 then 27	2022 to 2023	Chapter 8 (Marine Mammals)

*Constructed sequentially, Project Alpha then Project Bravo

16.315. Harwood and King (2017) present suggested demographic parameters for grey seals in UK waters, recommending that the same parameters are used for all MUs, given that telemetry data have shown that females can breed at colonies outside of the MUs in which they are found the rest of the year. Based on SCOS (2012) the growth rate was set to 1% per year and demographic rates were taken from annually monitored colonies as provided in SCOS (2012) and adjusted to achieve a 1% annual growth rate. This is a precautionary assumption for this assessment given the higher rates of increase reported for the east coast UK populations.

16.316. The median predicted population size for the baseline population after 24 years was 35,545 (95% CI 25,841 to 48,317). The median predicted population size for the impacted population after 24 years was 35,545 animals (95% CI: 25,834 to 48,315), which is 99.99% of the size of the baseline population. This means that after a simulated 24 years the size difference between the median baseline and impacted population was three animals, with a large overlap in confidence intervals. Therefore, there was no significant difference between the predicted baseline and impacted population sizes as a result of the predicted levels of disturbance.

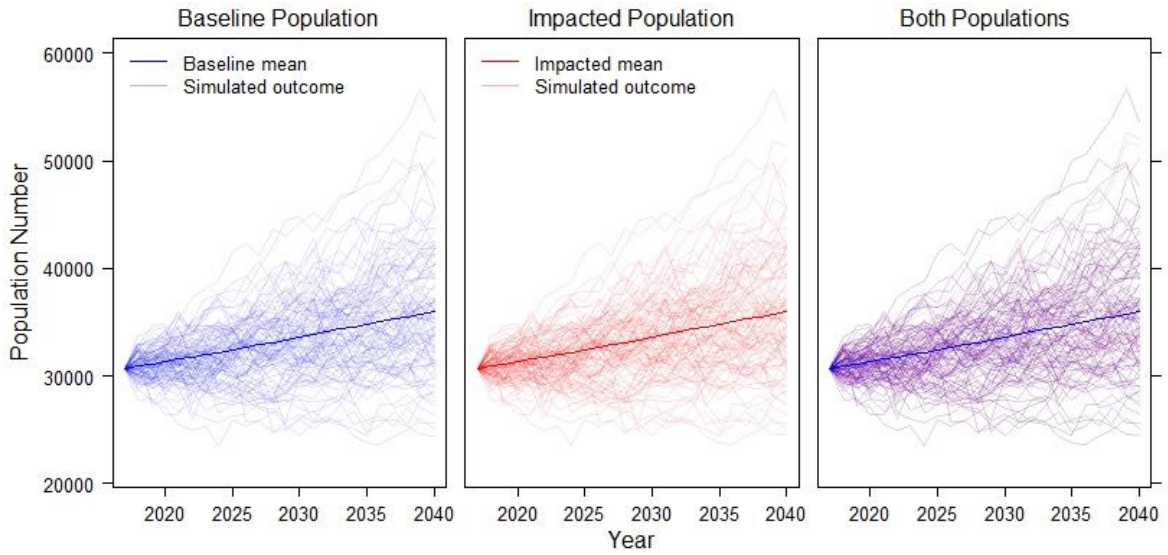
16.317. When the ratios of population size between the paired baseline and impacted simulations were examined, the median ratio over the 1000 paired simulations was 1.

16.318. Similarly the ratio of median growth rate between the 1000 paired simulations was 1.

16.319. The centile of the impacted population that matched the 50th centile of the baseline population was 50 in all years of the simulation.

16.320. In conclusion, the worst case grey seal in combination impact scenario did not result in a significant long term population effect. Plate 16.3 shows that the population trajectory for the impacted population does not differ from the baseline population under this in combination assessment scenario. Given that there are no population consequences predicted from the population modelling under the in combination scenario, there is **no likelihood of an adverse effect on site integrity or any effect on the conservation** objectives as a result of disturbance to grey seals for the Berwickshire and North Northumberland Coast SAC.

Plate 16.3 Simulated grey seal sizes for both the baseline and the impacted populations under the in combination scenario.



Bottlenose Dolphin as a Qualifying Feature of the Moray Firth SAC in combination Disturbance Assessment

16.321. The potential impact of disturbance from underwater noise from the construction of the optimised Seagreen Project in combination with other projects and plans was assessed quantitatively for bottlenose dolphin. Where available, the quantitative estimates for magnitude and duration of disturbance were included in the iPCoD modelling. This modelling exercise is described in detail in Chapter 10 and is summarised below.

16.322. The following projects were not included in the bottlenose dolphin iPCoD modelling and a justification is provided:

- Beatrice OWF: the disturbance impact ranges provided in the Environmental Statement did not overlap with grid cells that contained dolphins. Therefore, no bottlenose dolphins were predicted to have been disturbed during the piling at Beatrice;
- Port Of Ardersier: Port of Ardersier Ltd went into administration in 2015 and future construction plans for this site are currently unknown;
- Port of Cromarty Firth: The EIA Report for this project (Affric, 2018) did not quantify the number of animals predicted to be disturbed. The low hammer energies that will be used for cylindrical piling (500 kJ) and sheet piling (120 kJ) resulted in very small impact ranges (impact ranges of 145+ dB SELss were highly localised around the development and did not extend outside of the Cromarty Firth). In addition, there is a low likelihood of encountering bottlenose dolphins in the inner Cromarty Firth. Therefore it is not anticipated that this project will give rise to any significant levels of bottlenose dolphin disturbance;
- Kincardine Floating Offshore Windfarm: piling will not be used and SNH have previously advised that this wind farm will not give rise to any significant levels of bottlenose dolphin disturbance (pers. comm MS-LOT to Seagreen, 15/03/2018);
- Forthwind Wind Farm: piling will not be used and SNH have previously advised that this wind farm will not give rise to any significant levels of bottlenose dolphin disturbance (pers. comm MS-LOT to Seagreen, 15/03/2018); and

- Aberdeen Offshore Wind Farm: piling will not be used and SNH have previously advised that this wind farm will not give rise to any significant levels of bottlenose dolphin disturbance (pers. comm MS-LOT to Seagreen, 15/03/2018).

16.323. Two scenarios were compared in Chapter 10 (Marine Mammals); shortest overall duration and longest overall duration. The longest duration (single vessel piling on all projects) was demonstrated to be worst case therefore this HRA assessment is based on that scenario. The details for each project included under that scenario are outlined in Table 16.18.

Table 16.18 Modelled scenarios for the bottlenose dolphin in combination assessment.

Project	Number of WTG	Number of Piles	Number of Vessels	Number of Piles/Day/vessel	Total Piling Days	Piling Period	Number of Dolphins PTS per Day	Number of Dolphins Disturbed per Day	Years	Source
Single piling, longest duration										
Moray East	100	400	2	3	134	April to Oct	0	17	2019 to 2020	Moray East Piling Strategy
Inch Cape (consented)	213	852	1	2	426	Year round	0[1]	3	2020 to 2021	Inch Cape (2013)
Neart na Gaoithe (revised)	54	324	1	6	54	year round	0	2	1/7/21 to 30/9/22	Neart na Gaoithe (2018)
Seagreen (Project Alpha = A; Project Bravo = B)	120 (70 A, 50 B)	480	1	2	240	year round (80% between Apr to Oct)	0	3 A 2 B	2022 to 2023	This EIA Report
Moray West	85	85	1	3	133	Year round	0	10	2022 to 2023	Pre-application information
Aberdeen Harbour Expansion Project (AHEP)	NA	NA	NA	2 blasts	36	May to Nov	0	4	2018	AHEP & MS-LOT

16.324. The median predicted population size for the baseline population after 24 years was 272, and the median impacted population size (across 1,000 simulations) was 256. This means that by the end of the simulations, the size difference between the median baseline and impacted population was a total of 16 individuals and the median impacted population size was 94.1% of the median baseline population size.

[1] The original assessment presented by Inch Cape (2012) predicted that 1-2 dolphins may experience PTS as a result of exposure to pile driving noise. However, as a result in changes in methodology and the licence conditions attached to the consent, no PTS will actually occur. Therefore this in combination assessment assumes no PTS at Inch Cape. See Chapter 10 for more details.

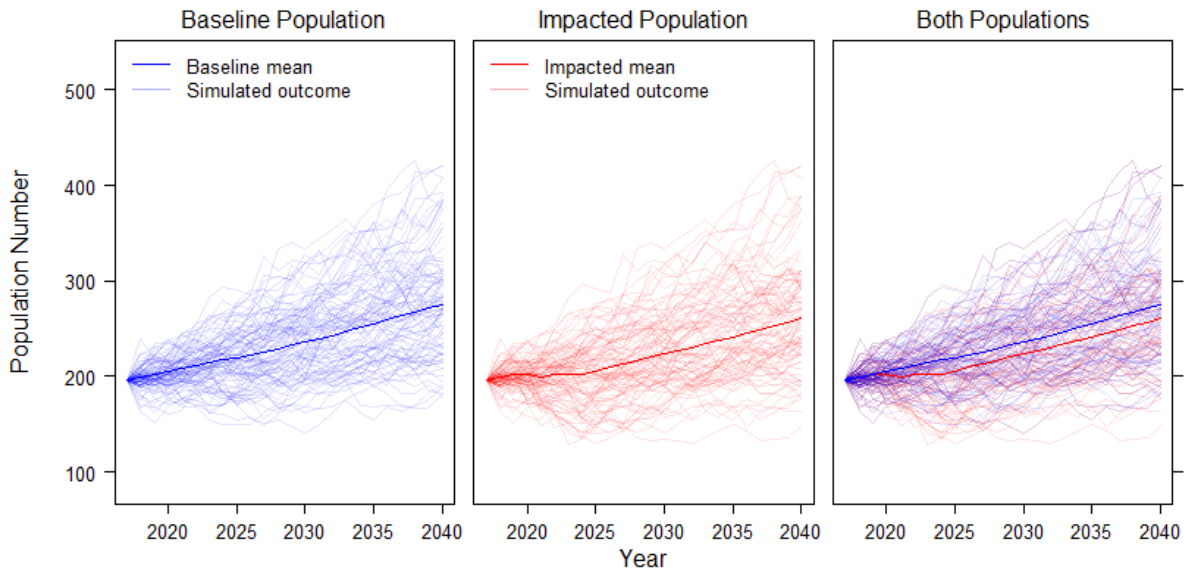
16.325. When the ratios of population size between the paired baseline and impacted simulations were examined, the median ratio over the 1000 paired simulations was 1 in year 1, 0.99 in years 6, 12 and 18, and 1 in year 24.

16.326. The ratio of median growth rate between the 1000 paired simulations was 1 in all years.

16.327. The centile of the impacted population that matched the 50th centile of the baseline population was 50 in year 1, 36 in year 6 and 12, 38 in year 18 and 39 in year 24.

16.328. The modelling predictions resulted in no significant long term population effect. No direct mortality as a result of the disturbance is predicted and the effects were generally related to a slowdown in population growth rate linked to a reduction in fecundity. The population trajectory for both the baseline and the impacted populations (the mean and each individual of the 1,000 simulated outcomes) are presented in Plate 16.4. This demonstrates that the mean impacted population is predicted to experience an initial decline in growth rate relative to the baseline population, after which it then returns to the same growth rate as the baseline population and continues to increase at the same rate as the baseline population for the remainder of the simulations.

Plate 16.4 Simulated bottlenose dolphin population sizes for both the baseline and the impacted populations under the longest piling duration in - combination scenario.



16.329. Therefore, there is no predicted long term effect on the East Coast Scotland bottlenose dolphin population as a result of the in combination disturbance from Moray East, Moray West, AHEP, Neart na Gaoithe, the optimised Seagreen Project (Project Alpha and Project Bravo) and Inch Cape. Due to the lack of any density dependent mechanism being included in the modelling, the mean impacted population is not predicted to increase above the baseline growth rate. Therefore, although the population growth rate is expected to recover once the period of disturbance is over, the population size may remain slightly lower than the equivalent baseline population.

In Combination Appropriate Assessment Matrix

16.330. Table 16.19 summarises the assessment undertaken and the determination, prior to mitigation, of whether or not there is an adverse effect on site integrity for each European site.

Table 16.19 Appropriate Assessment Matrix: In Combination disturbance from pile installation

Conservation Objective	Berwickshire and North Northumberland Coast SAC	Firth of Tay and Eden Estuary SAC	Isle of May SAC	Moray Firth SAC
To ensure for the qualifying species that the following are maintained in the long term:				
Population of the species as a viable component of the site	*No Adverse Effect on Site Integrity* Level of temporary disturbance during construction of Project Alpha and Project Bravo combined is very low and will not affect animals present in any European site. Disturbance outside of any European site at other times of year will potentially only affect a low number of animals and will not have any population consequences.			*No Adverse Effect on Site Integrity* Level of disturbance from construction of Project Alpha and Project Bravo will have no population consequences.
Distribution of the species within site	*No Adverse Effect on Site Integrity* Project Alpha and Project Bravo combined is located outwith the European site. The potential effect of displacement will therefore not impact the distribution of the qualifying interests within site.			
Distribution and extent of habitats supporting the species	*No Adverse Effect on Site Integrity* Project Alpha and Project Bravo combined is located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
Structure, function and supporting processes of habitats supporting the species	*No Adverse Effect on Site Integrity* Project Alpha and Project Bravo combined is located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
No significant disturbance of the species	*No Adverse Effect on Site Integrity* Level of temporary disturbance during construction of Project Alpha and Project Bravo combined is very low and will not affect animals present in any European site. Disturbance outside of any European site at other times of year will potentially only affect a low number of animals and will not have any population consequences.			*No Adverse Effect on Site Integrity* Level of disturbance from construction of Project Alpha and Project Bravo will have no population consequences.
Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its qualifying interests	*No Adverse Effect on Site Integrity* Level of temporary disturbance during construction of Project Alpha and Project Bravo combined is very low and will not affect animals present in any European site in the breeding season. Disturbance outside of any European site at other times of year will potentially only affect a low number of animals.			
The extent and distribution of qualifying natural habitats and habitats of qualifying species	*No Adverse Effect on Site Integrity* Project Alpha and Project Bravo combined is located outwith the European site and the impacts related to habitats were scoped out of this assessment.			
The structure and function (including typical species) of qualifying natural habitats	*No Adverse Effect on Site Integrity* Project Alpha and Project Bravo combined is located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
The structure and function of the habitats of qualifying species	*No Adverse Effect on Site Integrity* Project Alpha and Project Bravo combined is located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely	*No Adverse Effect on Site Integrity* Project Alpha and Project Bravo combined is located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
The populations of qualifying interests	*No Adverse Effect on Site Integrity* Level of temporary disturbance during construction of Project Alpha and Project Bravo combined is very low and will not affect animals present in any European site. Disturbance outside of any European site at other times of year will potentially only affect a low number of animals and will not have any population consequences.			
The distribution of qualifying interests within the site	*No Adverse Effect on Site Integrity* Project Alpha and Project Bravo combined is located outwith the European site. The potential effect of disturbance will therefore not impact the distribution of the qualifying interests within site.			

IMPACT PREDICTION: SPECIAL PROTECTION AREAS

Introduction

16.331. This section considers the potential effects on those Special Protection Areas (SPA) and their features that are screened into the HRA:

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

16.332. The 2017 Scoping Opinion advised that information is provided on the licensed Seagreen Transmission Asset project to inform the HRA with regards to in combination impacts and the Outer Firth of Forth and St Andrews Bay Complex pSPA.

16.333. This section of the HRA is structured as follows. First, the information sources on which the assessment relies are summarised, including reference to other chapters of the EIA Report and relevant technical appendices.

16.334. Information is then provided on how impacts have been predicted for displacement and collision, noting the high levels of precaution that are included in those predictions. The way in which those predicted impacts are then apportioned to the specific SPAs and features that are screened into this HRA.

16.335. This is followed by a section explaining how the implications of those apportioned impacts are assessed in relation to the populations of interest and the role that PVA plays in that assessment.

16.336. The following sections then consider each of the sites and features in turn for both Project Alpha and Project Bravo alone, for Project Alpha and Project Bravo combined and finally for the optimised Seagreen Project in combination with other relevant projects.

Information Sources

16.337. In order to ensure that adequate information is available to complete the appropriate assessment the checklist in Table 16.20 has been completed. Additional information is contained in the following chapters and appendices:

- Chapter 8 (Ornithology);
- Appendix 8A – Ornithology Technical Report (ECON Ltd) including rangefinder technical information;
- Appendix 8B – Collision Risk Modelling (ECON Ltd);
- Appendix 8C – Displacement of Seabirds (NIRAS);
- Appendix 8D – Population Viability Analysis (DMPStats); and
- Appendix 16B – Seabird Apportioning (NIRAS)

Impact Prediction

Introduction

16.338. The prediction of impacts considers displacement and collision mortality during the operational phase only, all other potential impacts are screened out of the HRA.

16.339. The potential impacts on the specific sites and features screened into HRA have been calculated using the impact predictions calculated in Chapter 8 (Ornithology) and the technical appendices to that chapter. The mortality attributable to each site has been calculated through a process referred to as 'apportioning'.

16.340. The approaches to impact assessment and their subsequent apportioning to specific SPA populations are described in more detail below, each of these processes includes a number of precautionary assumptions. These assumptions compound and lead to an assessment that this highly conservative, the results of this HRA should be interpreted in light of this inherent conservatism.

Displacement

16.341. Displacement refers to the phenomenon whereby seabirds are deterred, due to the physical presence of the offshore wind farm, from accessing sea areas that they would otherwise have utilised (Drewitt and Langston, 2006). This effect is difficult to observe in practice, due to the highly variable distribution of birds at sea, but is considered, for the purposes of HRA, to be an impact because it has the potential to exclude birds from within the wind farm area depriving them of foraging opportunities. If foraging resources were limited for a population, this deprivation could lead to a reduction in the survival rates of adults or their young.

16.342. The methodology for calculating displacement impacts is detailed in Appendix 8C (Displacement of Seabirds). In the absence of more sophisticated tools for understanding how restricting foraging opportunities might affect a population, the approach in this assessment follows recently published joint SNCB interim guidance (JNCC *et al.*, 2017), which assumes that a proportion of the birds present at a proposed offshore wind farm are displaced and that a proportion of those birds die. The resulting mortality is assumed to be the impact.

16.343. As discussed in paragraphs 16.93 to 16.130, there are several precautionary assumptions in this process. The 2017 Scoping Opinion instructs that a displacement rate of 60% should be used for guillemot, razorbill and puffin and 30% for kittiwake. This rate to be applied across the wind farm area plus a 2km buffer. A mortality rate from displacement of 2% for puffin and kittiwake and 1% for guillemot and razorbill should be assumed.

16.344. Chapter 8 presents a detailed analysis of the evidence about displacement rates for auks and kittiwake, including empirical data from monitoring studies of operational wind farms, which concludes that the application of relatively high displacement rates across such a large area is highly precautionary.

16.345. There is some empirical monitoring data which suggests that auks can be sensitive to displacement, but primarily within the wind farm area (e.g. Krijgsveld *et al.*, 2011; Nelson *et al.*, 2014; Vanermen *et al.*, 2016, 2017) and that the effect tends to be variable (e.g. Petersen *et al.*, 2006; Leopold *et al.*, 2011). A number of these studies found no significant effect on the number of birds present in buffer areas around wind farms (APEM, 2017; Vanermen *et al.*, 2017).

Table 16.20 Special Protection Area Information Checklist for The Appropriate Assessment

Information about the project	Location of information				
	Buchan Ness to Collieston Coast SPA	**Forth Islands SPA**	**Fowlsheugh SPA**	**St Abb's Head to Fast Castle SPA**	**Outer Firth of Forth and St Andrews Bay Complex pSPA**
Full characteristics of the project which may affect the site	Chapter 5 (Project Description) Table 16.11				
Size and other specifications of the project					
The characteristics of existing, proposed or other approved projects or plans which may cause interactive or in combination impacts with the project being assessed and which may affect the site	Chapter 8 (Impact Assessment: Cumulative)				
Planned or contemplated nature conservation initiatives likely to affect the status of the site in the future	Para. 16.214	Para. 16.220 to 16.221	Para. 16.225	Para. 16.230	Para. 16.237
The relationship (e.g. key distances etc.) between the project and the Natura 2000 site	Para. 16.211	Para. 16.216	Para. 16.222	Para. 16.227	Para. 16.233
The information requirements (e.g. scoping opinion of the authorisation body or agency	Para. 16.26 to 16.29 Table 16.2				
The reasons for the designation of the Natura 2000 site	Para. 16.212	Para. 16.217	Para. 16.223	Para. 16.228	Para. 16.232 to 16.234
The conservation objectives of the site and the factors that contribute to the conservation value of the site	Para. 16.215	Para. 16.219	Para. 16.226	Para. 16.231	Para. 16.239 to 16.240
The conservation status of the site (favourable or otherwise)	Para. 16.213	Para. 16.218	Para. 16.224	Para. 16.229	Para. 16.232 to 16.236
The existing baseline condition of the site				Para. 16.229	
The key attributes of any species on the site (e.g. population size)					

Information about the project	Location of information				
	Buchan Ness to Collieston Coast SPA	**Forth Islands SPA**	**Fowlsheugh SPA**	**St Abb's Head to Fast Castle SPA**	**Outer Firth of Forth and St Andrews Bay Complex pSPA**
The dynamics of the habitats, species and their ecology (e.g. population trends)	Appendix 8D (Population Viability Analysis)				
	Para. 16.213	Para. 16.218	Para. 16.224	Para. 16.229	Para. 16.232 to 16.236
Those aspects of the site that are sensitive to change	Chapter 8 (Ornithology) Appendix 8D (Population Viability Analysis)				
	Para. 16.213	Para. 16.218	Para. 16.224	Para. 16.229	Para. 16.232 to 16.236
The key structural and functional relationships that create and maintain the site's integrity	The optimised Seagreen project is located outwith the site and no impacts related to structure or function have been identified				
The seasonal influences on the key species on the site	Appendix 16B (Apportioning)				
Other conservation issues relevant to the site, including likely future natural changes taking place	None known	Para. 16.219	Para. 16.224	Para. 16.230	Para. 16.232 to 16.236

16.346. To demonstrate the conservatism in the assessment a displacement value of 50% has also been calculated for guillemot (based on the conclusions of Vanermen *et al.*, (2016; 2017) and Nelson *et al.*, (2014), in particular) and this presented, for information, in addition to the 60% rate advised in the 2017 Scoping Opinion. A similar value has also been used for puffin, which is rarely considered separately to other auk species in monitoring.

16.347. The studies reviewed also indicate that razorbill appears to have a lower vulnerability to displacement impacts than guillemot, especially when considering the results obtained at Thortonbank (Vanermen *et al.* 2017), Blighbank (Vanermen *et al.*, 2016) and Robin Rigg (Nelson *et al.* 2014). For this species a displacement rate of 40% has also been calculated and this presented, for information, in addition to the 60% rate advised in the 2017 Scoping Opinion.

