

**Beatrice Offshore Windfarm
Environmental Statement Addendum**

**Annex 3B Report to Inform an
Appropriate Assessment**

ARCUS CONSULTANCY SERVICES

BEATRICE OFFSHORE WIND FARM

REPORT TO INFORM AN APPROPRIATE ASSESSMENT

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TABLE OF CONTENTS

1	INTRODUCTION.....	1
1.1	Structure of this Report.....	1
1.2	Overview of the HRA Process	2
1.3	Consultation.....	3
2	AMENDED PROJECT DESCRIPTION.....	5
2.1	The Amended Project.....	5
2.2	The Rochdale Envelope and 'Worst Case' Scenario.....	6
2.3	The Potential Effects of the Amended Project.....	6
3	ORNITHOLOGY	8
3.1	Natura 2000 Sites and Qualifying Interest Features	8
3.2	Conservation Objectives.....	8
3.3	Screening - Identification of Likely Significant Effects	9
3.3.1	Fulmar.....	10
3.3.2	Gannet.....	12
3.3.3	Kittiwake	12
3.3.4	Great Black-Backed Gull	13
3.3.5	Herring Gull.....	14
3.3.6	Guillemot.....	14
3.3.7	Razorbill	15
3.3.8	Puffin.....	16
3.3.9	Arctic Skua	17
3.3.10	Great Skua	18
3.3.11	Summary of Effects Considered.....	18
3.4	Appraisal of Effects on Conservation Objectives and Integrity of SPAs.....	19
3.4.1	Population Modelling.....	19
3.4.2	East Caithness Cliffs	23
3.4.3	North Caithness Cliffs	28
3.4.4	Summary of Predicted Effects on SPA Integrity.....	29
3.5	References.....	30
4	MARINE MAMMAL ECOLOGY	33
4.1	Natura 2000 Sites and Qualifying Interest Features	33
4.1.1	Moray Firth SAC	34

4.1.2	Dornoch Firth and Morrich More SAC	35
4.2	Conservation Objectives.....	36
4.2.1	Moray Firth SAC	36
4.2.2	Dornoch Firth and Morrich More SAC	37
4.3	Screening - Identification of Likely Significant Effects	37
4.3.1	Test of Likely Significance on the Qualifying Features of the Moray Firth SAC	38
4.3.2	Test of Likely Significance on the Qualifying Features of the Dornoch Firth and Morrich More SAC.....	38
4.3.3	Test of Likely Significance of In-Combination Effects	39
4.4	Appraisal of Effects on Conservation Objectives and Integrity of SACs	42
4.4.1	Moray Firth SAC	42
4.4.2	Dornoch Firth and Morrich More SAC	66
4.4.3	Summary of Effects on the Moray Firth SAC.....	85
4.4.4	Summary of Effects on the Dornoch Firth and Morrich More SAC.....	91
4.5	References.....	95
5	FISH AND SHELLFISH ECOLOGY	98
5.1	Natura 2000 Sites and Qualifying Interest Features	98
5.2	Conservation Objectives.....	98
5.3	Screening - Identification of Likely Significant Effects	99
5.4	Appraisal of Effects on Conservation Objectives and Integrity of SACs	102
5.4.1	Atlantic Salmon	103
5.4.2	Freshwater Pearl Mussel	106
5.4.3	Sea Lamprey	106
6	PHYSICAL PROCESSES AND GEOMORPHOLOGY	110
6.1	Natura 2000 Sites and Qualifying Interest Features	110
6.1.1	East Caithness Cliffs SAC	111
6.1.2	Moray Firth SAC	111
6.1.3	Dornoch Firth and Morrich More SAC	112
6.1.4	Culbin Bar SAC	114
6.2	Conservation Objectives.....	115
6.3	Screening - Identification of Likely Significant Effects	115
6.4	Appraisal of Effects on Conservation Objectives and Integrity of SACs	121
6.4.1	Introduction	121
6.4.2	Assessments Informing the Appraisal	121
6.4.3	Moray Firth SAC	125
6.4.4	Dornoch Firth and Morrich More SAC	125
6.4.5	Culbin Bar SAC	125