16.348. For kittiwake, there is conflicting information and few attempts to quantify the extent of displacement. 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).

16.349. The 30% displacement rate advised in the 2017 Scoping Opinion is considered to be a precautionary assumption, particularly with the inclusion of a 2km buffer.

16.350. In addition to these empirical studies, Searle *et al.* (2014) modelled the population consequences of displacement from proposed offshore wind energy developments on kittiwake, guillemot, razorbill and puffin breeding at SPAs in proximity to proposed Forth and Tay offshore wind farm developments. Displacement considered both the effects on birds intending to forage in a wind farm and birds intending to forage beyond a wind farm.

16.351. Whilst there was a large degree of uncertainty related to the magnitude of the predicted effects and considerable variation in adult survival and breeding success, the greatest effects were predicted in relation to kittiwake (Forth Island SPA and Fowlsheugh SPA) and puffin (Forth Island SPA) (Searle *et al.*, 2014). However, the 2014 Appropriate Assessment (MS-LOT, 2014) concluded that there would be no adverse effect on the integrity of these SPAs.

16.352. The interpretation of the predicted displacement impact in this HRA takes into account changes in baseline conditions since the 2014 Appropriate Assessment (Marine Scotland, 2014).

Collision

16.353. Collision risk modelling (CRM) was undertaken to quantify the potential risk of additional mortality through collisions with operational turbines above the current baseline mortality for each species. The collision risk modelling undertaken in this case is detailed in Appendix 8B (Collision Risk Modelling).

16.354. As discussed in paragraphs 16.131 to 16.164, 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.), however, emerging empirical data now indicate some areas where CRM is particularly precautionary.

16.355. As discussed in Chapter 8, 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.

16.356. With respect to flight speeds, empirical data were obtained for two species (kittiwake and gannet) of relevance to this HRA. In both cases those data indicate that lower flight speeds should be used in CRM, compared to those that have been applied in this assessment (which are in line with the values recommend in the 2017 Scoping Opinion). The use of lower flight speeds would lead to predicted collision rates that are approximately 6% lower for gannet and approximately 19% lower for kittiwake (see Table 14, Appendix 8B [Collision Risk Modelling]), depending on the version of model used and turbine characteristics.

16.357. The data obtained on nocturnal activity is indicative of lower levels of flight activity than have been assumed in this assessment. The level of nocturnal activity observed were approximately 5% of those observed during daytime (all species combined), whereas for kittiwake and herring gull, a value of 25% has been used in accordance with the 2017 Scoping Opinion.

16.358. The most important potential areas of conservatism in CRM relates to the choice of avoidance rate. Skov *et al.* (2018) indicate rates of avoidance that are significantly higher than those assumed in this assessment. For gannet, the avoidance rate used in this assessment is 98.9% (as indicated in the 2017 Scoping Opinion), whereas there is evidence that this could be as high as 99.9%. The use of this revised rate would lead to a predicted collision rate that is less than 10% of the values used in this assessment. For kittiwake the relevant values are 98.9% and 99.8% respectively resulting in a predicted collision rate that is less than 20% of the values used in this assessment. For herring gull they are 99.5% (for modelling using Option 2 of the CRM) or 99% (for Option 3) compared to 99.9% resulting in a predicted collision rate that is between 10% to 20% less than the values used in this assessment.

16.359. The interpretation of the predicted collision mortality impact in this HRA also takes into account changes in recommended model options and parameters such as avoidance rates in order to more accurately account for bird movement and behaviour since the 2014 Appropriate Assessment (MS-LOT, 2014). Therefore this HRA presents an assessment using the updated baseline survey data with the contemporary methodological approach.

Apportioning

16.360. The displacement impact is apportioned to each of the qualifying interest populations using the methodology detailed in Appendix 16B (Seabird Apportioning) and involving the steps indicated in Table 16.21.

16.361. The apportioning method for a given location divides the breeding adults present amongst the colonies weighted by distance to each colony and the sea area surrounding each colony for which the location is within foraging range. There is however increasing evidence (see for example Wakefield *et al.*, 2013 and Wakefield *et al.*, 2017) that species forage in largely mutually exclusive areas and that these colony-specific home ranges are determined by density-dependent competition. Therefore the apportioning method weighted by the total sea area with the foraging range surrounding each colony is considered to be conservative.

16.362. In this case it should be noted that the apportioning methodology assumes that kittiwake are as likely to be present at the optimised Seagreen Project site as at any other sea area at a similar distance from those colonies. Two GPS tracking studies (FAME, Future of the Atlantic Marine Environment [2012] and CEH [2010 to 2011]), however, recorded few kittiwake from Fowlsheugh SPA interacting with the project site (Appendix 16B [Seabird Apportioning]). Furthermore, only a small number of kittiwake from the Forth Islands SPA were tracked through the project site (CEH [2012 to 2014]).

Table 16.21 Process for apportioning impacts

Approach	Gannet	Kittiwake	Herring gull	Guillemot	Razorbill	Puffin
DATA: Number of birds from the optimised Seagreen Project area boat-based survey data with densities of birds in flight corrected to 'box method' densities (see Methodology Data Analysis, Ornithology section of this chapter)						
STEP 1: Segregation of data into seasons						
Following SNH guidance on seasonality (SNH 2017d)						
Breeding Season	Mid-March to September	Mid-April to August	April to August	April to mid-August	April to mid-August	April to mid-August
Non-breeding (encompasses post-, non- and pre-breeding)	October to mid-March	September to mid-April	September to March	mid-August to March	mid-August to March	mid-August to March
DATA ANALYSIS: Collision risk modelling for gannet, kittiwake and herring gull only (see Appendix 8B Collision Risk Modelling).						
STEP 2: Apportioning breeding season effects from the Seagreen Offshore Wind Farm between relevant SPAs (see Appendix 16B Apportioning Impacts; Methods – Apportioning estimated effects from the breeding season						
Numbers of birds/collisions multiplied by the proportional weight of the SPA as calculated according to the method of SNH (2016).	Forth Islands SPA: 0.99	Forth Islands SPA: 0.06 Fowlsheugh SPA: 0.61 St. Abb's Head to Fast Castle SPA: 0.10	Buchan Ness to Collieston Coast SPA: 0.06 Forth Islands SPA: 0.29 Fowlsheugh SPA: 0.10 St. Abb's Head to Fast Castle SPA: 0.02	Buchan Ness to Collieston Coast SPA: 0.04 Forth Islands SPA: 0.18 Fowlsheugh SPA: 0.52 St. Abb's Head to Fast Castle SPA: 0.13	Forth Islands SPA: 0.17 Fowlsheugh SPA: 0.52 St. Abb's Head to Fast Castle SPA: 0.07	Forth Islands SPA: 0.75

Approach	Gannet	Kittiwake	Herring gull	Guillemot	Razorbill	Puffin
STEP 3: Apportioning non-breeding season effects from the Seagreen Offshore Wind Farm between relevant SPAs (Appendix 16B Apportioning Impacts; Methods – Calculation of apportioning values for non-breeding seasons)						
Numbers of birds/collisions multiplied by the estimated non-breeding season contribution of adult birds from the relevant SPA using the proportions from a PVA stable age structure (Furness 2015).	Forth Islands SPA: Post-breeding = 0.24 Pre-breeding = 0.31	Forth Islands SPA: Post-breeding = 0.00 Non-breeding = 0.01 Fowlsheugh SPA: Post-breeding = 0.01 Non-breeding = 0.02 St. Abb's Head to Fast Castle SPA: Post-breeding = 0.00 Non-breeding = 0.01				Not assessed in the non-breeding season
Number of collisions multiplied by the contribution of adult birds for an SPA as the proportion of the Forth and Tay non-breeding season population of adults only			Buchan Ness to Collieston Coast SPA: Non-breeding = 0.08 Forth Islands SPA: Non-breeding = 0.26 Fowlsheugh SPA: Non-breeding = 0.00 St. Abb's Head to Fast Castle SPA: Non-breeding = 0.07			

Approach	Gannet	Kittiwake	Herring gull	Guillemot	Razorbill	Puffin
The non-breeding season effects is assigned to relevant SPAs within, when breeding, a species' foraging range of the proposed development by multiplying the numbers of birds by the proportional weight of the SPA as calculated according to the method of SNH (2016).				Buchan Ness to Collieston Coast SPA: Post-breeding = 0.04 Forth Islands SPA: Post-breeding = 0.18 Fowlsheugh SPA: Post-breeding = 0.52 St. Abb's Head to Fast Castle SPA: Post-breeding = 0.13	Forth Islands SPA: Post-breeding = 0.17 Fowlsheugh SPA: Post-breeding = 0.52 St. Abb's Head to Fast Castle SPA: Post-breeding = 0.07	
STEP 4: Removal of the proportion of immature (non-adult) birds to which effects apportioned to during the breeding season (Appendix 16B Apportioning Impacts; Methods - Age Composition)						
Numbers of birds/collisions multiplied by the proportion of adults calculated using the optimised Seagreen Project area boat-based survey data collected in the breeding season (reference).	0.973	0.9146	0.286			

Approach	Gannet	Kittiwake	Herring gull	Guillemot	Razorbill	Puffin
Numbers of birds/collisions multiplied by the estimated breeding season contribution of adult birds using the proportions from a PVA stable age structure (Furness 2015).				0.575	0.571	0.49
STEP 5: Removal of the proportion of immature (non-adult) birds to which effects apportioned to during the non-breeding season (Appendix 16B Apportioning Impacts; Methods - Age Composition)						
No adjustment required as the removal of immatures (non-adults) is an integral part of STEP 4.	An integral part of STEP 4	An integral part of STEP 4				Not assessed in the non-breeding season
Numbers of collisions multiplied by the proportion of adults calculated using the optimised Seagreen Project area boat-based survey data collected in the non-breeding season.			0.50			

Approach	Gannet	Kittiwake	Herring gull	Guillemot	Razorbill	Puffin
Numbers of birds/collisions multiplied by the estimated breeding season contribution of adult birds using the proportions from a PVA stable age structure (Furness 2015).				0.575	0.571	
STEP 6: Removal of the proportion of adults to which effects apportioned to that skip breeding and take a sabbatical (Appendix 16B Apportioning Impacts; Methods – Sabbaticals)						
Breeding season only correction factor, used by multiplying bird numbers/densities (reference)	0.9	0.9	0.65	0.93	0.93	0.93

16.363. A further aspect of apportioning is to determine the proportion of the observed population that comprises adult birds. 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 to the different breeding colonies. Typically, however, surveys tend to over-estimate the proportion of adults present, particularly for species such as kittiwake where some immature age classes are indistinguishable from adult birds in the field.

Implications for qualifying populations

16.360. The implications for the qualifying populations of each SPA are examined in several ways. First, the scale of the predicted impact (mortality arising from displacement or collision) is compared to the population size and, in particular the existing adult baseline mortality within those populations. A widely used criterion in impact assessment is to consider whether predicted impacts exceed 1% of this baseline mortality rate. As an impact below this threshold is considered to be very small and of a scale that is indistinguishable from the inherent variability within the population it is considered to be a suitable first step in evaluating the likely effect of a given impact on a specific population.

16.361. The assessment, therefore, makes reference, initially, to the scale of predicted impacts in relation to background mortality (as calculated in Table 16.22).

16.362. In accordance with the 2017 Scoping Opinion the potential population consequences of additional adult mortality are also assessed for the qualifying interests (excluding herring gull) of the Forth Islands SPA and Fowlsheugh SPA using the PVA detailed in Appendix 8D (Population Viability Analysis) and specifically the following metrics:

- Growth rate, comprising:
  - Median predicted population growth rate with and without the predicted additional annual adult mortality; and
  - Counterfactual of population growth rate, i.e. the ratio between the un-impacted population growth rate and impacted population growth rate.
- Population size comprising:
  - Median end population size, i.e. the population size after 25 years of the predicted additional annual adult mortality;
  - Counterfactual of population size, i.e. the ratio between the un-impacted population size and impacted population size; together with supporting metrics including; and
  - Centile of un-impacted population that matches the 50th centile for impacted the population.

16.363. The 2017 Scoping Opinion specifically requires the presentation of the following PVA metrics (which are included in the above):

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

16.364. The metrics relating to growth rate indicate the change in the rate at which the population will grow (or decline), both in absolute terms and as a ratio of impacted to un-impacted predicted growth rates. In this case a ratio of 1 would indicate no change in growth rate. The model also compares the likely absolute population size, with and without additional mortality, and the ratio of impacted to un-impacted predicted population sizes. The final metric indicates the centile of the un-impacted population that matches the 50th centile for the impacted population. This metric is taken to indicate both the likely scale of the predicted change in the population after 25 years and also the likelihood that a change will occur. The greater the value the larger and more likely the change. It should be noted that if no change were predicted, the value for this metric would be 0.50, indicating an equal probability that the final, impacted population would be higher or lower than the un-impacted population.

16.365. There are several issues which should be considered when interpreting the outputs of PVA. The models do not simulate bird populations and their dynamics nor the influence of wider environmental factors (including climate change). They calculate the growth potential for a population based on assumptions, primarily, about survival rates and productivity rates within the breeding population. This is simply extrapolated, with some randomised environmental variability ('environmental stochasticity') introduced at each time step, to generate a population trajectory. If this trajectory is one of growth (modelled growth rate >1), then the population will continue to grow at the modelled growth rate indefinitely. Similarly if the population is declining (modelled growth rate <1) then the population will decline, eventually to extinction. In reality, other factors will become important as the population grows or declines and population numbers will not follow the simple trajectories used in this method. As some point the availability of nesting sites or competition for resources will impose a limit on growth. For declining populations, reduced competition or immigration can lead to greater stability. The model used in this assessment includes no compensatory density-dependence, nor does it make any assumption about the immigration or emigration of individuals to and from other colonies. The inability to add in real-world restrictions such as the limits on colony size imposed by the availability of viable nesting sites or food can result in population change trajectories calculating unrealistic final population figures. For example, it is not likely that the gannet colony on Bass Rock will continue to grow indefinitely due to the eventual lack of availability of nesting sites.

16.366. Given the timescales over which the model operates (25 years for this project), minor variations in the input figures can lead to final population figures which are considerably different from one another. As the model produces simple trajectories, the difference between the populations is compounded each year in an unrealistic manner and expert interpretation of these figures is required to draw meaningful conclusions from the model.

16.367. The important factors in the interpretation of PVA are primarily the relativities (differences) between the predicted growth rate with and without an impact (counterfactual of population growth rate) and the differences between the predicted end population size with and without an impact (counterfactual of end population size). There are, however, no agreed objective criteria for evaluating these metrics in this regard. Nor is there any agreed framework for linking these to an assessment of the effects on European sites and their interest features.

16.368. The PVA outputs, therefore, provide a suite of indicators of the probability for population-level consequences arising from the impacts scoped into this HRA which are evaluated using expert judgement. In accordance with the 2017 Scoping Opinion the key judgement is whether each feature screened into this HRA will remain a viable component of the SPA (or (p)SPA) for which it forms a feature in the long term.

16.369. For the purposes of this HRA, the population of a bird interest feature scoped into the HRA that is already in favourable condition is considered to remain a viable component of a SPA (or pSPA) if the PVA model outputs indicate that the impacted population will be maintained at or above the population at the time of designation.

16.370. For populations that have already declined, are declining, and/or are in unfavourable condition, the test is whether the PVA model indicates that the predicted impacts will prevent the population from being restored to favourable condition.

Assessment of Project Alpha alone

Predicted impacts

Displacement

16.371. The impact of displacement is assessed in respect of the following European sites and qualifying interests:

- Buchan Ness to Collieston Coast (guillemot);
- Forth Islands (kittiwake, guillemot, razorbill and puffin);
- Fowlsheugh (kittiwake, guillemot and razorbill); and
- St Abb's Head to Fast Castle (kittiwake, guillemot and razorbill).

16.372. The impact of displacement for kittiwake, guillemot and razorbill is highest in relation to the breeding season and for Fowlsheugh SPA. In accordance with the advice of the Scottish Ministers in the 2017 Scoping Opinion, puffin is assessed in relation to Forth Islands SPA only (Table 16.23).

16.373. Predicted mortality has been calculated for two baseline datasets, one with and the other without the July 2017 counts, which were unusually high and considered to be an outlier. Appendix 8A (Ornithology Technical Report) provides more detail on the exceptional foraging event that led to the observation of atypically high densities during one of the surveys. For the purpose of this assessment data are presented with and without this event, which is considered to be an outlier. In this case, the difference between these baseline scenarios is relatively small in real terms and below the respective 1% of baseline adult mortality for each of the qualifying interests regardless of the displacement and mortality rates used (Appendix 8C (Displacement of Seabirds)). Each scenario is assessed against a worst case of displacement and mortality. Taking into account evidence of displacement of auks obtained from monitoring, the impact arising if other, lower, rates of displacement are assumed is also provided for information.

16.374. The effect of the predicted displacement mortality above has been tested through PVA modelling and the results are summarised in Table 16.24 and discussed in the site assessments below.

Table 16.22 Baseline mortality estimates

Qualifying interest	Buchan Ness to Collieston Coast SPA	Forth Islands SPA	Fowlsheugh SPA	St Abb's Head to Fast Castle SPA
Baseline population (individuals) (a)				
Gannet	N/a	150,518	N/a	N/a
Guillemot	33,632	38,573	74,379	36,206
Razorbill	N/a	7,792	9,950	2,067
Puffin	N/a	90,010	N/a	N/a
Kittiwake	22,964	9,326	19,310	9,606
Herring Gull	6,230	13,160	250	650
Inverse of adult survival rate (=1 - survival rate [Horswill & Robinson, 2015]) (b)				
Gannet	0.081			
Guillemot	0.061			
Razorbill	0.105			
Puffin	0.094			
Kittiwake	0.146			
Herring Gull	0.166			
Baseline adult mortality (c= a × b)				
Gannet	N/a	12,192	N/a	N/a
Guillemot	2,052	2,353	4,537	2,209
Razorbill	N/a	818	1,045	217
Puffin	N/a	8,461	N/a	N/a
Kittiwake	3,353	1,362	2,819	1,402
Herring Gull	1,034	2,185	42	108
1% of baseline adult mortality (c × 0.01)				
Gannet	N/a	122	N/a	N/a
Guillemot	21	24	45	22
Razorbill	N/a	8	10	2
Puffin	N/a	85	N/a	N/a
Kittiwake	34	14	28	14
Herring Gull	10	22	0.4	1

N/a = not assessed in this HRA

Table 16.23 Predicted annual adult mortality from displacement in relation to Project Alpha alone

Qualifying interest/SPA	Predicted mortality (with outlier)*				Predicted mortality (without outlier)*				Difference
	PB	B	NB	Total	PB	B	NB	Total	
Kittiwake (30% displacement; 2% mortality)									
Forth Islands	-	2	-	**2**	-	1	-	**1**	**-1**
Fowlsheugh	-	22	-	**22**	-	9	-	**9**	**-13**
St Abb's Head to Fast Castle	-	4	-	**4**	-	2	-	**2**	**-2**
Guillemot (60% displacement; 1% mortality)									
Buchan Ness to Collieston Coast	-	2	1	**3**	-	1	1	**2**	**-1**
Forth Islands	-	8	3	**11**	-	5	3	**8**	**-3**
Fowlsheugh	-	23	8	**31**	-	15	8	**23**	**-8**
St Abb's Head to Fast Castle	-	6	2	**8**	-	4	2	**6**	**-2**
Guillemot (50% displacement; 1% mortality)									
Buchan Ness to Collieston Coast	-	2	1	**3**	-	1	1	**2**	**-1**
Forth Islands	-	7	2	**9**	-	4	2	**6**	**-2**
Fowlsheugh	-	19	7	**26**	-	13	7	**20**	**-6**
St Abb's Head to Fast Castle	-	5	2	**7**	-	3	2	**5**	**-2**
Razorbill (60% displacement; 1% mortality)									
Forth Islands	-	3	1	**4**	-	2	1	**3**	**-1**
Fowlsheugh	-	10	2	**12**	-	5	2	**7**	**-5**
St Abb's Head to Fast Castle	-	1	0	**1**	-	1	0	**1**	**0**
Razorbill (50% displacement; 1% mortality)									
Forth Islands	-	3	0	**3**	-	1	0	**1**	**-2**
Fowlsheugh	-	8	2	**10**	-	4	2	**6**	**-4**
St Abb's Head to Fast Castle	-	1	0	**1**	-	1	0	**1**	**0**
Razorbill (40% displacement; 1% mortality)									
Forth Islands	-	2	0	**2**	-	1	0	**1**	**-1**
Fowlsheugh	-	7	1	**8**	-	4	1	**5**	**-3**
St Abb's Head to Fast Castle	-	1	0	**1**	-	0	0	**0**	**-1**
Puffin (60% displacement; 1% mortality)									
Forth Islands	-	11	-	**11**	-	11	-	**11**	**0**
Puffin (50% displacement; 1% mortality)									
Forth Islands	-	9	-	**9**	-	9	-	**9**	**0**

PB = Pre-breeding; B = Breeding; NB = Non-breeding (guillemot, razorbill, puffin)/Post-breeding (kittiwake)

* All values, including totals are round to nearest whole number

NB. Values underlined are used in the in combination assessment

Table 16.24 PVA metrics for annual adult mortality from displacement in relation to Project Alpha alone

Metric	Kittiwake (Forth Islands)	Kittiwake (Fowlsheugh)	Guillemot (Forth Islands)	Guillemot (Fowlsheugh)	Razorbill (Forth Islands)	Razorbill (Fowlsheugh)	Puffin (Forth Islands)
1% of adult baseline mortality	14	28	24	45	8	10	85
Additional annual adult mortality[A]	1 to 2	9 to 22	8 to 11	23 to 31	3 to 4	7 to 12	11
Counterfactual population size[B]	1 to 0.99	0.99 to 0.97	0.99	0.99	0.99	0.99 to 0.98	1.00
Median pop$^{n.}$ growth rate[B]	1.03	1.03	1.03	1.03	1.00	1.00	1.03
Counterfactual median growth rate[B]	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Centile of un-impacted pop$^{n.}$ = 50th centile for impacted pop$^{n.}$[B]	0.50 to 0.51	0.52 to 0.55	0.52 to 0.53	0.54 to 0.55	0.51 to 0.52	0.52 to 0.53	0.50
Median end population size[B]	10,610 to 10,577p	22,122 to 21,654p	86,409 to 86,221i	165,811 to 165,375i	7,252 to 7,199i	9,090 to 8,959i	89,238 to 89,210p
Current population size[C]	4,663p	9,655p	38,573i	74,379i	7,792i	9,950i	45,005p
Designated population size[C]	8,400p	36,650p	21,440i	56,450i	2,800i	5,800i	14,000p

[A] Table 16.23;

[B] Methodology underpinning these outputs is described in Appendix 8D (Population Viability Analysis);

[C] Scottish Natural Heritage, 2017c; p = pairs; i = individuals

Collision Mortality

16.375. The impact of collision (Table 16.25) is assessed in respect of the following European sites and qualifying interests:

- Buchan Ness to Collieston Coast (herring gull);
- Forth Islands (gannet, kittiwake, and herring gull);
- Fowlsheugh (kittiwake and herring gull); and
- St Abb's Head to Fast Castle (kittiwake and herring gull).

16.376. As discussed in Chapter 8, 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. This research demonstrates the precaution built into the CRM used in this HRA which follows the 2017 Scoping opinion and does not, therefore, take into account this new empirical data.

Table 16.25 Predicted annual adult mortality from collision in relation to Project Alpha alone

Qualifying interest/SPA	Adult collision mortality			
	PB	B	NB	Total^
Gannet	**(Option 1, 98.9% AR)**			
Forth Islands	2	70	1	**73**
Kittiwake	**(Option 2, 98.9% AR)**			
Forth Islands	0	6	0	**6**
Fowlsheugh	1	58	1	**60**
St Abb's Head to Fast Castle	0	10	0	**11**
Herring Gull	**(Option 3, 99.0% AR)**			
Buchan Ness to Collieston Coast	0.0	0.0	0.1	**0.1**
Forth Islands	0.0	0.1	0.1	**0.2**
Fowlsheugh	0.0	0.0	0.0	**0.0**
St Abb's Head to Fast Castle	0.0	0.4	0.0	**0.4**

* MS-LOT, 2014

PB = Pre-breeding; B = Breeding; NB = Non-breeding (herring gull)/Post-breeding (gannet and kittiwake);

^ Except in the case of herring gull, all values, including totals are round to nearest whole number

NB. Values underlined are used in the in combination assessment

16.377. The effect of the predicted collision mortality above has been tested through PVA modelling and the results are summarised in Table 16.26 and discussed in the site assessments below.

Table 16.26 PVA metrics for annual adult mortality from collision in relation to Project Alpha alone

Metric	Gannet (Forth Islands)	Kittiwake (Forth Islands)	Kittiwake (Fowlsheugh)
1% baseline adult mortality	122	14	22
Additional annual adult mortality[A]	73	6	60
Counterfactual population size[B]	0.99	0.98	0.91
Median pop$^{n.}$ growth rate[B]	1.01	1.03	1.03
Counterfactual median pop$^{n.}$ growth rate[B]	1.00	1.00	1.00
Centile of un-impacted pop$^{n.}$ = 50th centile for impacted pop$^{n.B}$	0.54	0.53	0.61
Median end population size[B]	87,384p	10,443p	20,463p
Current population size[C]	75,259p	4,663p	9,655p
Designated population size[D]	21,600p	8,400p	36,650p

[A] Table 16.25;

[B] Methodology underpinning these outputs is described in Appendix 8D (Population Viability Analysis);

[C] Scottish Natural Heritage, 2017c; p = pairs; i = individuals

Site assessments

Buchan Ness to Collieston Coast SPA

16.378. The assessment has been conducted with respect to the following features screened into the HRA:

- Kittiwake (collision and displacement);
- Herring gull (collision); and
- Guillemot (displacement)

16.379. Although **kittiwake** was screened into HRA, no impacts are predicted on this population from Project Alpha. The colony lies at the limits of foraging distance (using the mean maximum foraging range indicated in Thaxter *et al.* (2012) + 1 standard deviation) which is considered to be a highly precautionary method for establishing connectivity.

16.380. Consequently, it is considered that there will be no effect on population size and it is concluded that kittiwake will remain a viable component of the site.

16.381. The additional annual adult collision mortality for **herring gull** is effectively zero and therefore well below 1% of the baseline adult mortality (0.1 cf. 10 individuals).

16.382. Consequently, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that herring gull will remain a viable component of the site.

16.383. The predicted additional annual adult mortality for **guillemot** arising from displacement is below 1% of the baseline adult mortality (2-3 cf. 21 individuals) for the current population of 33,632 individuals.

16.384. This level of mortality represents a very small proportion of the population that is not indicative of an adverse effect. Furthermore, the impact assessment methodology is considered to be highly precautionary and there is also uncertainty that an impact will occur for these species (see Searle *et al.*, 2014; APEM, 2017; Vanermen *et al.*, 2017). Consequently, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that guillemot will remain a viable component of the site.

16.385. With respect to the predicted impacts associated with Project Alpha, **an adverse effect on site integrity can be excluded because all the qualifying interests will remain viable components of the site.**

Forth Islands SPA

16.386. The assessment has been conducted with respect to the following features screened into the HRA:

- Gannet (collision);
- Kittiwake (collision and displacement);
- Herring gull (collision);
- Guillemot (displacement);
- Razorbill (displacement); and
- Puffin (displacement).

16.387. The predicted collision mortality for **gannet** is 73 individuals per annum. It should be noted, however, that this prediction is considered to be precautionary because it is based on CRM assumptions that do not take account of recent empirical data relating to flight speed and avoidance rates, all of which, if factored into CRM individually or collectively, would significantly reduce the predicted magnitude of this impact.

16.388. The rate of additional annual adult collision mortality is below 1% of the baseline adult mortality (73 cf. 122 individuals). This impact is, therefore, relatively low in comparison to the size of the gannet population which now (75,259 pairs) far exceeds that for which it was designated (21,600 pairs). Recent monitoring data also indicate that the gannet population continues to grow rapidly (Table 16.27).

Table 16.27 Recent monitoring counts of gannet and kittiwake at Forth Islands. Source: JNCC (2018)

Year	Gannet	Kittiwake
Units	Apparently Occupied Sites	Apparently Occupied Nests
1994	34,397	-
1995	-	-
1996	-	9,377
1997	-	10,693
1998	-	-
1999	-	6,354
2000	-	6,632
2001	-	5,109
2002	-	5,277
2003	-	5,092
2004	48,065	5,380
2005	-	5,196
2006	-	4,593
2007	-	4,649
2008	-	4,522
2009	60,853	3,654
2010	-	4,827
2011	-	3,884
2012	-	3,766
2013	-	2,450
2014	75,259	3,339
2015	-	4,785

16.389. Further work has also been undertaken to understand the consequences of this level of impact on the Forth Islands SPA gannet 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 (Table 16.26) 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 (1.01) 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 87,384 pairs. This is very similar to the predicted population in the absence of any impact as indicated by the high ratio of the counterfactual of population size (0.99) and the similarity of the centile of un-impacted population that is equivalent to the 50th centile for the impacted population (0.54).

16.390. 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. 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.

16.391. The additional annual adult mortality of **kittiwake** has been calculated separately for collision and displacement. In both cases the predicted mortality is below 1% of the baseline adult mortality for kittiwake (collision: 6 cf. 14 individuals; displacement: 1–2 cf. 14 individuals).

16.392. Further work has been undertaken to understand the consequences of the higher of these predicted impacts (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 (Table 16.26) 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 10,443 pairs. This is very similar to the predicted population in the absence of any impact as indicated by the high ratio of the counterfactual of population size (0.98) and the similarity of the centile of un-impacted population that is equivalent to the 50th centile for the impacted population (0.53).

16.393. It should be noted that the magnitude of the collision mortality impact is likely to be overestimated for a number of reasons:

- The collision risk modelling for the optimised Seagreen project makes a number of conservative assumptions including that kittiwake foraging activity at night is equivalent to 25% of the daytime activity levels and flight speed is 13.1 m/s. Recent studies at Thanet (Skov *et al.* 2018) found kittiwake nocturnal activity to be less than 5% of daytime activity and measured average flight speeds of 8.71 m/s. The same study

also calculated empirical avoidance rates of 99.8% for kittiwake, higher than the 99.2% avoidance rate estimated in Cook *et al.* (In press), and the 98.9% applied in this assessment. Whilst, avoidance behaviour may differ for breeding birds tied to their colonies for chick provisioning compared to those at Thanet, which were, in the main, non-breeding birds, it seems likely that current guidance on avoidance rates is precautionary; and

- The rotor speed used to derive the collision numbers is based on values for the worst case 167 m rotor diameter turbine. Should larger turbines be deployed – up to 220m rotor – rotor speed would reduce.

16.394. Estimates of precaution are quantified in Appendix 8B Collision Risk Modelling Table 14. They show that changing flight speed from 13.1 m/s to 8.71 m/s would reduce kittiwake collision estimates by ~19%. Changing rotor parameters from 167m to 220m would reduce them by 9%. These effects were modelled separately, but if modelled together would reduce effects still further.

16.395. 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 impact of Project Alpha 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. Recent monitoring data from the colony (Table 16.27) also indicate that the population is stable or growing. In 2014 the Isle of May colony within the Forth Islands SPA recorded a high productivity rate of 1.17 chicks per pair (Scottish Natural Heritage, 2014).

16.396. As highlighted in the Scoping Opinions for all Forth and Tay Projects (Marine Scotland, 2017), for kittiwake, collision 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. Combining the predicted cumulative collision and displacement mortality results in a combined adult mortality of seven to eight individuals per year, which in terms of the PVA, is not materially higher than that predicted for collision alone.

16.397. 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.

16.398. The additional annual adult collision mortality for **herring gull** is effectively zero and therefore well below 1% of the baseline adult mortality (0.2 cf. 22 individuals).

16.399. Consequently, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that herring gull will remain a viable component of the site.

16.400. For **auk** species, the predicted additional annual adult mortality arising from displacement is relatively low and, in each case, below 1% of the baseline adult mortality: guillemot (8–11 cf. 24 individuals), razorbill (3–4 cf. 8 individuals) and puffin (11 cf. 85 individuals). These impacts are also relatively low in comparison to the size of the auk populations which now comprise guillemot 38,573 individuals compared to 21,440 individuals at designation; razorbill 7,792 individuals compared to 2,800 individuals at designation; puffin 45,005 pairs compared to 14,000 pairs at designation). Recent monitoring data also indicate that these auk populations are stable or continuing to grow (Table 16.28).

Table 16.28 Recent monitoring counts for auks at Forth Islands. Source: JNCC (2018)

Year	Guillemot	Razorbill	Puffin
Units	**Breeding adults***	**Breeding adults***	**Apparently Occupied Burrows**
1996	44,861	2,788	-
1997	48,697	2,877	-
1998	-	-	-
1999	40,146	5,379	42,012
2000	49,123	5,437	-
2001	50,645	-	-
2002	41,712	5,343	
2003	46,328	6,264	82,866
2004	39,289	6,429	-
2005	37,866	5,185	-
2006	37,854	5,065	-
2007	28,171	5,509	-
2008	31,620	6,450	-
2009	32,116	6,165	50,271
2010	31,483	5,881	-
2011	30,516	5,456	-
2012	-	4,799	-
2013	26,200	5,062	51,955
2014	33,505	4,950	-
2015	42,361	5,227	-

* Calculated: Breeding Adults = ((AOS/0.67)+Individuals)*1.34 where AOS = Apparently Occupied Sites

16.401. Further work has also been undertaken to understand the consequences of this level of impact on the Forth Islands SPA auk populations 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 (Table 16.26) indicate that:

- For guillemot and puffin the impacted populations will continue to grow at very similar rates to those that are predicted by the PVA for the un-impacted population. The predicted median population growth rate for both species (1.03) for the impacted population is essentially indistinguishable from that of the un-impacted population (counterfactual of the median population growth rate ≈ 1 in both cases);
- The similarity of the predicted growth rates for guillemot and puffin leads to similar population outcomes. The model predicts a median end population size (in the impacted scenario) of 86,409 to 86,221 individuals for guillemot and 89,238 to 89,210 pairs for puffin. These are very similar to the predicted populations in the absence of any impact as indicated by the high ratio of the counterfactual of population size (0.99 for guillemot and 1.00 for puffin) and the similarity of the centile of un-impacted population that is equivalent to the 50th centile for the impacted population (0.52 to 0.53 for guillemot and 0.50 for puffin);

- For razorbill, the PVA model indicates a slightly declining population over the model period with or without the impacted populations. The predicted median population growth rate is 1.00 (although as the end population slightly declines over 25 years, this value is probably very slightly less than 1) when the effects of displacement are included which is essentially indistinguishable from that of the un-impacted population (counterfactual of the median population growth rate ≈ 1); and
- As the growth rate is less than 1 the predicted median end population 7,252 to 7,199 individuals is slightly less than the current population (7,729 individuals) but similar to that predicted in the absence of any impact (counterfactual of population size = 0.99 and the centile of un-impacted population that is equivalent to the 50th centile for the impacted population = 0.51 to 0.52). This difference should be considered to be negligibly small given that the model is predicting changes over a 25 year period.

16.402. The current guillemot, razorbill and puffin populations far exceed the populations for which the SPA was designated. At the levels of displacement mortality predicted for Project Alpha, PVA modelling indicates that the populations of guillemot and razorbill are likely to continue to grow and that razorbill will decline slightly (with or without the additional mortality). At this level of impact it is considered that there is a negligible risk that the populations of guillemot, razorbill or puffin would decline to a level at which they would no longer be considered to be viable components of the SPA. In practice both the impacts and population responses are expected to be of lower magnitude than considered here due to the precaution in the quantification of displacement impacts and the simplistic nature of the PVA model which does not include any assumptions about density dependent compensatory mechanisms within the modelled populations.

16.403. With respect to the predicted impacts associated with Project Alpha, **an adverse effect on site integrity can be excluded because all the qualifying interests will remain viable components of the site**.

Fowlsheugh SPA

16.404. The assessment has been conducted with respect to the following features screened into the HRA:

- Kittiwake (collision and displacement);
- Herring gull (collision);
- Guillemot (displacement); and
- Razorbill (displacement).

16.405. For **kittiwake**, predicted collision mortality is above 1% of the baseline adult mortality (60 cf. 28 individuals), whereas, for displacement, predicted additional annual adult mortality (9 to 22 individuals) is below that threshold.

16.406. It should be noted that the magnitude of the collision mortality impact is likely to be overestimated for a number of reasons:

- The collision risk modelling for the optimised Seagreen project makes a number of conservative assumptions including that kittiwake foraging activity at night is equivalent to 25% of the daytime activity levels and flight speed is 13.1 m/s. Recent studies at Thanet (Skov *et al.* 2018) found kittiwake nocturnal activity to be less than 5% of daytime activity

and measured average flight speeds of 8.71 m/s. The same study also calculated empirical avoidance rates of 99.8% for kittiwake, higher than the 99.2% avoidance rate estimated in Cook et al (In press), and the 98.9% applied in this assessment. Whilst, avoidance behaviour may differ for breeding birds tied to their colonies for chick provisioning compared to those at Thanet, which were, in the main, non-breeding birds, it seems likely that current guidance on avoidance rates is precautionary.

- The rotor speed used to derive the collision numbers is based on values for the worst case 167 m rotor diameter turbine. Should larger turbines be deployed – up to 220m rotor – rotor speed would reduce.
- Estimates of precaution are quantified in Appendix 8B Collision Risk Modelling Table 14. They show that changing flight speed from 13.1 m/s to 8.71 m/s would reduce kittiwake collision estimates by ~19%. Changing rotor parameters from 167 m to 220m would reduce them by 9%. These effects were modelled separately, but if modelled together would reduce effects still further.

16.407. The assumed connectivity with Fowlsheugh SPA, and associated apportioning, of impacts to that site is also highly conservative:

- The optimised Seagreen project lies within the mean-max foraging range (Thaxter *et al.* 2012) of kittiwake breeding at that colony. However, the results of GPS tracking studies (FAME, Future of the Atlantic Marine Environment [2012]) indicated that very few kittiwakes tracked from Fowlsheugh interacted with the project site. The peer-reviewed paper (Wakefield *et al.* 2017) based on these data suggested that the optimised Seagreen project was in an area where at-sea utilisation by breeding kittiwake was only between 5 and 10%. Similarly, the tracking of 54 birds from Fowlsheugh by CEH indicated that the Seagreen sites were not part of the core foraging area for this colony (Daunt, 2011a; 2011b). The apportioning model currently under development by CEH is understood to be based, at least in part, on tracking data. Current apportioning methods which do not take such data into account may therefore be another source of precaution;
- The apportioning conducted for this assessment has led to an apparent increase in the effect on kittiwake at Fowlsheugh from 51% (used to assign collision effects in the previous Scottish Ministers HRA [2014] [SNH Unpublished data, Seagreen ES 2014]) to 61% (Appendix 16B [Seabird Apportioning]). Without access to the details of the 2014 methodology used by Marine Scotland in the 2014 Appropriate Assessment, this difference appears to be related primarily to the definition of the Fowlsheugh population used. In this assessment, all of the relevant count sectors for the SPA have been included which increases the relative weight of Fowlsheugh in the apportioning exercise; and
- The assessment assumes that 94.2% of birds are adult breeding birds based on the proportion of first year birds recorded during boat-based surveys and the likely age structure of the population. Although 10% are assumed to be sabbatical i.e. non-breeding in that year, numbers are likely to remain precautionary because the proportion of first year birds present in natal waters is likely to be lower than that of older immature birds which are indistinguishable from adults, and such immature birds may be concentrated in certain foraging areas (Appendix 16B Apportioning Assessment Ornithology).

16.408. Consequently it is considered that there is considerable precaution both in relation to the estimation of collision mortality for kittiwake and in the apportioning of that impact to Fowlsheugh SPA.

16.409. In accordance with the advice of the Scottish Ministers in the 2017 Scoping Opinion, PVA (Appendix 8D [Population Viability Analysis]) was used to the establish whether or not the population of kittiwake can be maintained as a viable component of Fowlsheugh SPA in the long term. The 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, 2011b), the current Fowlsheugh SPA population of 9,655 pairs being lower than the population of 36,650 pairs cited at the time of the marine extension designation in 2009 (Scottish Natural Heritage, 2009c). More recent counts indicate a more stable population, albeit at a reduced level from that which was designated (Table 16.29).

Table 16.29 Recent monitoring counts for kittiwake at Fowlsheugh. Source: JNCC (2018)

Count date	Count	Units
31 May 1986 to 8 June 1986	22051	Occupied nests
1991	23522	Occupied nests
1992	34872	Occupied nests
1999	18800	Occupied nests
17 June 2006	11140	Occupied nests
2009	9454	Occupied nests
1 January 2012 to 28 November 2012	9337	Occupied nests
3 June 2015 to 8 June 2015*	9655	Occupied nests

**In 2015 "average productivity was 1.38 chicks per nest, which is the best we've had here since we started collecting data on productivity in 1993" (https://ww2.rspb.org.uk/community/placestovisit/fowlsheugh/b/fowlsheugh-blog/default.aspx)*

16.410. The outputs of the PVA modelling, using the metrics advised by Marine Scotland, over the 25 year operational life time of the Project Alpha (Table 16.26) predict that the un-impacted population will grow slowly and this is not considered to be inconsistent with the recent monitoring data for Fowlsheugh (Table 16.29).

16.411. The effect of including the predicted additional annual mortality on the population has been tested using a PVA model and it indicates:

- 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 22,122–21,654 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 (0.91) and the centile of un-impacted population that is equivalent to the 50th centile for the impacted population (0.61).

16.412. Whilst the PVA model indicates that the kittiwake population would continue to grow, there would be a lower kittiwake population at Fowlsheugh SPA after Project Alpha has operated for 25 years than there would be in the absence of the wind farm (counterfactual of the end population size is 0.91), 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; and
- Over-estimation of the population response to the apportioned impact due to the simplistic nature of the PVA model used.

16.413. As highlighted in the Scoping Opinions for all Forth and Tay Projects (Marine Scotland, 2017), for kittiwake, collision 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. Combining the predicted cumulative collision and displacement mortality results in a combined adult mortality of 69 to 82 individuals per year, which PVA modelling indicates, in any case, is unlikely to lead to a significantly different outcome for the population than that predicted for collision alone.

16.414. In light of this precaution it is considered unlikely that the population would be reduced below that which is currently present due to the effects of Project Alpha. The long term viability of kittiwake as a component of Fowlsheugh SPA will therefore be maintained in its current state.

16.415. The additional annual adult collision mortality for **herring gull** is effectively zero and therefore well below 1% of the baseline adult mortality (0 cf. 0.4 individuals).

16.416. Consequently, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that herring gull will remain a viable component of the site.

16.417. For **guillemot**, the predicted mortality from displacement is 23 to 31 individuals per annum, based on the relatively high assumed displacement rate of 60% across the wind farm and a 2km buffer area. This level of mortality is, however, below 1% of the baseline adult mortality (23–31 cf. 45 individuals). For **razorbill**, the predicted mortality from displacement is 7 to 12 individuals per annum. At the lower end of this range, the level of mortality is below 1% of the baseline adult mortality (7 cf. 10 individuals), at the higher end it just exceeds that threshold.

16.418. Further work has been undertaken to understand the consequences of this level of impact on Fowlsheugh SPA guillemot and razorbill populations 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 (Table 16.26) indicate that:

- For guillemot, 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);
- 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 165,811 to 165,375 individuals. This is very similar to the predicted population in the absence of any impact as indicated by the high ratio of the counterfactual of population size (0.99) and the similarity of the centile of un-impacted population that is equivalent to the 50th centile for the impacted population (0.54 to 0.55);

- For razorbill, the PVA model indicates a slightly declining population over the model period with or without the impact. The predicted median population growth rate is 1.00 (although as the end population slightly declines over 25 years, this value is probably very slightly less than 1) when the effects of displacement are included which is essentially indistinguishable from that of the un-impacted population (counterfactual of the median population growth rate ≈ 1); and
- As the growth rate is less than 1 the predicted median end population 9,090 to 8,959 individuals is slightly less than the current population (9,950 individuals) but similar to that predicted in the absence of any impact (counterfactual of population size = 0.99 to 0.98 and the centile of un-impacted population that is equivalent to the 50th centile for the impacted population = 0.52 to 0.53). This difference should be considered to be negligibly small given that the model is predicting changes over a 25 year period.

16.419. The current guillemot and razorbill populations far exceed the populations for which the SPA was designated. At the levels of displacement mortality predicted for Project Alpha, PVA modelling indicates that the populations of guillemot are likely to continue to grow and that razorbill will decline slightly (with or without this additional mortality). At this level of impact it is considered that there is a negligible risk that the populations of guillemot and razorbill would decline to a level at which they would no longer be considered to be viable components of the SPA. In practice both the impacts and population responses are expected to be of lower magnitude than considered here due to the precaution in the quantification of displacement impacts and the simplistic nature of the PVA model which does not include any assumptions about density dependent compensatory mechanisms within the modelled populations.

16.420. With respect to the predicted impacts associated with Project Alpha, **an adverse effect on site integrity can be excluded because all the qualifying interests will remain viable components of the site**.