Figure 1.1a	International & European Designations within 100 km of the Wind Farm Site – Orkney and the Far North
Figure 1.1b	International & European Designations within 100 km of the Wind Farm Site – North East Scotland
Figure 1.1c	International & European Designations within 100 km of the Wind Farm Site – Moray Firth
Figure 4.1	Predicted Probability of Encountering Bottlenose Dolphins in Each 4x4 km Grid Cell Based on 2009 & 2010 Data
Figure 4.2	Variation in the Probability of Detecting Dolphins on T-PODs at Different Coastal Sites Around the Moray Firth SAC (Jan – Dec 2008)
Figure 4.3	Predicted Numbers of Harbour Seals from the Dornoch Firth and Morrich More SAC and Loch Fleet NNR in Different 4x4 km Grid Cells Across the Moray Firth
Figure 4.4	Noise Contours for PTS Fleeing for Bottlenose Dolphin Generated Using the Dose-Response Curve
Figure 4.5	Noise Contours for Behavioural Displacement of Bottlenose Dolphin Using the Dose-Response Curve
Figure 4.6	Noise Contours for Concurrent Piling at the Wind Farm Overlaid on the Probability of Occurrence of Bottlenose Dolphin within the Moray Firth
Figure 4.7	Noise Contours for the In-Combination Concurrent Piling Scenario (worst case spatially) Overlaid on the Probability of Occurrence of Bottlenose Dolphin within the Moray Firth
Figure 4.8	Noise Contours for PTS Fleeing for Pinnipeds Generated Using the Dose-Response Curve
Figure 4.9	Noise Contours for Behavioural Displacement of Pinnipeds Using the Dose-Response Curve
Figure 4.10	Noise Contours for Concurrent Piling at the Wind Farm Overlaid on the Harbour Seal Density Map
Figure 4.11	Noise Contours for the In-Combination Concurrent Piling Scenario (worst case spatially) Overlaid on the Harbour Seal Density Map

1 INTRODUCTION

1. This Report presents information to support an Appropriate Assessment in relation to the development consent applications for the Beatrice Offshore Wind Farm ('the Wind Farm') and associated Offshore Transmission Works ('the OfTW'), together known as 'the Project', in relation to potential effects on a number of designated European (Natura 2000) sites. The assessments within this Report consider the effects of both the Wind Farm and the OfTW. This Report relies on information provided in the Original ES (and the Technical Annexes) and ES Addendum (and the Technical Annexes) and cross-references are made to these documents to avoid repetition. Figures 1.1a-c show the location of Natura 2000 sites within 100 km of the Wind Farm Site and OfTW.
2. For clarity, this Report incorporates the additional information provided in the ES Addendum and assesses the 'Amended Project', as described in Section 4: Amended Project Description of the ES Addendum.
3. The development consents required for the Wind Farm and OfTW are as described in Section 1.1 of the Original ES (Section 36 consent, Section 36A declaration and Marine Licences). The applications will be determined by the Scottish Ministers (acting through Marine Scotland). It is also the responsibility of the Scottish Ministers (acting through Marine Scotland), as the competent authority, to undertake an Appropriate Assessment under the terms of the Conservation of Habitats and Species Regulations 2010, Conservation (Natural Habitats, &c.) Regulations 1994, and the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (hereafter referred to collectively as 'the Habitats Regulations').
4. A Habitats Regulations Assessment (HRA) is a three stage process comprising: (1) ascertaining whether or not the Project is necessary to the management of the European site for nature conservation; (2) 'Screening' for Likely Significant Effects (LSE) on European sites; and (3) if there is potential for LSEs, carrying out an 'Appropriate Assessment' of the implications on the site in view of its Conservation Objectives.
5. The Wind Farm and OfTW are not directly connected with, or necessary to, the management of any European site for nature conservation, therefore this Report provides information to support Stages (2) and (3).
6. It is intended that this Report, provides all the information necessary to allow the Scottish Ministers (acting through Marine Scotland) to carry out the HRA process.