St Abb's Head to Fast Castle SPA

16.421. The assessment has been conducted with respect to the following features screened into the HRA:

- Kittiwake (collision and displacement);
- Herring gull (collision);
- Guillemot (displacement); and
- Razorbill (displacement).

16.422. The additional annual adult mortality of **kittiwake** has been calculated separately for collision and displacement. In both cases the predicted mortality is below 1% of the baseline adult mortality for kittiwake (collision: 11 cf. 14 individuals; displacement: 2–4 cf. 14 individuals). This is relative to the population size for kittiwake (9,606 pairs).

16.423. This level of mortality represents a very small proportion of the population that is not indicative of an adverse effect, particularly within the context of the precaution built into the impact assessment methodology.

16.424. As highlighted in the Scoping Opinions for all Forth and Tay Projects (Marine Scotland, 2017), for kittiwake, collision 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. Combining the predicted collision and displacement mortality results in a combined adult mortality of 13–15 individuals per year still represents a very small proportion of the population that is not indicative of an adverse effect, particularly within the context of the precaution built into the impact assessment methodology.

16.425. Consequently, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that guillemot and razorbill will remain viable components of the site.

16.426. The additional annual adult collision mortality for **herring gull** is effectively zero and therefore well below 1% of the baseline adult mortality (0.4 cf. 1 individuals). This is relative to the population size for herring gull (650 individuals).

16.427. Consequently, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that herring gull will remain a viable component of the site.

16.428. For **auks** the additional annual adult mortality is below 1% of the baseline adult mortality: guillemot (6–8 cf. 22 individuals) and razorbill (1 cf. 2 individuals). This is relative to the current population size for guillemot (36,206 individuals) and razorbill (2,067 individuals).

16.429. This level of mortality represents a very small proportion of the population that is not indicative of an adverse effect. Furthermore, the impact assessment methodology is considered to be highly precautionary and there is also uncertainty that an impact will occur for these species (see Searle *et al.*, 2014; APEM, 2017; Vanermen *et al.*, 2017). Consequently, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that guillemot and razorbill will remain viable components of the site.

16.430. With respect to the predicted impacts associated with Project Alpha, **an adverse effect on site integrity can be excluded because all the qualifying interests will remain viable components of the site**.

Outer Firth of Forth and St Andrews Bay pSPA

16.431. There is no direct predicted impact of Project Alpha on this pSPA, however, there exists the potential for an indirect effect, should the populations of those SPAs from which foraging birds originate be adversely affected. The relevant features for this assessment are:

- Gannet;
- Kittiwake ;
- Herring gull;
- Guillemot;
- Razorbill; and
- Puffin.

16.432. With respect to these features, the conservation objectives of the pSPA are to:

- Avoid significant mortality, injury and disturbance of the qualifying interests, so that the distribution of the species and ability to use the site are maintained in the long-term; and
- Maintain the habitats and food resources of the qualifying interests in favourable condition.

16.433. This assessment has already considered the potential for an adverse effect on each of the breeding populations that are also features of the pSPA. In each case it has been concluded that these features will remain viable components of the respective sites and no adverse effect on the integrity of those sites is predicted. Project Alpha is not located within the pSPA and no part of the proposed development will directly impact the pSPA, consequently it is not predicted that there will be any impact on the habitats or food resources of the pSPA.

16.434. Consequently, with respect to the predicted impacts associated with Project Alpha, **an adverse effect on site integrity is not predicted.**

Appropriate Assessment Summary: Project Alpha Alone

16.435. Table 16.30 summarises the assessment undertaken and the determination, prior to mitigation, of whether or not there is an adverse effect on site integrity for each European site.

Table 16.30 Appropriate Assessment Matrix: Project Alpha alone

Conservation Objective	**Buchan Ness to Collieston Coast SPA**	**Forth Islands SPA**	**Fowlsheugh SPA**	**St Abb's Head to Fast Castle SPA**
	Kittiwake Herring gull Guillemot	**Gannet (PVA) Kittiwake (PVA) Herring gull Guillemot (PVA) Razorbill (PVA) Puffin (PVA)**	**Kittiwake (PVA) Herring gull Guillemot (PVA) Razorbill (PVA)**	**Kittiwake Herring gull Guillemot Razorbill**
To ensure for the qualifying species that the following are maintained in the long term:				
Population of the species as a viable component of the site	*No Adverse Effect on Site Integrity* Predicted additional annual adult mortality will not be of a magnitude that will prevent any qualifying interest from remaining a viable component of the site in the long term. For qualifying interests except kittiwake at Forth Islands SPA and Fowlsheugh SPA, this conclusion is based on there being no indication that the population at the end of the project will be less than that at designation. For species not assessed by PVA this conclusion is based on a comparison between the magnitude of the impact with baseline adult mortality within the context of using the worst case displacement and mortality rates and the precaution built into the displacement and collision impact prediction methodology. For those kittiwake populations that are already below the level for which they were designated, PVA does not indicate that the additional impact will reduce growth rates sufficiently to prevent those populations from growing and hence from being potentially restored to their former level.			
Distribution of the species within site	*No Adverse Effect on Site Integrity* Project Alpha is located outwith the European site. The potential effect of displacement will therefore not impact the distribution of the qualifying interests within site.			
Distribution and extent of habitats supporting the species	*No Adverse Effect on Site Integrity* Project Alpha is located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
Structure, function and supporting processes of habitats supporting the species	*No Adverse Effect on Site Integrity* Project Alpha is located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
No significant disturbance of the species	*No Adverse Effect on Site Integrity* Project Alpha is located outwith the European site and the impact of disturbance was scoped out of this assessment.			

16.436. Table 16.31 provides summary information with regard to the Outer Firth of Forth and St Andrews Bay Complex pSPA.

Table 16.31 Appropriate Assessment Matrix for Outer Firth of Forth and St Andrews Bay pSPA: Project Alpha alone

Conservation objective	Outer Firth of Forth and St Andrews Bay pSPA
	Gannet **Kittiwake** **Herring gull** **Guillemot** **Razorbill** **Puffin**
Avoid significant mortality, injury and disturbance of the qualifying interests, so that the distribution of the species and ability to use the site are maintained in the long-term	*No Adverse Effect on Site Integrity* Additional annual adult mortality will not be of a magnitude that will impact the potential for any qualifying interest to remain a viable component in the long term of the SPA breeding colonies that use the pSPA for foraging. Consequently the qualifying interest distribution and ability to use the pSPA is maintained in the long-term. For qualifying interests assessed by PVA this conclusion is based on there being no indication that the population at the end of the project will be less than that at designation or that the growth rate in the population would be reduced sufficiently to prevent the population from growing and potentially being restored to its former level. For species not assessed by PVA this conclusion is based on a comparison between the magnitude of the impact with baseline adult mortality within the context of using the worst case displacement and mortality rates and the precaution built into the displacement and collision impact prediction methodology.
To maintain the habitats and food resources of the qualifying interests in favourable condition	*No Adverse Effect on Site Integrity* Project Alpha is located outwith the pSPA and the impacts related to habitats and food resources were scoped out of this assessment.

Assessment of Project Bravo alone

Predicted impacts

Displacement

16.437. The impact of displacement is assessed in respect of the following European sites and qualifying interests:

- Buchan Ness to Collieston Coast (guillemot);
- Forth Islands (kittiwake, guillemot, razorbill and puffin);
- Fowlsheugh (kittiwake, guillemot and razorbill); and
- St Abb's Head to Fast Castle (kittiwake, guillemot and razorbill).

16.438. The impact of displacement for kittiwake, guillemot and razorbill is predicted to be highest in relation to the breeding season and for Fowlsheugh SPA. In accordance with the advice of the Scottish Ministers in the 2017 Scoping Opinion, puffin is assessed in relation to Forth Islands SPA only (Table 16.32).

16.439. The difference between 2018 baseline scenarios, i.e. with and without the outlier data, is relatively small in real terms and below the respective 1% of baseline adult mortality for each of the qualifying interests (Appendix 8C [Displacement of Seabirds]).

Table 16.32 Predicted annual adult mortality from displacement in relation to Project Bravo alone

Qualifying interest/SPA	Predicted mortality (with outlier)*				Predicted mortality (without outlier)*				Difference
	PB	B	NB	Total	PB	B	NB	Total	
Kittiwake (30% displacement; 2% mortality)									
Forth Islands	-	1	-	**1**	-	1	-	**1**	**0**
Fowlsheugh	-	13	-	**13**	-	7	-	**7**	**-6**
St Abb's Head to Fast Castle	-	2	-	**2**	-	1	-	**1**	**-1**
Guillemot (60% displacement; 1% mortality)									
Buchan Ness to Collieston Coast	-	2	1	**3**	-	1	1	**2**	**-1**
Forth Islands	-	6	3	**9**	-	4	3	**7**	**-2**
Fowlsheugh	-	18	7	**25**	-	11	7	**18**	**-7**
St Abb's Head to Fast Castle	-	5	2	**7**	-	3	2	**5**	**-2**
Guillemot (50% displacement; 1% mortality)									
Buchan Ness to Collieston Coast	-	1	0	**1**	-	1	0	**1**	**0**
Forth Islands	-	5	2	**7**	-	3	2	**5**	**-2**
Fowlsheugh	-	15	6	**21**	-	9	6	**15**	**-6**
St Abb's Head to Fast Castle	-	4	2	**6**	-	2	2	**4**	**-2**
Razorbill (60% displacement; 1% mortality)									
Forth Islands	-	2	1	**3**	-	1	1	**2**	**-1**
Fowlsheugh	-	6	2	**8**	-	2	2	**4**	**-4**
St Abb's Head to Fast Castle	-	1	0	**1**	-	0	0	**0**	**-1**
Razorbill (50% displacement; 1% mortality)									
Forth Islands	-	2	1	**3**	-	1	1	**2**	**-1**
Fowlsheugh	-	5	2	**7**	-	2	2	**4**	**-3**
St Abb's Head to Fast Castle	-	1	0	**1**	-	0	0	**0**	**-1**
Razorbill (40% displacement; 1% mortality)									
Forth Islands	-	1	0	**1**	-	1	0	**1**	**0**
Fowlsheugh	-	4	2	**6**	-	2	2	**4**	**-2**
St Abb's Head to Fast Castle	-	1	0	**1**	-	0	0	**0**	**-1**
Puffin (60% displacement; 1% mortality)									
Forth Islands	-	15	-	**15**	-	15	-	**15**	**0**
Puffin (50% displacement; 1% mortality)									
Forth Islands	-	12	-	**12**	-	12	-	**12**	**0**

PB = Pre-breeding; B = Breeding; NB = Non-breeding (guillemot, razorbill, puffin)/Post-breeding (kittiwake)

* All values, including totals, are round to nearest whole number

NB. Values underlined are used in the in combination assessment

16.440. The effect of the predicted collision mortality above has been tested through PVA modelling and the results are summarised in Table 16.33 and discussed in the site assessments below.

Table 16.33 PVA metrics for annual adult mortality from displacement in relation to Project Bravo alone

Metric	Kittiwake (Forth Islands)	Kittiwake (Fowlsheugh)	Guillemot (Forth Islands)	Guillemot (Fowlsheugh)	Razorbill (Forth Islands)	Razorbill (Fowlsheugh)	Puffin (Forth Islands)
1% of adult baseline mortality	14	28	24	45	8	10	85
Additional annual adult mortality[A]	1	7 to 13	7 to 9	18 to 25	2 to 3	4 to 8	15
Counterfactual population size[B]	1.00	0.98 to 0.96	1.00 to 0.99	0.99	0.99	0.99 to 0.98	1.00
Median pop$^{n.}$ growth rate[B]	1.03	1.03	1.03	1.03	1.00	1.00	1.03
Counterfactual median growth rate[B]	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Centile of un-impacted popn. = 50th centile for impacted popn.[B]	0.50	0.52 to 0.53	0.52	0.53 to 0.54	0.51 to 0.52	0.52 to 0.53	0.51
Median end population size[B]	10,610p	22,189 to 21,987p	86,597 to 86,346i	166,123 to 165,686i	7,252 to 7,225i	9,143 to 9,063i	89,153 to 89,097p
Current population size[C]	4,663p	9,655p	38,573i	74,379i	7,792i	9,950i	45,005p
Designated population size[C]	8,400p	36,650p	21,440i	56,450i	2,800i	5,800i	14,000p

[A] Table 16.32;

[B] Methodology underpinning these outputs is described in Appendix 8D (Population Viability Analysis);

[C] Scottish Natural Heritage, 2017c; p = pairs; i = individuals

Collision Mortality

16.441. The impact of collision (Table 16.34) is assessed in respect of the following European sites and qualifying interests:

- Buchan Ness to Collieston Coast (herring gull);
- Forth Islands (gannet, kittiwake, and herring gull);
- Fowlsheugh (kittiwake and herring gull); and
- St Abb's Head to Fast Castle (kittiwake and herring gull).

16.442. When assessing the 2018 baseline data there is a higher peak population observed in Project Bravo in 2017 compared to the 2014 baseline (Appendix 8A [Ornithology Technical Report]).

Table 16.34 Predicted annual adult mortality from collision in relation to Project Bravo alone

Qualifying interest/SPA	Adult collision mortality			
	PB	B	NB	Total^
Gannet	**(Option 1, 98.9% AR)**			
Forth Islands	8	218	6	**233**
Kittiwake	**(Option 1, 98.9% AR)**			
Forth Islands	0	2	0	**2**
Fowlsheugh	0	23	0	**24**
St Abb's Head to Fast Castle	0	4	0	**4**
Herring Gull	**(Option 3, 99.0% AR)**			
Buchan Ness to Collieston Coast	0.0	0.0	0.0	**0.1**
Forth Islands	0.0	0.1	0.0	**0.1**
Fowlsheugh	0.0	0.0	0.0	**0.0**
St Abb's Head to Fast Castle	0.0	0.3	0.0	**0.3**

* Marine Scotland Licensing Operations Team, 2014

PB = Pre-breeding; B = Breeding; NB = Non-breeding (herring gull)/Post-breeding (gannet and kittiwake);

^Except in the case of herring gull, all values, including totals, are round to nearest whole number

NB. Values underlined are used in the in combination assessment

16.443. The effect of the predicted collision mortality above has been tested through PVA modelling and the results are summarised in Table 16.35 and discussed in the site assessments below.

Table 16.35 PVA metrics for annual adult mortality from collision in relation to Project Bravo alone

Metric	Gannet (Forth Islands)	Kittiwake (Forth Islands)	Kittiwake (Fowlsheugh)
1% of baseline adult mortality	122	14	28
Additional annual adult mortality[A]	233	2	24
Counterfactual population size[B]	0.96	0.99	0.96
Median pop$^{n.}$ growth rate[B]	1	1.03	1.03
Counterfactual median growth rate[B]	1	1	1
Centile of un-impacted popn. = 50th centile for impacted popn.[B]	0.62	0.51	0.55
Median end population size[B]	84,700p	10,577p	21,621p
Current population size[C]	75,259p	4,663p	9,655p
Designated population size[D]	21,600p	8,400p	36,650p

[A] Table 16.34;

[B] Methodology underpinning these outputs is described in Appendix 8D (Population Viability Analysis);

[C] Scottish Natural Heritage, 2017c; p = pairs; i = individuals

Site assessments

Buchan Ness to Collieston Coast SPA

16.444. The assessment has been conducted with respect to the following features screened into the HRA:

- Kittiwake (collision and displacement);
- Herring gull (collision); and
- Guillemot (displacement).

16.445. Although **kittiwake** was screened into HRA, no impacts are predicted on this population from Project Bravo. The colony lies at the limits of foraging distance (using the mean maximum foraging range indicated in Thaxter *et al.* (2012) + 1 standard deviation, which is considered to be a highly precautionary method for establishing connectivity.

16.446. Consequently, it is considered that there will be no effect on population size and it is concluded that kittiwake will remain a viable component of the site.

16.447. The additional annual adult collision mortality for **herring gull** is effectively zero and therefore well below 1% of the baseline adult mortality (0.1 cf. 10 individuals).

16.448. The predicted additional annual adult mortality for **guillemot** arising from displacement is below 1% of the baseline adult mortality (2–3 cf. 21 individuals) for the current population of 33,632 individuals.

16.449. This level of mortality represents a very small proportion of the population that is not indicative of an adverse effect. Furthermore, the impact assessment methodology is considered to be highly precautionary and there is also uncertainty that an impact will occur for these species (see Searle *et al.*, 2014; APEM, 2017; Vanermen *et al.*, 2017). Consequently, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that guillemot will remain a viable component of the site.

16.450. Consequently, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that herring gull will remain a viable component of the site.

16.451. With respect to the predicted impacts associated with Project Bravo, **an adverse effect on site integrity can be excluded because all the qualifying interests will remain viable components of the site.**

Forth Islands SPA

16.452. The assessment has been conducted with respect to the following features screened into the HRA:

- Gannet (collision);
- Kittiwake (collision and displacement);
- Herring gull (collision);
- Guillemot (displacement);
- Razorbill (displacement); and
- Puffin (displacement).

16.453. The predicted collision mortality for **gannet** is 233 individuals per annum. It should be noted, however, that this prediction is considered to be precautionary because it is based on CRM assumptions that do not take account of recent empirical data relating to flight speed and avoidance rates which, if factored into CRM individually or collectively, would significantly reduce the predicted magnitude of this impact.

16.454. For example, the use of a flight speed of 13.3 m/s compared to 14.9 m/s as used in this assessment would reduce predicted mortality rates by approximately 6% (see Table 14, Appendix 8B [Collision Risk Modelling]). The use of a higher avoidance rate (say 99.9%) would reduce the predicted collision rate to a value that is approximately 10% of that used in this assessment.

16.455. 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 (Table 16.27) 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]).

16.456. The outputs of the PVA modelling over the 25 year operational life time of the optimised Seagreen Project (Table 16.35) 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).

16.457. 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.

16.458. The additional annual adult mortality of **kittiwake** has been calculated separately for collision and displacement. In both cases the predicted mortality is low and below 1% of the baseline adult mortality for kittiwake (collision: 2 cf. 14 individuals; displacement: 1 cf. 14 individuals).

16.459. It should be noted that the impact magnitude for kittiwake is, in any case, likely to be over-estimated. There is significant precaution in the calculation of both collision and displacement effects, furthermore, tracking studies indicate that few kittiwake from the Forth Islands SPA (Appendix 16B [Seabird Apportioning]) interact with the project site.

16.460. Further work has been undertaken to understand the consequences of the higher of these predicted impacts (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 (Table 16.35) 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 10,577 pairs. This is very similar to the predicted population in the absence of any impact as indicated by the high ratio of the counterfactual of population size (0.99) and the similarity of the centile of un-impacted population that is equivalent to the 50th centile for the impacted population (0.51).

16.461. 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 impact of Project Bravo 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. Recent monitoring data from the colony (Table 16.27) also indicate that the population is stable or growing.

16.462. As highlighted in the Scoping Opinions for all Forth and Tay Projects (Marine Scotland, 2017), for kittiwake, collision 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. Combining the predicted cumulative collision and displacement mortality results in a combined adult mortality of three individuals per year, which in terms of the PVA, is not materially higher than that predicted for collision alone.

16.463. 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.

16.464. The additional annual adult collision mortality for **herring gull** is effectively zero and therefore well below 1% of the baseline adult mortality (0.1 cf. 22 individuals).

16.465. Consequently, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that herring gull will remain a viable component of the site.

16.466. For **auk** species, the predicted additional annual adult mortality arising from displacement is relatively low and, in each case, below 1% of the baseline adult mortality: guillemot (7–9 cf. 24 individuals), razorbill (2–3 cf. 8 individuals) and puffin (15 cf. 85 individuals). These impacts are also relatively low in comparison to the size of the auk populations which now comprise guillemot 38,573 individuals compared to 21,440 individuals at designation; razorbill 7,792 individuals compared to 2,800 individuals at designation; puffin 45,005 pairs compared to 14,000 at designation). Recent monitoring data indicate that each of these populations as stable or growing (Table 16.28).

16.467. Further work has also been undertaken to understand the consequences of this level of impact on the Forth Islands SPA auk populations 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 (Table 16.33) indicate that:

- For guillemot and puffin the impacted populations will continue to grow at very similar rates to those that are predicted by the PVA for the un-impacted population. The predicted median population growth rate for both species (1.03) for the impacted population is essentially indistinguishable from that of the un-impacted population (counterfactual of the median population growth rate ≈ 1 in both cases);
- The similarity of the predicted growth rates for guillemot and puffin leads to similar population outcomes. The model predicts a median end population size (in the impacted scenario) of 86,597 to 86,346 individuals for guillemot and 89,153 to 89,097 pairs for puffin. These are very similar to the predicted populations in the absence of any impact as indicated by the high ratio of the counterfactual of population size (1.00 to 0.99 for guillemot and 1.00 for puffin) and the similarity of the centile of un-impacted population that is equivalent to the 50th centile for the impacted population (0.52 for guillemot and 0.51 for puffin);
- For razorbill, the PVA model indicates a slightly declining population over the model period with or without the impacted populations. Although it should be noted that recent monitoring data indicate population growth. The predicted median population growth rate is 1.00 (although as the end population slightly declines over 25 years, this value is probably very slightly less than 1) when the effects of displacement are included which is essentially indistinguishable from that of the un-impacted population (counterfactual of the median population growth rate ≈ 1); and
- As the growth rate is slightly less than 1 the predicted median end population 7,252 to 7,225 individuals is slightly less than the current population (7,792 individuals) but similar to that predicted in the absence of any impact (counterfactual of population size = 0.99 and the centile of un-impacted population that is equivalent to the 50th centile for the impacted population = 0.51 to 0.52). This difference should be considered to be negligibly small given that the model is predicting changes over a 25 year period.

16.468. The current guillemot, razorbill and puffin populations far exceed the populations for which the SPA was designated. At the levels of displacement mortality predicted for Project Bravo, PVA modelling indicates that the populations of guillemot and razorbill are likely to continue to grow and that razorbill will decline slightly (with or without the additional mortality). At this level of impact it is considered that there is a negligible risk that the populations of guillemot, razorbill or puffin would decline to a level at which they would no longer be considered to be viable components of the SPA. In practice both the impacts and population responses are expected to be of lower magnitude than considered here due to the precaution in the quantification of displacement impacts and the simplistic nature of the PVA model which does not include any assumptions about density dependent compensatory mechanisms within the modelled populations.

16.469. With respect to the predicted impacts associated with Project Bravo, **an adverse effect on site integrity can be excluded because all the qualifying interests will remain viable components of the site**.

Fowlsheugh SPA

16.470. The assessment has been conducted with respect to the following features screened into the HRA:

- Kittiwake (collision and displacement);
- Herring gull (collision);
- Guillemot (displacement); and
- Razorbill (displacement).

16.471. The additional annual adult mortality of **kittiwake** has been calculated separately for collision and displacement. In both cases the predicted mortality is low and below 1% of the baseline adult mortality for kittiwake (collision: 24 cf. 28 individuals; displacement: 7-13 cf. 28 individuals).

16.472. It should be noted that the magnitude of the collision mortality impact is likely to be overestimated for a number of reasons:

- The collision risk modelling for the optimised Seagreen project makes a number of conservative assumptions including that kittiwake foraging activity at night is equivalent to 25% of the daytime activity levels and flight speed is 13.1m/s. Recent studies at Thanet (Skov *et al.* 2018) found kittiwake nocturnal activity to be less than 5% of daytime activity and measured average flight speeds of 8.71m/s. The same study also calculated empirical avoidance rates of 99.8% for kittiwake, higher than the 99.2% avoidance rate estimated in Cook et al (In press), and the 98.9% applied in this assessment. Whilst, avoidance behaviour may differ for breeding birds tied to their colonies for chick provisioning compared to those at Thanet, which were, in the main, non-breeding birds, it seems likely that current guidance on avoidance rates is precautionary;
- The rotor speed used to derive the collision numbers is based on values for the worst case 167m rotor diameter turbine. Should larger turbines be deployed – up to 220 m rotor – rotor speed would reduce; and
- Estimates of precaution are quantified in Appendix 8B Collision Risk Modelling Table 14. They show that changing flight speed from 13.1m/s to 8.71m/s would reduce kittiwake collision estimates by ~19%. Changing rotor parameters from 167m to 220m would reduce them by 9%. These effects were modelled separately, but if modelled together would reduce effects still further.

16.473. The assumed connectivity with Fowlsheugh SPA, and associated apportioning, of impacts to that site is also highly conservative:

- The optimised Seagreen project lies within the mean-max foraging range (Thaxter *et al.* 2012) of kittiwake breeding at that colony. However, the results of GPS tracking studies (FAME, Future of the Atlantic Marine Environment [2012] indicated that very few kittiwakes tracked from Fowlsheugh interacted with the project site. The peer-reviewed paper [Wakefield *et al.* 2017] based on these data suggested that the optimised Seagreen project was in an area where at-sea utilisation by breeding kittiwake was only between 5 and 10%. Similarly, the tracking of 54 birds from Fowlsheugh by CEH indicated that the Seagreen sites were not part of the core foraging area for this colony (Daunt, 2011a; 2011b). The apportioning model currently under development by CEH is understood to be based, at least in part, on tracking data. Current apportioning methods which do not take such data into account may therefore be another source of precaution;

- The apportioning conducted for this assessment has led to an apparent increase in the effect on kittiwake at Fowlsheugh from 51% (used to assign collision effects in the previous Scottish Ministers HRA [2014] [SNH Unpublished data, Seagreen ES 2014]) to 61% (Appendix 16B [Seabird Apportioning]). This difference, however, appears to be related primarily to the definition of the Fowlsheugh population used. In this assessment, all of the relevant count sectors for the SPA have been included which increases the relative weight of Fowlsheugh in the apportioning exercise; and
- The assessment assumes that 94.2% of birds are adult breeding birds based on the proportion of first year birds recorded during boat-based surveys and the likely age structure of the population. Although 10% are assumed to be sabbatical i.e. non-breeding in that year, numbers are likely to remain precautionary because the proportion of first year birds present in natal waters is likely to be lower than that of older immature birds which are indistinguishable from adults, and such immature birds may be concentrated in certain foraging areas (Appendix 16B Apportioning Assessment Ornithology).

16.474. Consequently it is considered that there is considerable precaution both in relation to the estimation of collision mortality for kittiwake and in the apportioning of that impact to Fowlsheugh SPA.

16.475. In accordance with the advice of the Scottish Ministers in the 2017 Scoping Opinion, PVA (Appendix 8D [Population Viability Analysis]) was used to the establish whether or not the population of kittiwake can be maintained as a viable component of Fowlsheugh SPA in the long term. The 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, 2011b), the current Fowlsheugh SPA population of 9,655 being lower than the population of 36,650 pairs cited at the time of the marine extension designation in 2009 (Scottish Natural Heritage, 2009c). More recent counts indicate a more stable population, albeit at a reduced level from that which was designated (Table 16.29).

16.476. The outputs of the PVA modelling, using the metrics advised by Marine Scotland, over the 25 year operational life time of the Project Bravo (Table 16.35) predict that the un-impacted population will grow slowly and this is not considered to be inconsistent with the recent monitoring data for Fowlsheugh (Table 16.29).

16.477. The effect of including the predicted 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 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 21,621 pairs. This is very 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 similarity of the centile of un-impacted population that is equivalent to the 50th centile for the impacted population (0.55).

16.478. Whilst the PVA model indicates that the kittiwake population would continue to grow, there would be a lower kittiwake population at Fowlsheugh SPA after Project Bravo 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; and
- Over-estimation of the population response to the apportioned impact due to the simplistic nature of the PVA model used.

16.479. As highlighted in the Scoping Opinions for all Forth and Tay Projects (Marine Scotland, 2017), for kittiwake, collision 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. Combining the predicted cumulative collision and displacement mortality results in a combined adult mortality of 31 to 37 individuals per year, which PVA modelling indicates, in any case, is unlikely to lead to a significantly different outcome for the population than that predicted for collision alone.

16.480. In light of this precaution it is considered unlikely that the population would be reduced below that which is currently present due to the effects of Project Bravo. The long term viability of kittiwake as a component of Fowlsheugh SPA will therefore be maintained in its current state.

16.481. The additional annual adult collision mortality for **herring gull** is effectively zero and therefore well below 1% of the baseline adult mortality (0 cf. 0.4 individuals).

16.482. Consequently, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that herring gull will remain a viable component of the site.

16.483. For **guillemot**, the predicted mortality from displacement is 18 to 25 individuals per annum, based on the relatively high assumed displacement rate of 60% across the wind farm and a 2km buffer area. For **razorbill**, the predicted mortality from displacement is 4 to 8 individuals per annum. The predicted displacement impacts for both specie are considered to be low and are below 1% of the baseline adult mortality for the respective populations (guillemot: 19–26 cf. 45 individuals; razorbill: 5-8 cf. 10 individuals).

16.484. Further work has been undertaken to understand the consequences of this level of impact on Fowlsheugh SPA guillemot and razorbill populations 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 (Table 16.33) indicate that:

- For guillemot, 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);
- 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 166,123 to 165,686 individuals. This is very similar to the predicted population in the absence of

any impact as indicated by the high ratio of the counterfactual of population size (0.99) and the similarity of the centile of un-impacted population that is equivalent to the 50th centile for the impacted population (0.53 to 0.54);

- For razorbill, the PVA model indicates a slightly declining population over the model period with or without the impacted populations. The predicted median population growth rate is 1.00 (although as the end population slightly declines over 25 years, this value is probably very slightly less than 1) when the effects of displacement are included which is essentially indistinguishable from that of the un-impacted population (counterfactual of the median population growth rate ≈ 1); and
- As the growth rate is slightly less than 1 the predicted median end population 9,143 to 9,063 individuals is slightly less than the current population (9,950 individuals) but similar to that predicted in the absence of any impact (counterfactual of population size = 0.99 to 0.98 and the centile of un-impacted population that is equivalent to the 50th centile for the impacted population = 0.52 to 0.53). This difference should be considered to be negligibly small given that the model is predicting changes over a 25 year period.

16.485. The current guillemot and razorbill populations far exceed the populations for which the SPA was designated. At the levels of displacement mortality predicted for Project Bravo, PVA modelling indicates that the populations of guillemot and razorbill are likely to continue to grow and that razorbill will decline slightly (with or without this additional mortality). At this level of impact it is considered that there is a negligible risk that the populations of guillemot and razorbill would decline to a level at which they would no longer be considered to be viable components of the SPA. In practice both the impacts and population responses are expected to be of lower magnitude than considered here due to the precaution in the quantification of displacement impacts and the simplistic nature of the PVA model which does not include any assumptions about density dependent compensatory mechanisms within the modelled populations.

16.486. With respect to the predicted impacts associated with Project Bravo, **an adverse effect on site integrity can be excluded because all the qualifying interests will remain viable components of the site**.

St Abb's Head to Fast Castle SPA

16.487. The assessment has been conducted with respect to the following features screened into the HRA:

- Kittiwake (collision and displacement);
- Herring gull (collision);
- Guillemot (displacement); and
- Razorbill (displacement).

16.488. The additional annual adult mortality of **kittiwake** has been calculated separately for collision and displacement. In both cases the predicted mortality is below 1% of the baseline adult mortality for kittiwake (collision: 4 cf. 14 individuals; displacement: 1–2 cf. 14 individuals). This is relative to the population size for kittiwake (9,606 pairs).

16.489. This level of mortality represents a very small proportion of the population that is not indicative of an adverse effect, particularly within the context of the precaution built into the impact assessment methodology.

16.490. As highlighted in the Scoping Opinions for all Forth and Tay Projects (Marine Scotland, 2017), for kittiwake, collision 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. Combining the predicted collision and displacement mortality results in a combined adult mortality of five to six individuals per year still represents a very small proportion of the population that is not indicative of an adverse effect, particularly within the context of the precaution built into the impact assessment methodology.

16.491. 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 viable components of the site.

16.492. The additional annual adult collision mortality for **herring gull** is effectively zero and therefore well below 1% of the baseline adult mortality (0.3 cf. 1 individuals). This is relative to the population size for herring gull (650 individuals).

16.493. Consequently, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that herring gull will remain a viable component of the site.

16.494. For **auks** additional annual adult mortality is below 1% of the baseline adult mortality: guillemot (5-7 cf. 22 individuals) and razorbill (0-1 cf. 2 individuals). This is relative to the current population size for guillemot (36,206 individuals) and razorbill (2,067 individuals).

16.495. This level of mortality represents a very small proportion of the population that is not indicative of an adverse effect. Furthermore, the impact assessment methodology is considered to be highly precautionary and there is also uncertainty that an impact will occur for these species (see Searle *et al.*, 2014; APEM, 2017; Vanermen *et al.*, 2017). Consequently, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that guillemot and razorbill will remain viable components of the site.

16.496. With respect to the predicted impacts associated with Project Bravo, **an adverse effect on site integrity can be excluded because all the qualifying interests will remain viable components of the site**.

Outer Firth of Forth and St Andrews Bay pSPA

16.497. There is no direct predicted impact of Project Bravo on this pSPA, however, there exists the potential for an indirect effect, should the populations of those SPAs from which foraging birds originate be adversely affected. The relevant features for this assessment are:

- Gannetp;
- Kittiwake;
- Herring gull;
- Guillemot;
- Razorbill; and
- Puffin.

16.498. With respect to these features, the conservation objectives of the pSPA are to:

- Avoid significant mortality, injury and disturbance of the qualifying interests, so that the distribution of the species and ability to use the site are maintained in the long-term; and
- Maintain the habitats and food resources of the qualifying interests in favourable condition.

16.499. This assessment has already considered the potential for an adverse effect on each of the breeding populations that are also features of the pSPA. In each case it has been concluded that these features will remain viable components of the respective sites and no adverse effect on the integrity of those sites is predicted. Project Bravo is not located within the pSPA and no part of the proposed development will directly impact the pSPA, consequently it is not predicted that there will be any impact on the habitats or food resources of the pSPA.

16.500. Consequently, with respect to the predicted impacts associated with Project Bravo, **an adverse effect on site integrity is not predicted.**

Appropriate Assessment Summary: Project Bravo Alone

16.501. Table 16.36 summarises the assessment undertaken and the determination, prior to mitigation, of whether or not there is an adverse effect on site integrity for each European site.

Table 16.36 Appropriate Assessment Matrix: Project Bravo alone

Conservation Objective	Buchan Ness to Collieston Coast SPA	Forth Islands SPA	Fowlsheugh SPA	St Abb's Head to Fast Castle SPA
	Kittiwake Herring gull Guillemot	Gannet (PVA) Kittiwake (PVA) Herring gull Guillemot (PVA) Razorbill (PVA) Puffin (PVA)	Kittiwake (PVA) Herring gull Guillemot (PVA) Razorbill (PVA)	Kittiwake Herring gull Guillemot Razorbill
To ensure for the qualifying species that the following are maintained in the long term:				
Population of the species as a viable component of the site	*No Adverse Effect on Site Integrity* Predicted additional annual adult mortality will not be of a magnitude that will prevent any qualifying interest from remaining a viable component of the site in the long term. For qualifying interests except kittiwake at Forth Islands SPA and Fowlsheugh SPA, this conclusion is based on there being no indication that the population at the end of the project will be less than that at designation. For species not assessed by PVA this conclusion is based on a comparison between the magnitude of the impact with baseline adult mortality within the context of using the worst case displacement and mortality rates and the precaution built into the displacement and collision impact prediction methodology. For those kittiwake populations that are already below the level for which they were designated, PVA does not indicate that the additional impact will reduce growth rates sufficiently to prevent those populations from growing and hence from being potentially restored to their former level.			
Distribution of the species within site	*No Adverse Effect on Site Integrity* Project Bravo is located outwith the European site. The potential effect of displacement will therefore not impact the distribution of the qualifying interests within site.			
Distribution and extent of habitats supporting the species	*No Adverse Effect on Site Integrity* Project Bravo is located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
Structure, function and supporting processes of habitats supporting the species	*No Adverse Effect on Site Integrity* Project Bravo is located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
No significant disturbance of the species	*No Adverse Effect on Site Integrity* Project Bravo is located outwith the European site and the impact of disturbance was scoped out of this assessment.			

16.502. Table 16.37 provides summary information with regard to the Outer Firth of Forth and St Andrews Bay Complex pSPA.

Table 16.37 Appropriate Assessment Matrix for Outer Firth of Forth and St Andrews Bay pSPA: Project Bravo alone

Conservation objective	Outer Firth of Forth and St Andrews Bay pSPA
	Gannet **Kittiwake** **Herring gull** **Guillemot** **Razorbill** **Puffin**
Avoid significant mortality, injury and disturbance of the qualifying interests, so that the distribution of the species and ability to use the site are maintained in the long-term	*No Adverse Effect on Site Integrity* Additional annual adult mortality will not be of a magnitude that will impact the potential for any qualifying interest to remain a viable component in the long term of the SPA breeding colonies that use the pSPA for foraging. Consequently the qualifying interest distribution and ability to use the pSPA is maintained in the long-term. For qualifying interests assessed by PVA this conclusion is based on there being no indication that the population at the end of the project will be less than that at designation or that the growth rate in the population would be reduced sufficiently to prevent the population from growing and potentially being restored to its former level. For species not assessed by PVA this conclusion is based on a comparison between the magnitude of the impact with baseline adult mortality within the context of using the worst case displacement and mortality rates and the precaution built into the displacement and collision impact prediction methodology.
To maintain the habitats and food resources of the qualifying interests in favourable condition	*No Adverse Effect on Site Integrity* Project Bravo is located outwith the pSPA and the impacts related to habitats and food resources were scoped out of this assessment.

Assessment of Project Alpha and Project Bravo Combined

Predicted impacts

16.503. It should be noted that the maximum number of WTGs that would be installed for Project Alpha and Project Bravo combined (the optimised Seagreen Project) is 120.

Displacement

16.504. The impact of displacement is assessed in respect of the following European sites and qualifying interests:

- Buchan Ness to Collieston Coast (guillemot);
- Forth Islands (kittiwake, guillemot, razorbill and puffin);
- Fowlsheugh (kittiwake, guillemot and razorbill); and
- St Abb's Head to Fast Castle (kittiwake, guillemot and razorbill).

16.505. The impact of displacement predicted for Project Alpha and Project Bravo combined is summarised in Table 16.38 and follows that pattern described above for Project Alpha and Project Bravo individually, i.e. the predicted impact of displacement is highest in relation to the breeding season and at Fowlsheugh SPA. As above, predicted mortality has been calculated for two baseline datasets, one with and the other without the July 2017 counts, which were unusually high and considered to be an outlier. In accordance with the advice of the Scottish Ministers in the 2017 Scoping Opinion, puffin is assessed in relation to Forth Islands SPA only.

Table 16.38 Predicted annual adult mortality from displacement in relation to Project Alpha and Project Bravo combined

Qualifying interest/SPA	Predicted mortality (with outlier)*				Predicted mortality (without outlier)*				Difference
	PB	B	NB	Total	PB	B	NB	Total	
Kittiwake (30% displacement; 2% mortality)									
Forth Islands	-	3	-	**3**	-	1	-	**2**	**-1**
Fowlsheugh	-	31	-	**31**	-	14	-	**14**	**-17**
St Abb's Head to Fast Castle	-	5	-	**5**	-	2	-	**2**	**-3**
Guillemot (60% displacement; 1% mortality)									
Buchan Ness to Collieston Coast	-	3	1	**4**	-	2	1	**3**	**-1**
Forth Islands	-	13	6	**19**	-	9	6	**15**	**-4**
Fowlsheugh	-	37	16	**53**	-	25	16	**41**	**-11**
St Abb's Head to Fast Castle	-	9	4	**13**	-	6	4	**10**	**-3**
Guillemot (50% displacement; 1% mortality)									
Buchan Ness to Collieston Coast	-	2	1	**3**	-	2	1	**3**	**0**
Forth Islands	-	11	5	**16**	-	7	5	**12**	**-4**
Fowlsheugh	-	31	13	**44**	-	21	13	**34**	**-10**
St Abb's Head to Fast Castle	-	8	3	**11**	-	5	3	**8**	**-3**
Razorbill (60% displacement; 1% mortality)									
Forth Islands	-	5	1	**6**	-	2	1	**3**	**-3**
Fowlsheugh	-	14	4	**18**	-	7	4	**11**	**-7**
St Abb's Head to Fast Castle	-	2	0	**2**	-	1	0	**1**	**-1**
Razorbill (50% displacement; 1% mortality)									
Forth Islands	-	4	1	**5**	-	2	1	**3**	**-2**
Fowlsheugh	-	12	3	**15**	-	6	3	**9**	**-6**
St Abb's Head to Fast Castle	-	1	0	**1**	-	1	0	**1**	**-0**
Razorbill (40% displacement; 1% mortality)									
Forth Islands	-	3	1	**4**	-	2	1	**3**	**-1**
Fowlsheugh	-	9	3	**12**	-	5	3	**8**	**-4**
St Abb's Head to Fast Castle	-	1	0	**1**	-	1	0	**1**	**0**
Puffin (60% displacement; 1% mortality)									
Forth Islands	-	23	-	**23**	-	23	-	**23**	**0**
Puffin (50% displacement; 1% mortality)									
Forth Islands	-	19	-	**19**	-	19	-	**19**	**0**

PB = Pre-breeding; B = Breeding; NB = Non-breeding (guillemot, razorbill, puffin)/Post-breeding (kittiwake)

* All values, including totals, are round to nearest whole number

NB. Values underlined are used in the in combination assessment

16.506. The effect of the predicted displacement mortality above has been tested through PVA modelling and the results are summarised in Table 16.39 and discussed in the site assessments below.

Table 16.39 PVA metrics for annual adult mortality from displacement in relation to Project Alpha and Project Bravo combined

Metric	Kittiwake (Forth Islands)	Kittiwake (Fowlsheugh)	Guillemot (Forth Islands)	Guillemot (Fowlsheugh)	Razorbill (Forth Islands)	Razorbill (Fowlsheugh)	Puffin (Forth Islands)
1% of adult baseline mortality	14	28	24	45	8	10	85
Additional annual adult mortality[A]	2 to 3	14 to 31	15 to 19	41 to 53	3 to 6	11 to 18	23
Counterfactual population size[B]	0.99	0.98 to 0.95	0.99	0.98	0.99 to 0.98	0.97 to 0.95	0.99
Median pop$^{n.}$ growth rate[B]	1.03	1.03	1.03	1.03	1.00	1.00	1.03
Counterfactual growth rate[B]	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Centile of un-impacted popn. = 50th centile for impacted popn.[B]	0.50 to 0.51	0.57 to 0.53	0.53 to 0.55	0.57 to 0.59	0.52 to 0.54	0.54 to 0.56	0.51
Median end population size[B]	10,577 to 10,543p	21,920 to 21,391p	86,034 to 85,784i	164,693 to 164,013i	7,199 to 7,146i	8,985 to 8,804i	88,956 to 88,844p
Current population size[C]	4,663p	9,655p	38,573i	74,379i	7,792i	9,950i	45,005p
Designated population size[C]	8,400p	36,650p	21,440i	56,450i	2,800i	5,800i	14,000p

[A] Table 16.38;

[B] Methodology underpinning these outputs is described in Appendix 8D (Population Viability Analysis);

[C] Scottish Natural Heritage, 2017c; p = pairs; i = individuals

Collision

16.507. The impact of collision (Table 16.40) is assessed in respect of the following European sites and qualifying interests:

- Buchan Ness to Collieston Coast (herring gull);
- Forth Islands (gannet, kittiwake, and herring gull);
- Fowlsheugh (kittiwake and herring gull); and
- St Abb's Head to Fast Castle (kittiwake and herring gull).

16.508. The effect of the predicted collision mortality above has been tested through PVA modelling and the results are summarised in Table 16.41 and discussed in the site assessments below.

Table 16.40 Predicted annual adult mortality from in relation to Project Alpha and Project Bravo combined

Qualifying interest / SPA	Adult collision mortality			
	PB	B	NB	Total^
Gannet	**(Option 1, 98.9% AR)**			
Forth Islands	8	308	6	**323**
Kittiwake	**(Option 1, 98.9% AR)**			
Forth Islands	0	7	0	**7**
Fowlsheugh	1	66	1	**68**
St Abb's Head to Fast Castle	0	12	0	**12**
Herring Gull	**(Option 3, 99.0% AR)**			
Buchan Ness to Collieston Coast	0.0	0.0	0.1	**0.1**
Forth Islands	0.0	0.2	0.1	**0.3**
Fowlsheugh	0.0	0.1	0.0	**0.1**
St Abb's Head to Fast Castle	0.0	0.6	0.0	**0.6**

* Marine Scotland Licensing Operations Team, 2014

PB = Pre-breeding; B = Breeding; NB = Non-breeding (herring gull)/Post-breeding (gannet and kittiwake);

^ Except in the case of herring gull, all values, including totals, are round to nearest whole number

NB. Values underlined are used in the in combination assessment

Table 16.41 PVA metrics for annual adult mortality from collision in relation to Project Alpha and Project Bravo combined

Metric	Gannet (Forth Islands)	Kittiwake (Forth Islands)	Kittiwake (Fowlsheugh)
Additional annual adult mortality[A]	323	7	68
Counterfactual population size[B]	0.94	0.98	0.90
Median pop$^{n.}$ growth rate[B]	1.00	1.03	1.03
Counterfactual median growth rate[B]	1.00	1.00	1.00
Centile of un-impacted pop$^{n.}$ = 50th centile for impacted pop$^{n.B}$	0.66	0.53	0.63
Median end population size[B]	83,225p	10,410p	20,181p
Current population size[C]	75,259p	4,663p	9,655p
Designated population size[C]	21,600p	8,400p	36,650p

[A] Table 16.40;

[B] Methodology underpinning these outputs is described in Appendix 8D (Population Viability Analysis);

[C] Scottish Natural Heritage, 2017c; p = pairs; i = individuals

Site Assessments

Buchan Ness to Collieston Coast SPA

16.509. The assessment has been conducted with respect to the following features screened into the HRA:

- Kittiwake (collision and displacement);
- Herring gull (collision); and
- Guillemot (displacement).