1.1 STRUCTURE OF THIS REPORT

7. This Report contains the following sections:
 - **Introduction** – providing details of the purpose of this Report and an overview of the HRA process.
 - **Amended Project Description** – presenting a brief overview of the Amended Project and the key potential effects on natural heritage interests.

- **Ornithology** – presenting an assessment of the LSEs of the Wind Farm and OfTW on Special Protection Areas (SPA) designated for their important populations of birds. These principally comprise the large breeding seabird colonies found around the north and east coast of Scotland and the Northern Isles. For SPAs where a LSE has been identified, further information is presented to inform an Appropriate Assessment.
- **Marine Mammals** – presenting an assessment of the LSEs of the Wind Farm and OfTW on Special Areas of Conservation (SACs) designated for their important populations of marine mammals. The assessment presented herein focuses on two SACs in north-east Scotland, the qualifying interests of which include bottlenose dolphin (BND) and harbour (common) seal. For SACs where a LSE has been identified, further information is presented to inform an Appropriate Assessment.
- **Fish and Shellfish Ecology** – presenting an assessment of the LSEs of the Wind Farm and OfTW on SACs designated for their important populations of fish or shellfish. These mainly comprise the important salmon rivers that flow into the Moray Firth. For SACs where a LSE has been identified, further information is presented to inform an Appropriate Assessment.
- **Physical Processes and Geomorphology** – providing an assessment of the LSEs of the Wind Farm and OfTW on SACs designated for their important marine habitats. For SACs where a LSE has been identified, further information is presented to inform an Appropriate Assessment.

1.2 OVERVIEW OF THE HRA PROCESS

8. The European Union Council Directives on the Conservation of Wild Birds (2009/147/EC) – the Birds Directive – and on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) – the Habitats Directive – are implemented in the UK through the Habitats Regulations.
9. Under Article 6 of the Habitats Directive, as implemented by the Habitats Regulations, any plan or project that is not directly connected with, or necessary to, the management of a European site and is likely to have a significant effect on the European site, either alone or in combination with other plans or projects, must be subject to an Appropriate Assessment of its implications for the European site in view of its Conservation Objectives. As described in Section 1.1 above, this process is referred to as a HRA and is carried out by the competent authority, in this case the Scottish Ministers (acting through Marine Scotland).
10. It is the requirement of the project applicant to provide the information that the competent authority may reasonably require to undertake an Appropriate Assessment, which is the purpose of this Report.
11. The HRA is a three-stage process:
 - Stage One: Is the proposal directly connected with, or necessary to, the management of the site for nature conservation? In the case of this application for consent of the Amended Project, it is not; therefore Stage Two must be followed.

- Stage Two (Screening): Is the proposal likely to give rise to an LSE, alone or in combination with other plans or projects, on a European site? This test acts as a screening stage to remove proposals that do not need further consideration under Stage Three. If it is obvious that there are no effects on the qualifying interests of a European site despite a connection between the proposal and the European site, then the conclusion is one of no LSE. This step takes account of any mitigation measures implemented in the proposals. If there is a LSE on the European site, then Appropriate Assessment is required (Stage Three). Each of the four technical assessments presented in the sections below provide an analysis of the identification of LSEs. LSE screening was carried out at an early stage in the assessment process (other than for ornithology), taking account of SNH, Marine Scotland and other consultees' views (some of which were expressed during EIA Scoping).
 - Stage Three (Appropriate Assessment): Can it be ascertained that the proposal, including any necessary mitigation measures, will not adversely affect the integrity of the site? The competent authority, in this case, the Scottish Ministers (acting through Marine Scotland), carries out the Appropriate Assessment. Consideration of the Conservation Objectives is essential in determining effects on site integrity and an Appropriate Assessment must be carried out in view of these. Where considered to be necessary following consideration of LSEs, each of the four technical assessments presented in the sections below provide additional information to inform the Appropriate Assessment.
12. After consideration of the three stages in the HRA, if it cannot be ascertained that the proposal will not adversely affect the integrity of a European site, the proposal can only proceed if:
- There are no alternative solutions;
 - There are imperative reasons of over-riding public interest for doing so; and
 - Any necessary compensatory measures are taken to secure the coherence of the Natura 2000 site network.

1.3 CONSULTATION

13. The Original ES was submitted in April 2012. Consultation with Marine Scotland and SNH has been undertaken regarding the content of this Report. This included provision of a draft document containing the information that was intended to be submitted in this Report. A summary of consultation responses in respect of the draft document is outlined in Table 1.1.

Table 1.1: Summary of Consultation Received on the Draft Document

Consultee	Summary of Consultation Response	Project Response	Consultation Response Addressed
(Marine Mammals) SNH/Joint Nature Conservation Committee (JNCC)/ Marine Scotland Licensing Operations Team (MS-LOT) 6 Sep 2012 (Meeting)	While the ES acknowledges the above HRA requirements, and BOWL has now submitted a draft HRA report, the assessment for Beatrice is still incomplete, with a lack of interpretation against the Conservation Objectives of the relevant SPAs and SACs. For a number of key receptors, consideration of the conservation objective relating to 'population of the species as a viable component of the designated site' will need to be supported by population modelling work.	Population modelling has now been undertaken and has been included in the ES Addendum. In addition, the population modelling has been included in this document, which considers the potential effects against the Conservation Objectives of the SAC.	Section 4 of this Report
	For key receptors (including SPA and SAC interests) where there could be significant effects, we advise that mitigation options need to be discussed in the ES (and HRA report, where relevant). For operational impacts mitigation may be achieved through design – such as choice of turbine or windfarm layout. In respect of construction impacts the available mitigation includes construction programming.	A range of mitigation measures have been proposed in the Original ES and ES Addendum and Beatrice Offshore Wind Farm Ltd (BOWL) and the wider offshore wind industry are investigating the feasibility of a number of mitigation measures to reduce the effects of construction noise on marine mammals.	Section 4 of this Report
	For a range of key receptors, cumulative HRA is required and needs to be supported by population modelling in order to determine any long-term effects on populations of concern.	As discussed above BND population modelling has now been undertaken for cumulative effects.	Section 4.4 of this Report
(Fish and Shellfish Ecology) MSS	Given all the uncertainties we are not clear that a likely significant effect of SAC rivers would not occur for the project alone, but agree that in combination	Where there is limited information on which to base the assessment, the uncertainties of the assessment have been acknowledged in the ES Addendum and this Report, and a precautionary approach has been taken in the assessment of effects.	Section 5 of this Report

<i>Consultee</i>	<i>Summary of Consultation Response</i>	<i>Project Response</i>	<i>Consultation Response Addressed</i>
	a likely significant effect seems appropriate. However, we once again emphasise the large number of uncertainties which can affect this assessment in either direction.		
(Fish and Shellfish Ecology) SNH/JNCC	The assessment of construction impacts (primarily underwater noise) on diadromous SAC fish are among the key HRA requirements.	The disturbance associated with construction noise is one of the effects considered to have the potential to result in a likely significant effect and has been considered in this Report.	Section 5.4 of this Report
(Fish and Shellfish Ecology) SNH comments on Draft Report to Inform an Appropriate Assessment	We advise that Beatrice will have LSE, alone, on the qualifying fish interests and associated species of the SACs listed in Table 5.2 (of the Draft Report). We agree that River Borgie SAC and River Dee SAC (as listed in our scoping advice) do not need further consideration.	The River Borgie and River Dee SACs are not considered in this Report. The approach to the identification of LSE has been revised in light of SNH's comments.	Section 5 of this Report.