16.510. Although **kittiwake** was screened into HRA, no impacts are predicted on this population from Project Alpha. The colony lies at the limits of foraging distance (using the mean maximum foraging range indicated in Thaxter *et al.* (2012) + 1 standard deviation, which is considered to be a highly precautionary method for establishing connectivity.

16.511. Consequently, it is considered that there will be no effect on population size and it is concluded that kittiwake will remain a viable component of the site.

16.512. The additional annual adult mortality for **herring gull** is effectively zero and therefore well below 1% of the baseline adult mortality (0.1 cf. 10 individuals).

16.513. Consequently, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that herring gull will remain a viable component of the site.

16.514. The predicted additional annual adult mortality for **guillemot** from displacement is below 1% of the baseline adult mortality (3 cf. 21 individuals) for the current population of 33,632 individuals.

16.515. This level of mortality represents a very small proportion of the population that is not indicative of an adverse effect. Furthermore, the impact assessment methodology is considered to be highly precautionary and there is also uncertainty that an impact will occur for these species (see Searle *et al.*, 2014; APEM, 2017; Vanermen *et al.*, 2017). Consequently, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that guillemot will remain a viable component of the site.

16.516. With respect to the predicted impacts associated with Project Alpha and Project Bravo combined, **an adverse effect on site integrity can be excluded because all the qualifying interests will remain viable components of the site.**

Forth Islands SPA

16.517. The assessment has been conducted with respect to the following features screened into the HRA:

- Gannet (collision);
- Kittiwake (collision and displacement);
- Herring gull (collision);
- Guillemot (displacement);
- Razorbill (displacement); and
- Puffin (displacement).

16.518. The predicted collision mortality for **gannet** is 323 individuals per annum. It should be noted, however, that this prediction is considered to be precautionary because it is based on CRM assumptions that do not take account of recent empirical data relating to flight speed and avoidance rates which, if factored into CRM individually or collectively, would significantly reduce the predicted magnitude of this impact.

16.519. For example, the use of a flight speed of 13.3m/s compared to 14.9m/s as used in this assessment would reduce predicted mortality rates by approximately 6% (see Table 14, Appendix 8B [Collision Risk Modelling]). The use of a higher avoidance rate (say 99.9%) would reduce the predicted collision rate to a value that is approximately 10% of that used in this assessment.

16.520. 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 (Table 16.27) 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]).

16.521. The outputs of the PVA modelling over the 25 year operational life time of the optimised Seagreen Project (Table 16.41) 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).

16.522. 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.

16.523. The additional annual adult mortality of **kittiwake** has been calculated separately for collision and displacement. In both cases the predicted mortality is low and below 1% of the baseline adult mortality for kittiwake (collision: 7 cf. 14 individuals; displacement: 2-3 cf. 14 individuals).

16.524. It should be noted that the impact magnitude for kittiwake is, in any case, likely to be over-estimated. There is significant precaution in the calculation of both collision and displacement effects, furthermore, tracking studies indicate that few kittiwake from the Forth Islands SPA (Appendix 16B [Seabird Apportioning]) interact with the project site.

16.525. Further work has been undertaken to understand the consequences of the higher of these predicted impacts (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 (Table 16.41) 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 10,410 pairs. This is very similar to the predicted population in the absence of any impact as indicated by the high ratio of the counterfactual of population size (0.98) and the similarity of the centile of un-impacted population that is equivalent to the 50th centile for the impacted population (0.53).

16.526. 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 impact of Project Alpha and Project Bravo combined 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. Recent monitoring data from the colony (Table 16.27) also indicate that the population is stable or growing.

16.527. As highlighted in the Scoping Opinions for all Forth and Tay Projects (Marine Scotland, 2017), for kittiwake, collision 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. Combining the predicted cumulative collision and displacement mortality results in a combined adult mortality of 9 to 10 individuals per year, which in terms of the PVA, is not materially higher than that predicted for collision alone.

16.528. 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.

16.529. The additional annual adult collision mortality for **herring gull** is effectively zero and therefore well below 1% of the baseline adult mortality (0.3 cf. 22 individuals).

16.530. Consequently, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that herring gull will remain a viable component of the site.

16.531. For **auk** species, the predicted additional annual adult mortality arising from displacement is relatively low and, in each case, below 1% of the baseline adult mortality: guillemot (15–19 cf. 24 individuals), razorbill (3–6 cf. 8 individuals) and puffin (23 cf. 85 individuals). These impacts are also relatively low in comparison to the size of the auk populations which now comprise guillemot 38,573 individuals compared to 21,440 individuals at designation; razorbill 7,792 individuals compared to 2,800 individuals at designation; puffin 45,005 pairs compared to 14,000 at designation). Recent monitoring data indicate that each of these populations as stable or growing (Table 16.28).

16.532. Further work has also been undertaken to understand the consequences of this level of impact on the Forth Islands SPA auk populations 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 (Table 16.39) indicate that:

- For guillemot and puffin the impacted populations will continue to grow at very similar rates to those that are predicted by the PVA for the un-impacted population. The predicted median population growth rate for both species (1.03) for the impacted population is essentially indistinguishable from that of the un-impacted population (counterfactual of the median population growth rate ≈ 1 in both cases);
- The similarity of the predicted growth rates for guillemot and puffin leads to similar population outcomes. The model predicts a median end population size (in the impacted scenario) of 86,034 to 85,784 individuals for guillemot and 88,956–88,844 pairs for puffin. These are very similar to the predicted populations in the absence of any impact as indicated by the high ratio of the counterfactual of population size (0.99 for both guillemot and puffin) and the similarity of the centile of un-impacted population that is equivalent to the 50th centile for the impacted population (0.53 to 0.55 for guillemot and 0.51 for puffin).
- For razorbill, the PVA model indicates a slightly declining population over the model period with or without the impacted populations. Although it should be noted that recent monitoring data indicate population growth. The predicted median population growth rate is 1.00 (although as the end population slightly declines over 25 years, this value is probably very slightly less than 1) when the effects of displacement are included which is essentially indistinguishable from that of the un-impacted population (counterfactual of the median population growth rate ≈ 1);
- As the growth rate is less than 1 the predicted median end population 7,199 to 7,146 individuals of razorbill is slightly less than the current population (7,792 individuals) but similar to that predicted in the absence of any impact (counterfactual of population size = 0.99 to 0.98 and the centile of un-impacted population that is equivalent to the 50th centile for the impacted population = 0.52 to 0.54). This difference should be considered to be negligibly small given that the model is predicting changes over a 25 year period.

16.533. The current guillemot, razorbill and puffin populations far exceed the populations for which the SPA was designated. At the levels of displacement mortality predicted for Project Alpha and Project Bravo combined, PVA modelling indicates that the populations of guillemot and razorbill are likely to continue to grow and that razorbill will decline slightly (with or without the additional mortality). At this level of impact it is considered that there is a negligible risk that the populations of guillemot, razorbill or puffin would decline to a level at which they would no longer be considered to be viable components of the SPA. In practice both the impacts and population responses are expected to be of lower magnitude than considered here due to the precaution in the quantification of displacement impacts and the simplistic nature of the PVA model which does not include any assumptions about density dependent compensatory mechanisms within the modelled populations.

16.534. With respect to the predicted impacts associated with Project Alpha and Project Bravo combine, **an adverse effect on site integrity can be excluded because all the qualifying interests will remain viable components of the site**.

Fowlsheugh SPA

16.535. The assessment has been conducted with respect to the following features screened into the HRA:

- Kittiwake (collision and displacement);
- Herring gull (collision);
- Guillemot (displacement); and
- Razorbill (displacement).

16.536. The additional annual adult mortality of **kittiwake** has been calculated separately for collision and displacement. The predicted mortality exceeds 1% of the baseline adult mortality for kittiwake for collision (68 cf. 28 individuals) whereas for displacement this threshold is exceeded only if outlier data are included (14-31 cf. 28 individuals).

16.537. It should be noted that the magnitude of the collision mortality impact is likely to be overestimated for a number of reasons:

- The collision risk modelling for the optimised Seagreen project makes a number of conservative assumptions including that kittiwake foraging activity at night is equivalent to 25% of the daytime activity levels and flight speed is 13.1m/s. Recent studies at Thanet (Skov *et al.* 2018) found kittiwake nocturnal activity to be less than 5% of daytime activity and measured average flight speeds of 8.71m/s. The same study also calculated empirical avoidance rates of 99.8% for kittiwake, higher than the 99.2% avoidance rate estimated in Cook et al (In press), and the 98.9% applied in this assessment. Whilst, avoidance behaviour may differ for breeding birds tied to their colonies for chick provisioning compared to those at Thanet, which were, in the main, non-breeding birds, it seems likely that current guidance on avoidance rates is precautionary;
- The rotor speed used to derive the collision numbers is based on values for the worst case 167 m rotor diameter turbine. Should larger turbines be deployed – up to 220m rotor – rotor speed would reduce; and
- Estimates of precaution are quantified in Appendix 8B Collision Risk Modelling Table 14. They show that changing flight speed from 13.1m/s to 8.71m/s would reduce kittiwake collision estimates by ~19%. Changing rotor parameters from 167m to 220m would reduce them by 9%. These effects were modelled separately, but if modelled together would reduce effects still further.

16.538. The assumed connectivity with Fowlsheugh SPA, and associated apportioning, of impacts to that site is also highly conservative:

- The optimised Seagreen project lies within the mean-max foraging range (Thaxter *et al.* 2012) of kittiwake breeding at that colony. However, the results of GPS tracking studies (FAME, Future of the Atlantic Marine Environment [2012] indicated that very few kittiwakes tracked from Fowlsheugh interacted with the project site. The peer-reviewed paper (Wakefield *et al.* 2017) based on these data suggested that the optimised Seagreen project was in an area where at-sea utilisation by breeding kittiwake was only between 5 and 10%. Similarly, the tracking of 54 birds from Fowlsheugh by CEH indicated that the Seagreen sites were not part of the core foraging area for this colony (Daunt, 2011a; 2011b). The apportioning model currently under development by CEH is understood to be based, at least in part, on tracking data. Current apportioning methods which do not take such data into account may therefore be another source of precaution;

- The apportioning conducted for this assessment has led to an apparent increase in the effect on kittiwake at Fowlsheugh from 51% (used to assign collision effects in the previous Scottish Ministers HRA [2014] [SNH Unpublished data, Seagreen ES 2014]) to 61% (Appendix 16B [Seabird Apportioning]). This difference, however, appears to be related primarily to the definition of the Fowlsheugh population used. In this assessment, all of the relevant count sectors for the SPA have been included which increases the relative weight of Fowlsheugh in the apportioning exercise; and
- The assessment assumes that 94.2% of birds are adult breeding birds based on the proportion of first year birds recorded during boat-based surveys and the likely age structure of the population. Although 10% are assumed to be sabbatical i.e. non-breeding in that year, numbers are likely to remain precautionary because the proportion of first year birds present in natal waters is likely to be lower than that of older immature birds which are indistinguishable from adults, and such immature birds may be concentrated in certain foraging areas (Appendix 16B Apportioning Assessment Ornithology).

16.539. Consequently it is considered that there is considerable precaution both in relation to the estimation of collision mortality for kittiwake and in the apportioning of that impact to Fowlsheugh SPA.

16.540. In accordance with the advice of the Scottish Ministers in the 2017 Scoping Opinion, PVA (Appendix 8D [Population Viability Analysis]) was used to the establish whether or not the population of kittiwake can be maintained as a viable component of Fowlsheugh SPA in the long term. The 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, 2011b), the current Fowlsheugh SPA population of 9,655 being lower than the population of 36,650 pairs cited at the time of the marine extension designation in 2009 (Scottish Natural Heritage, 2009c). More recent counts indicate a more stable population, albeit at a reduced level from that which was designated (Table 16.29).

16.541. The outputs of the PVA modelling, using the metrics advised by Marine Scotland, over the 25 year operational life time of the Project Alpha and Project Bravo combined (Table 16.41) predict that the un-impacted population will grow slowly and this is not considered to be inconsistent with the recent monitoring data for Fowlsheugh (Table 16.29).

16.542. The effect of including the predicted 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 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 very similar to that of the un-impacted population (counterfactual of the median population growth rate = 1.00); 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 20,181 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 (0.90) and the centile of un-impacted population that is equivalent to the 50th centile for the impacted population (0.63).

16.543. Whilst the PVA model indicates the kittiwake population would continue to grow, there would be a lower kittiwake population at Fowlsheugh SPA after Project Alpha and Project Bravo combined have 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; and
- Over-estimation of the population response to the apportioned impact due to the simplistic nature of the PVA model used.

16.544. As highlighted in the Scoping Opinions for all Forth and Tay Projects (Marine Scotland, 2017), for kittiwake, collision 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. Combining the predicted cumulative collision and displacement mortality results in a combined adult mortality of 84 to 100 individuals per year, which PVA modelling indicates, in any case, is unlikely to lead to a significantly different outcome for the population than that predicted for collision alone.

16.545. In light of this precaution it is considered unlikely that the population would be reduced below that which is currently present due to the effects of Project Alpha and Project Bravo combined. The long term viability of kittiwake as a component of Fowlsheugh SPA will therefore be maintained in its current state.

16.546. The additional annual adult collision mortality for **herring gull** is effectively zero and therefore well below 1% of the baseline adult mortality (0.1 cf. 0.4 individuals).

16.547. Consequently, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that herring gull will remain a viable component of the site.

16.548. For **guillemot**, the predicted mortality from displacement is 41-53 individuals per annum, based on the relatively high assumed displacement rate of 60% across the wind farm and a 2km buffer area. For **razorbill**, the predicted mortality from displacement is 11 to 18 individuals per annum. The predicted displacement impacts for both species are considered to be low but exceed 1% of the baseline adult mortality for the respective populations (guillemot: 41–53 cf. 45 individuals; razorbill: 11-18 cf. 10 individuals), although guillemot is below this threshold if the outlying data are excluded.

16.549. Further work has been undertaken to understand the consequences of this level of impact on Fowlsheugh SPA guillemot and razorbill populations 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 (Table 16.39) indicate that:

- For guillemot, 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);
- 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 164,693

to 164,013 individuals. This is very similar to the predicted population in the absence of any impact as indicated by the high ratio of the counterfactual of population size (0.98) and the similarity of the centile of un-impacted population that is equivalent to the 50th centile for the impacted population (0.57 to 0.59);

- For razorbill, the PVA model indicates a slightly declining population over the model period with or without the impacted populations. The predicted median population growth rate is 1.00 (although as the end population slightly declines over 25 years, this value is probably very slightly less than 1) when the effects of displacement are included which is essentially indistinguishable from that of the un-impacted population (counterfactual of the median population growth rate ≈ 1); and
- As the growth rate is less than 1 the predicted median end population 8,985 to 8,804 individuals is slightly less than the current population (9,950 individuals) but similar to that predicted in the absence of any impact (counterfactual of population size = 0.97 to 0.95 and the centile of un-impacted population that is equivalent to the 50th centile for the impacted population = 0.54 to 0.56). This difference should be considered to be negligibly small given that the model is predicting changes over a 25 year period.

16.550. The current guillemot and razorbill populations far exceed the populations for which the SPA was designated. At the levels of displacement mortality predicted for Project Alpha and Project Bravo combined, PVA modelling indicates that the populations of guillemot and razorbill are likely to continue to grow and that razorbill will decline slightly (with or without this additional mortality). At this level of impact it is considered that there is a negligible risk that the populations of guillemot and razorbill would decline to a level at which they would no longer be considered to be viable components of the SPA. In practice both the impacts and population responses are expected to be of lower magnitude than considered here due to the precaution in the quantification of displacement impacts and the simplistic nature of the PVA model which does not include any assumptions about density dependent compensatory mechanisms within the modelled populations.

16.551. With respect to the predicted impacts associated with Project Alpha and Project Bravo combined, **an adverse effect on site integrity can be excluded because all the qualifying interests will remain viable components of the site**.

St Abb's Head to Fast Castle SPA

16.552. The assessment has been conducted with respect to the following features screened into the HRA:

- Kittiwake (collision and displacement);
- Herring gull (collision);
- Guillemot (displacement); and
- Razorbill (displacement).

16.553. The additional annual adult mortality of **kittiwake** has been calculated separately for collision and displacement. In both cases the predicted mortality is below 1% of the baseline adult mortality for kittiwake (collision: 12 cf. 14 individuals; displacement: 2–5 cf. 14 individuals). This is relative to the population size for kittiwake (9,606 pairs).

16.554. This level of mortality represents a very small proportion of the population that is not indicative of an adverse effect, particularly within the context of the precaution built into the impact assessment methodology.

16.555. As highlighted in the Scoping Opinions for all Forth and Tay Projects (Marine Scotland, 2017), for kittiwake, collision 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. Combining the predicted collision and displacement mortality results in a combined adult mortality of 14 to 17 individuals per year still represents a very small proportion of the population that is not indicative of an adverse effect, particularly within the context of the precaution built into the impact assessment methodology.

16.556. Consequently, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that guillemot and razorbill will remain viable components of the site.

16.557. The additional annual adult collision mortality for **herring gull** is effectively zero and therefore well below 1% of the baseline adult mortality (0.6 cf. 1 individuals). This is relative to the population size for herring gull (650 individuals).

16.558. Consequently, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that herring gull will remain a viable component of the site.

16.559. For **auks** additional annual adult mortality is below 1% of the baseline adult mortality: guillemot (10–13 cf. 22 individuals) and razorbill (1-2 cf. 2 individuals). This is relative to the current population size for guillemot (36,206 individuals) and razorbill (2,067 individuals).

16.560. This level of mortality represents a very small proportion of the population that is not indicative of an adverse effect. Furthermore, the impact assessment methodology is considered to be highly precautionary and there is also uncertainty that an impact will occur for these species (see Searle *et al.*, 2014; APEM, 2017; Vanermen *et al.*, 2017). Consequently, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that guillemot and razorbill will remain viable components of the site.

16.561. With respect to the predicted impacts associated with Project Alpha and Project Bravo combined, **an adverse effect on site integrity can be excluded because all the qualifying interests will remain viable components of the site**.

Outer Firth of Forth and St Andrews Bay pSPA

16.562. There is no direct predicted impact of Project Alpha and Project Bravo combined on this pSPA, however, there exists the potential for an indirect effect, should the populations of those SPAs from which foraging birds originate be adversely affected. The relevant features for this assessment are:

- Gannet;
- Kittiwake ;
- Herring gull;
- Guillemot;
- Razorbill; and
- Puffin.

16.563. With respect to these features, the conservation objectives of the pSPA are to:

- Avoid significant mortality, injury and disturbance of the qualifying interests, so that the distribution of the species and ability to use the site are maintained in the long-term; and
- Maintain the habitats and food resources of the qualifying interests in favourable condition.

16.564. This assessment has already considered the potential for an adverse effect on each of the breeding populations that are also features of the pSPA. In each case it has been concluded that these features will remain viable components of the respective sites and no adverse effect on the integrity of those sites is predicted. Project Alpha and Project Bravo combined are not located within the pSPA and no part of the proposed development will directly impact the pSPA, consequently it is not predicted that there will be any impact on the habitats or food resources of the pSPA.

16.565. Consequently, with respect to the predicted impacts associated with Project Alpha and Project Bravo combined, **an adverse effect on site integrity is not predicted.**

Appropriate Assessment Summary: Project Alpha and Project Bravo Combined Displacement

16.566. Table 16.42 summarises the assessment undertaken and the determination, prior to mitigation, of whether or not there is an adverse effect on site integrity for each European site.

Table 16.42 Appropriate Assessment Matrix: Project Alpha and Project Bravo combined

Conservation Objective	Buchan Ness to Collieston Coast SPA	Forth Islands SPA	Fowlsheugh SPA	St Abb's Head to Fast Castle SPA
	Kittiwake Herring gull Guillemot	Gannet (PVA) Kittiwake (PVA) Herring gull Guillemot (PVA) Razorbill (PVA) Puffin (PVA)	Kittiwake (PVA) Herring gull Guillemot (PVA) Razorbill (PVA)	Kittiwake Herring gull Guillemot Razorbill
To ensure for the qualifying species that the following are maintained in the long term:				
Population of the species as a viable component of the site	*No Adverse Effect on Site Integrity* Predicted additional annual adult mortality will not be of a magnitude that will prevent any qualifying interest from remaining a viable component of the site in the long term. For qualifying interests except kittiwake at Forth Islands SPA and Fowlsheugh SPA, this conclusion is based on there being no indication that the population at the end of the project will be less than that at designation. For species not assessed by PVA this conclusion is based on a comparison between the magnitude of the impact with baseline adult mortality within the context of using the worst case displacement and mortality rates and the precaution built into the displacement and collision impact prediction methodology. For those kittiwake populations that are already below the level for which they were designated, PVA does not indicate that the additional impact will reduce growth rates sufficiently to prevent those populations from growing and hence from being potentially restored to their former level.			
Distribution of the species within site	*No Adverse Effect on Site Integrity* Project Alpha and Project Bravo combined are located outwith the European site. The potential effect of displacement will therefore not impact the distribution of the qualifying interests within site.			
Distribution and extent of habitats supporting the species	*No Adverse Effect on Site Integrity* Project Alpha and Project Bravo combined are located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
Structure, function and supporting processes of habitats supporting the species	*No Adverse Effect on Site Integrity* Project Alpha and Project Bravo combined are located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
No significant disturbance of the species	*No Adverse Effect on Site Integrity* Project Alpha and Project Bravo combined are located outwith the European site and the impact of disturbance was scoped out of this assessment.			

16.567. Table 16.43 provides summary information with regard to the Outer Firth of Forth and St Andrews Bay Complex pSPA.

Table 16.43 Appropriate Assessment Matrix for Outer Firth of Forth and St Andrews Bay pSPA: Project Alpha and Project Bravo combined

Conservation objective	Outer Firth of Forth and St Andrews Bay pSPA
	Gannet **Kittiwake** **Herring gull** **Guillemot** **Razorbill** **Puffin**
Avoid significant mortality, injury and disturbance of the qualifying interests, so that the distribution of the species and ability to use the site are maintained in the long-term	*No Adverse Effect on Site Integrity* Additional annual adult mortality will not be of a magnitude that will impact the potential for any qualifying interest to remain a viable component in the long term of the SPA breeding colonies that use the pSPA for foraging. Consequently the qualifying interest distribution and ability to use the pSPA is maintained in the long-term. For qualifying interests assessed by PVA this conclusion is based on there being no indication that the population at the end of the project will be less than that at designation or that the growth rate in the population would be reduced sufficiently to prevent the population from growing and potentially being restored to its former level. For species not assessed by PVA this conclusion is based on a comparison between the magnitude of the impact with baseline adult mortality within the context of using the worst case displacement and mortality rates and the precaution built into the displacement and collision impact prediction methodology.
To maintain the habitats and food resources of the qualifying interests in favourable condition	*No Adverse Effect on Site Integrity* Project Alpha and Project Bravo combined are located outwith the pSPA and the impacts related to habitats and food resources were scoped out of this assessment.