2 AMENDED PROJECT DESCRIPTION

2.1 THE AMENDED PROJECT

14. The Original Wind Farm and the Original OfTW are described in detail in Section 7: Project Description of the Original ES. Minor amendments are described in Section 4: Amended Project Description of the ES Addendum and elements of the Amended Project are referred to herein as 'the Wind Farm' and 'the OfTW'.
15. The Amended Wind Farm will comprise up to 277 wind turbines in the Moray Firth with a maximum generating capacity of up to 1000 MW. The Wind Farm Site is located approximately 25 km south-south-east of Wick, Caithness, located on the Smith Bank, a bathymetric high in the outer Moray Firth. The Wind Farm Site boundary is, at its closest point, 13.5 km from the coastline (Figures 1.1 and 1.2 of the ES Addendum). The Wind Farm Site is approximately 19 km in length and 9 km in width at the maximum extents of the site, covering an area of approximately 131.5 km².
16. Following an amendment to the corridor within which the OfTW cable will be installed (the Original OfTW Corridor), the area is referred to as the 'Amended OfTW Corridor'. The Amended OfTW Corridor is approximately 65 km in length and varies between 575 m - 1.54 km in width running between the Wind Farm Site and the landfall at Mean High Water Springs (MHWS).

2.2 ***THE ROCHDALE ENVELOPE AND 'WORST CASE' SCENARIO***

17. Due to uncertainties associated with offshore construction it is not possible to define a detailed project design at this stage of the development process. Instead, a set of parameters have been developed for the Wind Farm and OfTW, for example, maximum and minimum turbine sizes. These parameters are referred to as the 'Rochdale Envelope' and final design of the project must fall within this Rochdale Envelope. In order to ensure that the EIA is sufficiently robust in assessing the LSE arising from the Wind Farm and OfTW, a 'worst case' scenario from within the parameters is identified for each receptor assessed. The assessment of the worst case scenarios on which the EIA is based, is also the basis for this Report.

2.3 ***THE POTENTIAL EFFECTS OF THE AMENDED PROJECT***

18. The Original ES (including the accompanying Technical Annexes) and ES Addendum (including the accompanying Technical Annexes) (all referred to together in this Report as the ES) report the findings of the EIA which has been carried out to assess the LSE of the Wind Farm and the OfTW, on the environment. The ES included assessments of the potential effects of the Wind Farm on ornithology, marine mammals, fish and shellfish ecology and physical processes and geomorphology.
19. The following sections of the Original ES and ES Addendum and technical annexes provide supporting information that is used in this Report:
- Original ES Section 7: Project Description (as supplemented by Section 4: Amended Project Description of the ES Addendum);
 - Original ES Section 13: Wind Farm Ornithology (as supplemented by Section 7: Ornithology of the ES Addendum);
 - Original ES Section 25: Offshore Transmission Works Ornithology;
 - Annex 13A of the Original ES: Beatrice Offshore Wind Farm Ornithological Technical Report;
 - Annex 13B of the Original ES: Beatrice Offshore Wind Farm Technical Report in Support of Ornithological Habitats Regulations Assessment;
 - Original ES Section 12: Wind Farm Marine Mammals (as supplemented by Section 6: Marine Mammals of the ES Addendum);
 - Original ES Section 24: Offshore Transmission Works Marine Mammals;
 - Annex 12A Appendix 1 of the Original ES: Aberdeen University Technical Report on Pre-Consent Marine Mammal Data Gathering at the MORL and BOWL Wind Farm Sites;
 - Annex 12A Appendix 2 of the Original ES: Aberdeen University Bottlenose dolphin densities across the Moray Firth;
 - Annex 12A Appendix 3 of the Original ES: SMRU Grey seal usage maps for Moray Firth Round 3 Zone /BOWL developments - Phase 2 delivery;
 - Annex 12A Appendix 4 of the Original ES: SMRU Updated Technical Report summarising information on marine mammals which occur in the Moray Firth;

- Annex 12B of the Original ES: Aberdeen University Framework for assessing the impacts of pile-driving noise from offshore wind farm construction on Moray Firth harbour seal populations;
 - Annex 6A of the ES Addendum: Bottlenose dolphin and harbour seal population modelling for BOWL;
 - Annex 6B of the ES Addendum: Integrating marine mammal research and monitoring to support conservation and development in the Moray Firth;
 - Original ES Section 11: Wind Farm Fish and Shellfish Ecology (as supplemented by Section 5: Fish and Shellfish Ecology of the ES Addendum);
 - Original ES Section 23: Offshore Transmission Works Fish and Shellfish Ecology (as supplemented by Section 5: Fish and Shellfish Ecology of the ES Addendum);
 - Annex 11A of the Original ES: Fish and Shellfish Ecology Technical Report;
 - Original ES Section 9: Wind Farm Physical Processes and Geomorphology (as supplemented by Section 9: Physical Processes and Geomorphology of the ES Addendum);
 - Original ES Section 21: Offshore Transmission Works Physical Processes and Geomorphology (as supplemented by Section 9: Physical Processes and Geomorphology of the ES Addendum);
 - Annex 9A of the Original ES: Physical Processes Baseline Assessment;
 - Annex 9B of the Original ES: Numerical Model Calibration and Validation Report;
 - Annex 9C of the Original ES: Scour Assessment; and
 - Annex 9D of the Original ES: Transmission Cable Landfall Impact Assessment.
20. The baseline studies and assessments were carried out by the following professional consultancies:
- Ornithology: MacArthur Green Ltd (and RPS Energy);
 - Marine Mammal Ecology: RPS Energy;
 - Fish and Shellfish Ecology: Brown and May Marine Limited; and
 - Physical Processes and Geomorphology: ABP marine environmental research (ABPmer).

3 ORNITHOLOGY

3.1 NATURA 2000 SITES AND QUALIFYING INTEREST FEATURES

21. SNH and Marine Scotland provided a list of the SPAs considered to have the potential for connectivity with the Wind Farm and so for which they considered HRA was required. While the list of SPAs and seabird populations is the same as that assessed in the Original ES, in consultation with SNH, Marine Scotland and JNCC, for some seabird species the population sizes have been revised. The list of SPAs and the population sizes assessed in this Report is provided in Table 3.1.

Table 3.1: SPAs and Qualifying Populations for Inclusion in the HRA (population sizes are those agreed with Marine Scotland, SNH and JNCC)

SPA	Species	Agreed Population for use in HRA	Source
East Caithness Cliffs	Fulmar	14,202 prs.	JNCC
	Kittiwake	14,140 prs.	JNCC
	Great black-backed gull	175 prs.	JNCC
	Herring gull	3,393 prs.	JNCC
	Guillemot	158,985 ind.	JNCC
	Razorbill	17,830 ind.	JNCC
	Puffin	274 prs.	JNCC
North Caithness Cliffs	Fulmar	13,950 prs.	JNCC
	Kittiwake	10,147 prs.	JNCC
	Guillemot	70,154 ind.	JNCC
	Razorbill	2,466 ind.	JNCC
	Puffin	7,071 prs.	JNCC
Hoy	Arctic skua	12 prs	JNCC
	Great skua	1,346 prs.	JNCC
	Puffin	417 ind.	JNCC

22. The potential effects on the SPA seabird populations in Table 3.1 are those presented as the worst case scenario associated with the construction, operation and decommissioning of the Wind Farm and the OfTW as presented in the Original ES and ES Addendum.
23. Only displacement and collision effects were considered in this Report as these were the only effects identified by SNH and MS for which assessment was required.