Optimised Seagreen Project in Combination with Other Projects

Introduction

16.568. The optimised Seagreen Project has the potential to act "in combination" with one or more plans/projects to produce a cumulative impact. In keeping with the assessments of Project Alpha alone, Project Bravo alone and Project Alpha and Project Bravo combined, the in combination assessment in this HRA considers cumulative operational displacement and collision mortality only on the following sites and features:

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

16.569. The 2017 Scoping Opinion advised that information is provided on the licensed Seagreen Transmission Asset project to inform the HRA with regards to in combination impacts and the Outer Firth of Forth and St Andrews Bay Complex pSPA.

16.570. In combination impacts have been calculated by combining the predicted impact of the optimised Seagreen Project (being equivalent to the impacts of Project Alpha and Project Bravo combined) together with the predicted impacts of other relevant projects (Table 16.5). Collision risk estimates for Neart na Gaoithe have been sourced from the recently submitted application documents (Mainstream, 2018). Appendix 8.B (Collision Risk Modelling) presents collision risk numbers for Inch Cape based on scenarios put forward in the scoping report for that project (ICOL, 2017). There are no relevant plans to include in this in combination assessment. For Project Alpha, Project Bravo and Project Alpha and Project Bravo combined, a range of impacts were predicted reflecting the inclusion and exclusion of outlier data from an exceptional foraging event encountered during a survey in July 2017. In those cases the outcome of the assessment is not materially different with or without the inclusion of those exceptional data (although it is considered that their inclusion does not reflect typical conditions and more weight should be placed on the predictions that exclude those data). For this in combination assessment, cumulative impacts have been calculated using those predictions for Project Alpha and Project Bravo combined that exclude the outlying data. This is on the basis that the impact predictions for Project Alpha and Project Bravo combined are more typical of the effects expected for those projects and that there is already considerable uncertainty and precaution incorporated into the in combination assessment. Furthermore the exclusion of the outlying data recorded in 2017 means the impact predictions for Project Alpha and Project Bravo combined are more comparable to those of other Forth and Tay projects whose impacts are predicted only on the basis of data collected prior to 2014.

16.571. It should be noted that projects have a differing potential to ultimately contribute to a cumulative impact alongside the optimised Seagreen Project. 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 where an impact pathway exists. Thus, appropriate weight can be given to each project in the decision-making process when considering the potential cumulative impact associated with the optimised Seagreen Project.

16.572. Furthermore, the precautionary elements in the calculation of impact magnitude for Project Alpha and Project Bravo combined are built in to all other projects considered in the in combination assessment. The resulting compound precaution in the cumulative impact magnitude means that the assessment can be considered as highly conservative.

16.573. It should be noted that, as set out in Table 16.11, the maximum number of WTGs that would be installed for Project Alpha and Project Bravo combined (the optimised Seagreen Project) is 120.

16.574. In the following sub-section the features and impacts screened into this assessment are summarised. The predicted in combination effects from relevant projects are summarised as are the results of any relevant PVA modelling. In combination impacts are then assessed.

Seagreen Transmission Asset

16.575. The potential impacts of the licensed Seagreen Transmission Asset are assessed in the 2012 Offshore ES Chapter 10 (Ornithology) paragraphs 10.319 to 10.339 and the conclusions of that assessment are summarised in Table 10.27 of that chapter.

16.576. The potential for disturbance and displacement, as well as indirect impacts, caused by the construction of up to five offshore substation platforms (OSP) requiring the installation of up to 72 piles and the export cable was assessed for gannet, kittiwake, great black-backed gull, guillemot, razorbill and puffin. The assessment focused on disturbance caused by construction activities, including piling and the presence of construction and cable laying vessels. Potential indirect effects on prey species resulting from loss of habitat, suspended sediments, sediment disturbance and noise were also assessed.

16.577. The impacts of OSP installation were considered to be localised and temporary and of negligible magnitude for all species. The impacts of export cable installation were considered to be localised and temporary and of negligible magnitude for all species. No potential for significant impacts were predicted for indirect effects on prey species either from OSP or export cable installation.

16.578. Overall, potential impacts were assessed as being of negligible to minor significance and, therefore, **not significant** in all cases (Table 10.27 of Chapter 10 [Ornithology]of the 2012 Offshore ES).

16.579. The Seagreen Transmission Asset was subsequently licenced on this basis.

16.580. The licensed Seagreen Transmission Asset has been included in this in combination assessment as requested in the 2017 Scoping Opinion. It is considered, however, on the basis of the assessment undertaken in the 2012 Offshore ES that the construction of the transmission asset will lead to negligible additional displacement and disturbance during the construction phase and no additional displacement and disturbance during the operational phase. As such there will be no material contribution of the transmission asset to the in combination impacts assessed here, which consider only operational effects as specified in the 2017 Scoping Opinion.

Site Assessments

Buchan Ness to Collieston Coast SPA

16.581. The assessment has been conducted with respect to the following features screened into the HRA:

- Kittiwake (collision and displacement);
- Herring gull (collision); and
- Guillemot (displacement).

16.582. Although **kittiwake** was screened into this HRA by the Scottish Ministers, no impacts are predicted on this population due to the optimised Seagreen Project. The colony lies at the limits of the foraging distance (using the mean maximum foraging range indicated in Thaxter *et al.* (2012) + 1 standard deviation, which is considered to be a highly precautionary method for establishing connectivity.

16.583. Consequently, it is considered that there will be no effect on the population size and it is concluded that kittiwake will remain a viable component of the site.

16.584. The additional annual adult mortality for **herring gull** is summarised in Table 16.44. The cumulative collision mortality rate is 10.1, which equal to 1% of the baseline adult mortality (10 individuals). It should be noted though that the contribution of the optimised Seagreen Project to this total is effectively zero.

Table 16.44 Predicted cumulative herring gull annual adult mortality from collision for Buchan Ness to Collieston Coast SPA

Project	Herring Gull		
	Breeding	Non-breeding	Total
1% baseline mortality	**10**		
The optimised Seagreen Project			
Project Alpha and Project Bravo combined (a)	<1	0.1	**0.1**
Forth & Tay Projects (b)			
Neart na Gaoithe	<1	<1	<1
Inch Cape	<1	1	**1**
Aberdeen Demo	2	<1	**2**
Hywind	1	<1	**1**
Kincardine	<1	<1	<1
Other UK Projects			
Combined UK Projects Total	-	5	**5**
In Combination			
Cumulative Total	3	8	**10.1**

16.585. In any case, the predicted impact is considered to be precautionary, the use of a flight speed of 12.8 m/s in the CRM is higher than the 9.7 m/s recorded in the ORJIP study (Skov *et al.*, 2018). Such a reduction in flight speed parameter would likely reduce the predicted mortality estimate for the optimised Seagreen Project in line within the range of reductions calculated for gannet and kittiwake, i.e. between 6–20% (Appendix 8B (Collision Risk Modelling)). The avoidance rate for herring gull is also considered to be precautionary in light of Skov *et al.* (2018), which indicates a higher rate of avoidance for this species than is currently assumed (leading to predicted to rates of mortality that are 10 to 20% of those assumed in this assessment). Additional reductions of a similar nature are also likely to be relevant for the predicted impacts arising from other offshore wind farm projects although the magnitude of these reductions are dependent on project specific turbine parameters.

16.586. In light of the relatively low in combination collision rate and the considerable precaution in collision rate predictions, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that herring gull will likely remain a viable component of the site.

16.587. The predicted cumulative additional annual adult mortality for **guillemot** from displacement is summarised in Table 16.45. The cumulative mortality rate from displacement is below 1% of the baseline adult mortality (9 cf. 21 individuals) for the current population of 33,632 individuals.

16.588. This level of cumulative mortality represents a very small proportion of the population that is not indicative of an adverse effect. Furthermore, the impact assessment methodology is considered to be highly precautionary and there is also uncertainty that an impact will occur for these species (see Searle *et al.*, 2014; APEM, 2017; Vanermen *et al.*, 2017). Consequently, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that guillemot will remain a viable component of the site.

Table 16.45 Predicted cumulative guillemot annual adult mortality from displacement for Buchan Ness to Collieston Coast SPA

Project	Guillemot		
	Breeding	Non-breeding	Total
1% baseline mortality	**21**		
The optimised Seagreen Project			
Project Alpha and Project Bravo combined	2	1	**3**
Forth & Tay Projects			
Inch Cape	<1	<1	<1
Neart na Gaoithe	<1	<1	1
Kincardine	<1	<1	<1
Hywind	1	<1	1
Aberdeen Demo	4	<1	4
In Combination			
Cumulative Total	7	3	**9**

NB. All values are rounded to the nearest whole number

16.589. With respect to the predicted cumulative impacts associated with the optimised Seagreen Project, **an adverse effect on site integrity can be excluded because all the qualifying interests will remain viable components of the site.**

Forth Islands SPA

16.590. The assessment has been conducted with respect to the following features screened into the HRA:

- Gannet (collision);
- Kittiwake (collision and displacement);
- Herring gull (collision);
- Guillemot (displacement);
- Razorbill (displacement); and
- Puffin (displacement).

16.591. The predicted cumulative collision mortality for **gannet** is 951 individuals per annum (Table 16.46).

16.592. It should be noted, however, that this prediction is considered to be precautionary because it is based on CRM assumptions that do not take account of recent empirical data relating to flight speed and avoidance rates which, if factored into CRM individually or collectively, would significantly reduce the predicted magnitude of this impact. For example, the use of a flight speed of 13.3m/s compared to 14.9m/s as used in this assessment would reduce predicted mortality rates by approximately 6% (see Table 14, Appendix 8B [Collision Risk Modelling]). The use of a higher avoidance rate (say 99.9%) would reduce the predicted collision rate to a value that is approximately 10% of that used in this assessment.

16.593. It should also be noted that the in combination collision rate includes contributions from projects are not certain to proceed to construction and operation.

Table 16.46 Predicted cumulative gannet, kittiwake and herring gull annual adult mortality from collision for Forth Islands SPA

Project	Gannet			Kittiwake			Herring Gull	
	B	Po/PB	Total	B	Po/PB	Total	B/NB	Total
1% baseline mortality	**122**			**14**			**22**	
The optimised Seagreen Project								
Project Alpha and Project Bravo combined	308	6/8	**323**	7	<1/<1	**7**	0.2/0.1	**0.3**
Forth & Tay Projects								
Neart na Gaoithe	91	14/<1	105	6	10/1	**17**	2/3	**5**
Inch Cape	352	2/1	**355**	1	1/0	**2**	<1/<1	<1
Aberdeen Demo	5	1/<1	**6**	-	-	**-**	-	**-**
Hywind	4	<1/1	**5**	-	-	**-**	-	**-**
Kincardine	8	<1/<1	**8**	-	-	**-**	-	**-**
Other UK Projects								
Combined UK Projects Total	-	104/44	**149**	-	4/6	**10**	-/5	**5**
In Combination								
Cumulative Total	768	128/55	**951**	13	16/8	**37**	2/10	**12.3**

PB = Pre-breeding; B = Breeding; NB = Non-breeding; Po = Post-breeding

NB. All values are rounded to the nearest whole number

16.594. 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 (Table 16.27) 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]).

16.595. The outputs of the PVA modelling over the 25 year operational life time of the optimised Seagreen Project (Table 16.47) 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.

16.596. 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.

Table 16.47 PVA metrics for cumulative gannet and kittiwake annual adult mortality from collision in relation to Forth Islands SPA

Metric	Gannet	Kittiwake
Total additional annual adult mortality[A]	951	37
Counterfactual population size[B]	0.83	0.89
Median pop[n.] growth rate[B]	1.00	1.03
Counterfactual population growth rate[B]	0.99	1.00
Centile of un-impacted popn. = 50th centile for impacted popn.[B]	0.88	0.64
Median end population size[B]	73,599p	9,461p
Current population size[C]	75,259p	4,663p
Designated population size[C]	21,600p	8,400p

[A] Table 16.46;

[B] Methodology underpinning these outputs is described in Appendix 8D (Population Viability Analysis);

[C] Scottish Natural Heritage, 2017c; p = pairs; i = individuals

16.597. The cumulative additional annual adult mortality of **kittiwake** has been calculated separately for collision and displacement. The predicted cumulative mortality is equivalent to 1% of the baseline adult mortality for displacement (14 cf. 14 individuals) but above 1% of the baseline adult mortality for collision (37 cf. 14 individuals).

16.598. It should be noted that the cumulative impact magnitude for kittiwake is, in any case, likely to be over-estimated. There is significant precaution in the calculation of both collision and displacement effects, furthermore, tracking studies indicate that few kittiwake from the Forth Islands SPA (Appendix 16B [Seabird Apportioning]) interact with the project site.

16.599. Further work has been undertaken to understand the consequences of the higher of these predicted cumulative impacts (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 (Table 16.47) 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).

16.600. As highlighted in the Scoping Opinions for all Forth and Tay Projects (Marine Scotland, 2017), for kittiwake, collision 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. Combining the predicted cumulative collision and displacement mortality results in a combined adult mortality of 51 individuals per year, which PVA modelling indicates, in any case, is unlikely to lead to a significantly different outcome for the population than that predicted for collision alone.

16.601. 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 (Table 16.27) 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).

16.602. 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.

16.603. The additional annual adult collision mortality for **herring gull** is low and well below 1% of the baseline adult mortality (12 cf. 22 individuals). It should also be noted that the optimised Seagreen Project makes a relatively small contribution to this total.

16.604. The predicted impact is considered to be precautionary; the use of a flight speed of 12.8m/s in the CRM is higher than the 9.7m/s recorded in the ORJIP study (Skov *et al.*, 2018). Such a reduction in flight speed parameter would likely reduce the predicted mortality estimate for the optimised Seagreen Project in line within the range of reductions calculated for gannet and kittiwake, i.e. between 6 to 20% (Appendix 8B [Collision Risk Modelling]). The avoidance rate for herring gull is also considered to be precautionary in light of Skov *et al.* (2018), which indicates a higher rate of avoidance for this species than is currently assumed (leading to predicted to rates of mortality that are 10 to 20% of those assumed in this assessment). Additional reductions of a similar nature are also likely to be relevant for the predicted impacts arising from other offshore wind farm projects although the magnitude of these reductions are dependent on project specific turbine parameters.

16.605. In light of the relatively low in combination collision rate and the considerable precaution in collision rate predictions, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that herring gull will likely remain a viable component of the site.

16.606. For **auk** species, the predicted cumulative additional annual adult mortality arising from displacement (Table 16.48) is above 1% of the baseline adult mortality: guillemot (58 cf. 24 individuals), razorbill (24 cf. 8 individuals) and puffin (86 cf. 85 individuals). These impacts are relatively low in comparison to the size of the auk populations which now comprise guillemot 38,573 individuals compared to 21,440 individuals at designation; razorbill 7,792 individuals compared to 2,800 individuals at designation; puffin 45,005 pairs compared to 14,000 pairs at designation). Recent monitoring data indicate that each of these populations are stable or growing (Table 16.28).

Table 16.48 Predicted cumulative kittiwake, guillemot, razorbill and puffin annual adult mortality from displacement for Forth Islands SPA

Project	Kittiwake			Guillemot		Razorbill		Puffin
	B	Po/PB	Total	B/NB	Total	B/NB	Total	B (Total)
1% baseline mortality	**14**			**24**		**8**		**85**
The optimised Seagreen Project								
Project Alpha and Project Bravo combined	1	-	**2**	9/6	**15**	2/1	**3**	**23**
Forth & Tay Projects								
Inch Cape	1	<1/<1	**1**	3/2	**5**	1/2	**3**	**28**
Neart na Gaoithe	5	6/<1	**11**	9/29	**38**	3/15	**18**	**35**
In Combination								
Cumulative Total	7	6/1	**14**	21/37	**58**	5/18	**24**	**86**

PB = Pre-breeding; B = Breeding; NB = Non-breeding; Po = Post-breeding

NB. All values are rounded to the nearest whole number

16.607. Further work has also been undertaken to understand the consequences of this level of cumulative impact on the Forth Islands SPA auk populations 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 (Table 16.49) indicate that:

- For guillemot and puffin the impacted populations will continue to grow at very similar rates to those that are predicted by the PVA for the un-impacted population. The predicted median population growth rate for guillemot and puffin (1.03) for the impacted population is essentially indistinguishable from that of the un-impacted population (counterfactual of the median population growth rate ≈ 1 in both cases);
- The similarity of the predicted growth rates for guillemot and puffin leads to similar population outcomes. The model predicts a median end population size (in the impacted scenario) of 83,389 individuals for guillemot and 87,090 pairs for puffin. These are similar to the predicted populations in the absence of any impact as indicated by the high ratio of the counterfactual of population size (0.96 for guillemot and 0.97 for puffin) and the centile of un-impacted population that is equivalent to the 50th centile for the impacted population (0.67 for guillemot and 0.53 for puffin); and
- For razorbill, the PVA model indicates a slightly declining population over the model period with or without the impacted populations. Although it should be noted that recent monitoring data indicate population growth. The predicted median population growth rate is 0.99 when the effects of cumulative displacement are included which is essentially indistinguishable from that of the un-impacted population (counterfactual of the median population growth rate ≈ 1).

16.608. As the growth rate is less than 1 the predicted median end population 6,690 individuals is less than the current population (7,792 individuals) but similar to that predicted in the absence of any impact (counterfactual of population size = 0.92 and the centile of un-impacted population that is equivalent to the 50th centile for the impacted population = 0.60). This difference should be considered to be very small given that the model is predicting changes over a 25 year period.

Table 16.49 PVA metrics for cumulative kittiwake, guillemot, razorbill and puffin annual adult mortality from displacement in relation to Forth Islands SPA

Metric	Kittiwake	Guillemot	Razorbill	Puffin
Total additional annual adult mortality[A]	14	58	24	86
Counterfactual population size[B]	0.96	0.96	0.92	0.97
Median pop$^{n.}$ growth rate[B]	1.03	1.03	0.99	1.03
Counterfactual population growth rate[B]	0.99	1.00	1.00	1.00
Centile of un-impacted popn. = 50th centile for impacted popn.[B]	0.56	0.67	0.60	0.53
Median end population size[B]	10,213p	83,389i	6,690i	87,090p
Current population size[C]	4,663p	38,573i	7,792i	45,005p
Designated population size[C]	8,400p	21,440i	2,800i	14,000p

[A] Table 16.48;

[B] Methodology underpinning these outputs is described in Appendix 8D (Population Viability Analysis);

[C] Scottish Natural Heritage, 2017c; p = pairs; i = individuals

16.609. The current guillemot, razorbill and puffin populations far exceed the populations for which the SPA was designated. At the levels of cumulative displacement mortality predicted for optimised Seagreen Project, PVA modelling indicates that the populations of guillemot and puffin are likely to continue to grow and that razorbill will decline slightly (with or without the additional mortality). At this level of cumulative impact it is considered that there is a negligible risk that the populations of guillemot, razorbill or puffin would decline to a level at which they would no longer be considered to be viable components of the SPA. In practice both the cumulative impacts and population responses are expected to be of lower magnitude than considered here due to the precaution in the quantification of displacement impacts and the simplistic nature of the PVA model which does not include any assumptions about density dependent compensatory mechanisms within the modelled populations.

16.610. With respect to the predicted cumulative impacts associated with optimised Seagreen Project, **an adverse effect on site integrity can be excluded because all the qualifying interests will remain viable components of the site**.

Fowlsheugh SPA

16.611. The assessment has been conducted with respect to the following features screened into the HRA:

- Kittiwake (collision and displacement);
- Herring gull (collision);
- Guillemot (displacement); and
- Razorbill (displacement).

16.612. The cumulative additional annual adult mortality of **kittiwake** (Table 16.50) has been calculated separately for collision and displacement. In both cases the predicted mortality is above 1% of the baseline adult mortality for kittiwake (collision: 125 cf. 28 individuals; displacement: 20 cf. 28 individuals).

Table 16.50 Predicted cumulative kittiwake and herring gull annual adult mortality from collision for Fowlsheugh SPA

Project	Kittiwake			Herring Gull	
	B	Po/PB	Total	B/NB	Total
1% baseline mortality	**28**			**0.4**	
The optimised Seagreen Project					
Project Alpha and Project Bravo combined	66	1/1	**68**	0.1/<1	**0.1**
Forth & Tay Projects					
Neart na Gaoithe	1	2/<1	**4**	<1/<1	<1
Inch Cape	3	3/1	**7**	<1/0.1	**0.1**
Aberdeen Demo	6	<1/<1	**6**	1.0/<1	**1.0**
Kincardine	8	<1/<1	**8**	0.2/<1	**0.2**
Other UK Projects					
Combined UK Projects Total	-	13/18	**31**	-/0.5	**0.5**
In Combination					
Cumulative Total	85	19/21	**125**	1.3/0.6	**1.9**

PB = Pre-breeding; B = Breeding; NB = Non-breeding; Po = Post-breeding

NB. All values are rounded to the nearest whole number, except in the case of herring gull

16.613. It should be noted that the magnitude of the cumulative collision mortality impact is likely to be overestimated for a number of reasons:

- The collision risk modelling for the optimised Seagreen project makes a number of conservative assumptions including that kittiwake foraging activity at night is equivalent to 25% of the daytime activity levels and flight speed is 13.1m/s. Recent studies at Thanet (Skov *et al.* 2018) found kittiwake nocturnal activity to be less than 5% of daytime activity and measured average flight speeds of 8.71m/s. The same study also calculated empirical avoidance rates of 99.8% for kittiwake, higher than the 99.2% avoidance rate estimated in Cook et al (In press), and the 98.9% applied in this assessment. Whilst, avoidance behaviour may differ for breeding birds tied to their colonies for chick provisioning compared to those at Thanet, which were, in the main, non-breeding birds, it seems likely that current guidance on avoidance rates is precautionary;
- The rotor speed used to derive the collision numbers is based on values for the worst case 167m rotor diameter turbine. Should larger turbines be deployed – up to 220m rotor – rotor speed would reduce; and
- Estimates of precaution are quantified in Appendix 8B Collision Risk Modelling Table 14. They show that changing flight speed from 13.1m/s to 8.71m/s would reduce kittiwake collision estimates by ~19%. Changing rotor parameters from 167m to 220m would reduce them by 9%. These effects were modelled separately, but if modelled together would reduce effects still further.

16.614. The assumed connectivity with Fowlsheugh SPA, and associated apportioning, of impacts to that site is also highly conservative:

- The optimised Seagreen project lies within the mean-max foraging range (Thaxter *et al.* 2012) of kittiwake breeding at that colony. However, the results of GPS tracking studies (FAME, Future of the Atlantic Marine Environment [2012] indicated that very few kittiwakes tracked from Fowlsheugh interacted with the project site. The peer-reviewed paper (Wakefield *et al.* 2017) based on these data suggested that the optimised Seagreen project was in an area where at-sea utilisation by breeding kittiwake was only between 5 and 10%. Similarly, the tracking of 54 birds from Fowlsheugh by CEH indicated that the Seagreen sites were not part of the core foraging area for this colony (Daunt, 2011a; 2011b). The apportioning model currently under development by CEH is understood to be based, at least in part, on tracking data. Current apportioning methods which do not take such data into account may therefore be another source of precaution;
- The apportioning conducted for this assessment has led to an apparent increase in the effect on kittiwake at Fowlsheugh from 51% (used to assign collision effects in the previous Scottish Ministers HRA [2014] [SNH Unpublished data, Seagreen ES 2014]) to 61% (Appendix 16B [Seabird Apportioning]). This difference, however, appears to be related primarily to the definition of the Fowlsheugh population used. In this assessment, all of the relevant count sectors for the SPA have been included which increases the relative weight of Fowlsheugh in the apportioning exercise; and
- The assessment assumes that 94.2% of birds are adult breeding birds based on the proportion of first year birds recorded during boat-based surveys and the likely age structure of the population. Although 10% are assumed to be sabbatical i.e. non-breeding in that year, numbers are likely to remain precautionary because the proportion of first year birds present in natal waters is likely to be lower than that of older immature birds which are indistinguishable from adults, and such immature birds may be concentrated in certain foraging areas (Appendix 16B Apportioning Assessment Ornithology).

16.615. Consequently it is considered that there is considerable precaution both in relation to the estimation of cumulative collision mortality for kittiwake and in the apportioning of that impact to Fowlsheugh SPA.

16.616. In accordance with the advice of the Scottish Ministers in the 2017 Scoping Opinion, PVA (Appendix 8D [Population Viability Analysis]) was used to the establish whether or not the population of kittiwake can be maintained as a viable component of Fowlsheugh SPA in the long term. The 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, 2011b). 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, 2009c). More recent counts indicate a more stable population, albeit at a reduced level from that which was designated (Table 16.29).

16.617. Further work has been undertaken to understand the consequences of the higher of these predicted cumulative impacts (collision mortality) on the kittiwake population at Fowlsheugh. 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 (Table 16.51) predict that the un-impacted population will grow slowly and this is not considered to be inconsistent with the recent monitoring data for Fowlsheugh (Table 16.29).

Table 16.51 PVA metrics for cumulative kittiwake annual adult mortality from collision in relation to Fowlsheugh SPA

Metric	Kittiwake
Total additional annual adult mortality[A]	125
Counterfactual population size[B]	0.83
Median pop[n.] growth rate[B]	1.03
Counterfactual population growth rate[B]	0.99
Centile of un-impacted popn. = 50th centile for impacted popn.[B]	0.72
Median end population size[B]	18,515p
Current population size[C]	9,655p
Designated population size[C]	36,650p

[A] Table 16.50;

[B] Methodology underpinning these outputs is described in Appendix 8D (Population Viability Analysis);

[C] Scottish Natural Heritage, 2017c; p = pairs; i = individuals

16.618. 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).

16.619. 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; and
- Over-estimation of the population response to the apportioned impact due to the simplistic nature of the PVA model used.

16.620. As highlighted in the Scoping Opinions for all Forth and Tay Projects (Marine Scotland, 2017), for kittiwake, collision 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. Combining the predicted cumulative collision and displacement mortality results in a combined adult mortality of 146 individuals per year, which in terms of the PVA, is not significantly higher than that predicted for collision alone.

16.621. 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.

16.622. The additional annual adult collision mortality for **herring gull** is above 1% of the baseline adult mortality (1.9 cf. 0.4 individuals), although it should be noted that the contribution of the optimised Seagreen Project to this figure is effectively zero.

16.623. The predicted impact is considered to be precautionary, the use of a flight speed of 12.8m/s in the CRM is higher than the 9.7m/s recorded in the ORJIP study (Skov *et al.*, 2018). Such a reduction in flight speed parameter would likely reduce the predicted mortality estimate for the optimised Seagreen Project in line within the range of reductions calculated for gannet and kittiwake, i.e. between 6 to 20% (Appendix 8B [Collision Risk Modelling]). The avoidance rate for herring gull is also considered to be precautionary in light of Skov *et al.* (2018), which indicates a higher rate of avoidance for this species than is currently assumed (leading to predicted to rates of mortality that are 10 to 20% of those assumed in this assessment). Additional reductions of a similar nature are also likely to be relevant for the predicted impacts arising from other offshore wind farm projects although the magnitude of these reductions are dependent on project specific turbine parameters.

16.624. In light of the relatively low in combination collision rate and the considerable precaution in collision rate predictions, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that herring gull will likely remain a viable component of the site.

16.625. For **guillemot**, the predicted cumulative mortality from displacement is 60 individuals per annum (Table 16.52), based on the relatively high assumed displacement rate of 60% across the wind farm and a 2km buffer area. For **razorbill**, the predicted mortality from displacement is 20 individuals per annum. The predicted displacement impacts for both species are considered to be low but exceed 1% of the baseline adult mortality for the respective populations (guillemot: 60 cf. 45 individuals; razorbill: 20 cf. 10 individuals).

Table 16.52 Predicted cumulative kittiwake, guillemot and razorbill annual adult mortality from displacement for Fowlsheugh SPA

Project	Kittiwake			Guillemot		Razorbill	
	B	Po/PB	Total	B/NB	Total	B/NB	Total
1% baseline mortality	**28**			**45**		**10**	
The optimised Seagreen Project							
Project Alpha and Project Bravo combined	14	-	**14**	25/16	**41**	7/4	**11**
Forth & Tay Projects							
Inch Cape	3	<1/<1	**3**	1/10	**11**	3/5	**7**
Neart na Gaoithe	1	1/1	**3**	1/4	**5**	<1/2	**2**
Kincardine	<1	<1/<1	**0**	2/<1	**2**	<1/<1	<1
Hywind	<1	<1/<1	**0**	<1/<1	**0**	<1/<1	<1
Aberdeen Demo	-	-	**-**	1/<1	**1**	-	-
In Combination							
Cumulative Total	18	2/<1	**20**	30/30	**60**	10/10	**20**

PB = Pre-breeding; B = Breeding; NB = Non-breeding; Po = Post-breeding

NB. All values are rounded to the nearest whole number

16.626. Further work has been undertaken to understand the consequences of this level of impact on Fowlsheugh SPA guillemot and razorbill populations 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 (Table 16.53) indicate that:

- For guillemot, 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);
- 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 163,213 individuals. This is similar to the predicted population in the absence of any impact as indicated by the ratio of the counterfactual of population size (0.98) and the centile of un-impacted population that is equivalent to the 50th centile for the impacted population (0.59);
- For razorbill, the PVA model indicates a slightly declining population over the model period with or without the impacted populations. The predicted median population growth rate is 0.99 when the effects of cumulative displacement are included which is essentially indistinguishable from that of the un-impacted population (counterfactual of the median population growth rate ≈ 1); and
- As the growth rate is less than 1 the predicted median end population 8,754 individuals is slightly less than the current population (9,950 individuals) but similar to that predicted in the absence of any impact (counterfactual of population size = 0.94 and the centile of un-impacted population that is equivalent to the 50th centile for the impacted population = 0.57).

Table 16.53 PVA metrics for cumulative kittiwake, guillemot and razorbill annual adult mortality from displacement in relation to Fowlsheugh SPA

Metric	Kittiwake	Guillemot	Razorbill
Total additional annual adult mortality[A]	20	60	20
Counterfactual population size[B]	0.97	0.98	0.94
Median pop$^{n.}$ growth rate[B]	1.03	1.03	0.99
Counterfactual population growth rate[B]	1	1.00	1.00
Centile of un-impacted popn. = 50th centile for impacted popn.[B]	0.54	0.59	0.57
Median end population size[B]	21,720p	163,213i	8,754i
Current population size[C]	9,655p	74,379i	9,950i
Designated population size[C]	36,650p	56,450i	5,800i

[A] Table 16.52;

[B] Methodology underpinning these outputs is described in Appendix 8D (Population Viability Analysis);

[C] Scottish Natural Heritage, 2017c; p = pairs; i = individuals

16.627. The current guillemot and razorbill populations far exceed the populations for which the SPA was designated. At the levels of cumulative displacement mortality predicted for the optimised Seagreen Project, PVA modelling indicates that the populations of guillemot and razorbill are likely to continue to grow and that razorbill will decline slightly (with or without this additional mortality). At this level of impact it is considered that there is a negligible risk that the populations of guillemot and razorbill would decline to a level at which they would no longer be considered to be viable components of the SPA. In practice both the cumulative impacts and population responses are expected to be of lower magnitude than considered here due to the precaution in the quantification of cumulative displacement impacts and the simplistic nature of the PVA model which does not include any assumptions about density dependent compensatory mechanisms within the modelled populations.

16.628. With respect to the predicted cumulative impacts associated with the optimised Seagreen Project, **an adverse effect on site integrity can be excluded because all the qualifying interests will remain viable components of the site.**

St Abb's Head to Fast Castle SPA

16.629. The assessment has been conducted with respect to the following features screened into the HRA:

- Kittiwake (collision and displacement);
- Herring gull (collision);
- Guillemot (displacement); and
- Razorbill (displacement).

16.630. The additional annual adult mortality of **kittiwake** has been calculated separately for collision (Table 16.54) and displacement (Table 16.55). The predicted mortality is below 1% of the baseline adult mortality for kittiwake in relation to displacement (9 cf. 14 individuals) but above 1% of the baseline adult mortality in relation to collision (31 cf. 14 individuals). This is relative to the population size for kittiwake (9,606 pairs).

16.631. This level of mortality represents a very small proportion of the population that is not indicative of an adverse effect, particularly within the context of the precaution built into the impact assessment methodology.

16.632. As highlighted in the Scoping Opinions for all Forth and Tay Projects (Marine Scotland, 2017), for kittiwake, collision 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. Combining the predicted cumulative collision and displacement mortality results in a combined adult mortality of 40 individuals per year still represents a very small proportion of the population that is not indicative of an adverse effect, particularly within the context of the precaution built into the impact assessment methodology.

16.633. 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 component of the site.

Table 16.54 Predicted cumulative kittiwake and herring gull annual adult mortality from collision for St Abb's Head to Fast Castle SPA

Project	Kittiwake			Herring Gull	
	B	Po/PB	Total	B/NB	Total
1% baseline mortality	**14**			**1**	
The optimised Seagreen Project					
Project Alpha and Project Bravo combined	11	<1/<1	**12**	0.60/<1	**0.60**
Forth & Tay Projects*					
Neart na Gaoithe	1	3/<1	**5**	0.04/0.12	**0.16**
Inch Cape	1	1/<1	**2**	<1/<1	<1
Other UK Projects					
Combined UK Projects Total	-	5/7	**11**	-/0.39	**0.39**
In Combination					
Cumulative Total	13	9/8	**31**	0.64/0.51	**1.15**

* Neart na Gaoithe and Inch Cape are the only other Forth & Tay Projects to make a contribution to collision mortality related to this SPA.

PB = Pre-breeding; B = Breeding; NB = Non-breeding; Po = Post-breeding

NB. All values are rounded to the nearest whole number, except in the case of herring gull

16.634. The additional annual adult collision mortality for **herring gull** (Table 16.54) is above 1% of the baseline adult mortality (1.14 cf. 1 individuals). This is relative to the population size for herring gull (650 individuals).

16.635. The predicted impact is considered to be precautionary, the use of a flight speed of 12.8m/s in the CRM is faster than the 9.7m/s recorded in the ORJIP study (Skov *et al.*, 2018). Such a reduction in flight speed parameter would likely reduce the predicted mortality estimate for the optimised Seagreen Project in line within the range of reductions calculated for gannet and kittiwake, i.e. between 6–20% (Appendix 8B [Collision Risk Modelling]). Additional cumulative reductions are likely to be realised for other Forth and Tay and UK projects although the magnitude of these reductions are dependent on project specific turbine parameters. Consequently, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that herring gull will remain a viable component of the site.

16.636. For **auks** additional annual adult mortality (Table 16.55) for guillemot (29 cf. 22 individuals) and razorbill (4 cf. 2 individuals) are both above the 1% of baseline adult mortality. This is relative to the current population size for guillemot (36,206 individuals) and razorbill (2,067 individuals).

Table 16.55 Predicted cumulative kittiwake, guillemot and razorbill annual adult mortality from displacement for St Abb's Head to Fast Castle SPA

Project	Kittiwake			Guillemot		Razorbill	
	B	Po/PB	Total	B/NB	Total	B/NB	Total
1% baseline mortality	**14**			**22**		**2**	
The optimised Seagreen Project							
Project Alpha and Project Bravo combined	2	-	**2**	6/4	**10**	1/<1	**1**
Forth & Tay Projects							
Inch Cape	1	<1/<1	**1**	3/2	**5**	<1/1	**1**
Neart na Gaoithe	4	2/<1	**6**	4/10	**14**	<1/2	**2**
In Combination							
Cumulative Total	7	2/<1	**9**	13/16	**29**	2/3	**4**

PB = Pre-breeding; B = Breeding; NB = Non-breeding; Po = Post-breeding

NB. All values are rounded to the nearest whole number

16.637. This level of mortality represents a very small proportion of the population that is not indicative of an adverse effect. Furthermore, the impact assessment methodology is considered to be highly precautionary and there is also uncertainty that an impact will occur for these species (see Searle *et al.*, 2014; APEM, 2017; Vanermen *et al.*, 2017). Consequently, it is considered that the predicted impact is not likely to have a material influence on population size and it is concluded that guillemot and razorbill will remain viable components of the site.

16.638. With respect to the predicted cumulative impacts associated with the optimised Seagreen Project, **an adverse effect on site integrity can be excluded because all the qualifying interests will remain viable components of the site**.

Outer Firth of Forth and St Andrews Bay pSPA

16.639. There is no direct predicted cumulative impact of the optimised Seagreen Project on this pSPA, however, there exists the potential for an indirect effect, should the populations of those SPAs from which foraging birds originate be adversely affected. The relevant features for this assessment are:

- Gannet;
- Kittiwake ;
- Herring gull;
- Guillemot;
- Razorbill; and
- Puffin.

16.640. With respect to these features, the conservation objectives of the pSPA are to:

- Avoid significant mortality, injury and disturbance of the qualifying interests, so that the distribution of the species and ability to use the site are maintained in the long-term; and
- Maintain the habitats and food resources of the qualifying interests in favourable condition.

16.641. This assessment has already considered the potential for an adverse effect on each of the breeding populations that are also features of the pSPA. In each case it has been concluded that these features will remain viable components of the respective sites and no adverse effect on the integrity of those sites is predicted. The optimised Seagreen Project is not located within the pSPA and no part of the proposed development will directly impact the pSPA, consequently it is not predicted that there will be any impact on the habitats or food resources of the pSPA.

Appropriate Assessment Summary: Cumulative Impacts of the optimised Seagreen Project

16.642. Table 16.56 summarises the assessment undertaken and the determination, prior to mitigation, of whether or not there is an adverse effect on site integrity for each European site.

Table 16.56 Appropriate Assessment Matrix: Cumulative Impacts of the optimised Seagreen Project

Conservation Objective	Buchan Ness to Collieston Coast SPA	Forth Islands SPA	Fowlsheugh SPA	St Abb's Head to Fast Castle SPA
	Kittiwake Herring gull Guillemot	**Gannet (PVA) Kittiwake (PVA) Herring gull Guillemot (PVA) Razorbill (PVA) Puffin (PVA)**	**Kittiwake (PVA) Herring gull Guillemot (PVA) Razorbill (PVA)**	**Kittiwake Herring gull Guillemot Razorbill**
To ensure for the qualifying species that the following are maintained in the long term:				
Population of the species as a viable component of the site	*No Adverse Effect on Site Integrity* Predicted cumulative additional annual adult mortality will not be of a magnitude that will prevent any qualifying interest from remaining a viable component of the site in the long term. For qualifying interests except kittiwake at Forth Islands SPA and Fowlsheugh SPA, this conclusion is based on there being no indication that the population at the end of the project will be less than that at designation. For species not assessed by PVA this conclusion is based on a comparison between the magnitude of the impact with baseline adult mortality within the context of using the worst case displacement and mortality rates and the precaution built into the displacement and collision impact prediction methodology. For those kittiwake populations that are already below the level for which they were designated, PVA does not indicate that the additional impact will reduce growth rates sufficiently to prevent those populations from growing and hence from being potentially restored to their former level.			
Distribution of the species within site	*No Adverse Effect on Site Integrity* The optimised Seagreen Project is located outwith the European site. The potential effect of displacement will therefore not impact the distribution of the qualifying interests within site.			
Distribution and extent of habitats supporting the species	*No Adverse Effect on Site Integrity* The optimised Seagreen Project is located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
Structure, function and supporting processes of habitats supporting the species	*No Adverse Effect on Site Integrity* The optimised Seagreen Project is located outwith the European site and impacts related to changes in habitat were scoped out of this assessment.			
No significant disturbance of the species	*No Adverse Effect on Site Integrity* The optimised Seagreen Project is located outwith the European site and the impact of disturbance was scoped out of this assessment.			

16.643. Table 16.57 provides summary information with regard to the Outer Firth of Forth and St Andrews Bay Complex pSPA.

Table 16.57 Appropriate Assessment Matrix for Outer Firth of Forth and St Andrews Bay pSPA: Cumulative Impacts of the optimised Seagreen Project

Conservation objective	Outer Firth of Forth and St Andrews Bay pSPA
	Gannet (PVA) **Kittiwake (PVA)** **Herring gull Guillemot (PVA)** **Razorbill (PVA)** **Puffin (PVA)**
Avoid significant mortality, injury and disturbance of the qualifying interests, so that the distribution of the species and ability to use the site are maintained in the long-term	*No Adverse Effect on Site Integrity* There is no direct cumulative impact of the optimised Seagreen Project, however, there exists the potential for an indirect effect, should the populations of those SPAs from which foraging birds originate be adversely affected. The conclusion of no adverse effect on site integrity is made in the context of the precaution built into the displacement and collision impact prediction methodology. Additional cumulative annual adult mortality will not be of a magnitude that will impact the potential for any qualifying interest to remain a viable component in the long term of the SPA breeding colonies that use the pSPA for foraging. Consequently the qualifying interest distribution and ability to use the pSPA is maintained in the long-term. For qualifying interests assessed by PVA this conclusion is based on there being no indication that the population at the end of the project will be less than that at designation or that the growth rate in the population would be reduced sufficiently to prevent the population from growing and potentially being restored to its former level. For species not assessed by PVA this conclusion is based on a comparison between the magnitude of the impact with baseline adult mortality within the context of using the worst case displacement and mortality rates and the precaution built into the displacement and collision impact prediction methodology.
To maintain the habitats and food resources of the qualifying interests in favourable condition	*No Adverse Effect on Site Integrity* The optimised Seagreen Project is located outwith the pSPA and the impacts related to habitats and food resources were scoped out of this assessment.

Mitigation measures

16.644. For marine mammals no adverse effects have been predicted and therefore no mitigation is proposed, other than that previously detailed, to ensure that the risk of injury to marine mammals (including auditory injury) is negligible.

16.645. For ornithology no adverse effects have been predicted and therefore no mitigation is proposed. It should be noted that there is a precedent for consent and that the optimised Seagreen Project represents in broad terms a better option than the originally consented project. Project design parameters such as number of turbines (150 [consented]; 120 [proposed]) and the increased turbine blade tip clearance (29.8m (LAT) [consented] cf. 32.5m (LAT) [proposed]) used in the determination of impact magnitude, generally result in an impact that is lower for the optimised Seagreen Project than that of the originally consented project.

16.646. 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). Ornithology and marine mammal monitoring will be required to validate the findings of the EIA Report and HRA.

16.647. 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, Neart na Gaoithe, 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.

Conclusions

16.648. This HRA has been undertaken in accordance with relevant legislation, guidance, the 2017 Scoping Opinion and consultation advice from Scottish Natural Heritage and Marine Scotland.

16.649. It is also undertaken on a precautionary basis, including in relation to the estimation of the magnitude of predicted impacts. Precautionary assumptions and methods have been used at all stages, including in relation to the baseline densities of marine mammals and birds and the methods of risk assessment. In some cases this is considered to lead to a significant over-estimation of the magnitude of some impacts, including the collision rates for breeding seabird species such as kittiwake and gannet, where emerging empirical data are becoming available on bird behaviour in and around offshore wind farms that highlight the precaution incorporated into collision risk modelling. The use of alternative avoidance rates, for example, could lead to collision rates that are many times lower than those used in this assessment.

16.650. The evaluation of the implications for populations that are features of European sites is also considered to be precautionary. The PVA models used to assist this process (as instructed in the 2017 Scoping Opinion) are simplistic and are highly sensitive to the effects of additional mortality within the population modelled. Any increase in mortality, even where the impact will be negligible within the population in reality will lead to lower predicted growth rates and reduced end population sizes in the model. In practice, it is often the case that populations are, to some extent, buffered against those effects, although this can be difficult to accurately replicate in computer models. In any case, the PVA outputs can be considered to be a very worst case of the likely fate of the populations modelled for any given level of assumed impact.

16.651. Notwithstanding the precautionary nature of the assessment, this HRA does not identify any indication that the optimised Seagreen Project would cause an adverse effect on the integrity of any European site either alone or in combination with other plans and projects.

16.652. When viewed in relation to the effects of the originally consented Project as requested in the 2017 Scoping Opinion, the worst case for the optimised Seagreen Project will, by design, have less of an impact on birds and marine mammals. The development area is the same as that originally consented, but the development comprises fewer, larger turbines, with increased blade tip clearance above sea level and the potential for greater spacing between turbines. For birds this means that the magnitude of displacement effects will be the same or less, and collision risk effects will be reduced for key species. For marine mammals, the reduced number of wind turbines means fewer foundation piling events and hence the potential for impacts from underwater noise is reduced.

16.653. Consequently, it is considered that the optimised Seagreen Project represents a clear improvement on the originally consented Project (which was consented on the basis of no adverse effect on the integrity of any European site), in that the predicted effects from the optimised Seagreen Project on the SACs and SPAs considered will be no higher (and specifically with respect to bird collisions for key species at breeding colony SPAs, will be lower) than those that would arise from the construction and operation of the originally consented Project, when considered on a like for like basis.

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