3.2 CONSERVATION OBJECTIVES

24. The same Conservation Objectives are provided for each of the SPAs in Table 3.1 and are reproduced below:
- *“To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and”*
 - *“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;*
 - *Structure, function and supporting processes of habitats supporting the species;*
 - *No significant disturbance of the species."*
25. Of these objectives, maintenance of the population as a viable component of the SPA is the most critical for the current assessment as it includes potential effects on the bird interests which are expected to occur outside the SPA site boundary. These can be both direct effects (e.g. displacement or collision mortality) and indirect effects (e.g. degradation of supporting habitats).
26. Consequently this Report provides a determination of the potential for LSE on each SPA population (the Screening stage), and for those populations where the potential for an LSE is predicted (or cannot be ruled out), further details of the risk of adverse effects are provided. Adverse effects under consideration are those resulting from the Amended Project alone, and in combination with other developments.

3.3 SCREENING - IDENTIFICATION OF LIKELY SIGNIFICANT EFFECTS

27. The first step in an HRA is the determination of the presence of LSE on the qualifying features of any SPAs with connectivity to the proposed development. The effects considered were described in detail in Section 13: Wind Farm Ornithology of the Original ES and Section 7: Wind Farm Ornithology of the ES Addendum, and are briefly summarised in the following sections. It is important to note the cumulative assessment provided in the Original ES and ES Addendum is referred to as an in-combination assessment within this Report to ensure compliance with the terminology required for HRAs, however the two terms are essentially interchangeable.
28. As can be seen in Table 3.1, several of the species considered in this Report are features of multiple SPAs. Establishing the relative contributions from each of these SPA populations to the number of birds seen on the Wind Farm Site is an important first step in determining the potential for LSEs.
29. A method for dividing the on-site population amongst candidate SPAs was developed and presented in the Annex 13B of the Original ES. This method weights individual SPA contributions on the basis of their relative population sizes, distance to the development and (for each species) the proportion of the area around the SPA within foraging range which is sea (for details refer to Annex 13B of the Original ES). This method was developed for the Beatrice ornithological HRA and forms the basis of draft guidance produced by SNH and JNCC for undertaking apportioning for HRA. Using this approach the proportion of each candidate SPA's population estimated to be on Site was calculated. SPAs which were estimated to have more than 1% of their population to be present on the Site (displacement) or more than 1% at risk of collision were considered at risk of an LSE. These methods have been discussed with SNH and MS who have agreed that they are useful for the purposes of identifying LSE.

30. All SPAs listed in Table 3.1 are located within the mean maximum foraging range of the Wind Farm Site (seabird.wikispaces¹, Thaxter et al., 2012). While SNH indicated that only these SPAs should be considered for LSEs, it is important to note that for some of these species there are several other SPAs within the foraging range. Not including these other SPAs in the apportioning calculations could potentially exaggerate the effects on the SPAs in Table 3.1, therefore the calculations included other SPAs as appropriate for each species.
31. The in-combination assessment was broken down along the same lines as that presented in the assessment of cumulative effects in the ES Addendum (Section 7.9), with the following scenarios:
- Scenario 1: Wind Farm plus Moray Firth Round 3 Zone MacColl wind farm;
 - Scenario 2: Wind Farm plus Moray Firth Round 3 Zone MacColl and Stevenson wind farms; and
 - Scenario 3: Wind Farm plus Moray Firth Round 3 Zone MacColl, Stevenson and Telford wind farms.
32. SPA populations for which an LSE was predicted were then assessed for the significance of that effect using the stochastic population models presented in the ES Addendum (Section 7.5.2) and this Report (Section 3.4.1). For these assessments the initial population sizes used in the model were those listed in Table 3.1 and the number of individuals from that SPA considered to be at risk (e.g. of displacement or collision) was calculated as the product of the total number estimated to be at risk of impact and the proportion assigned to the SPA in question. For example, if the total number of a species estimated to be in collision was 50 individuals, of which the proportion assigned to a particular SPA was 70%, the estimated mortality assigned to that SPA population would be $50 \times 0.7 = 35$. Further details on the methods are provided in Annex 13B of the Original ES.

3.3.1 FULMAR

33. Collision risk modelling generated very low numbers of collisions for fulmar (ES Addendum Section 7.6.3.1), therefore only displacement effects were considered here.
34. The SPAs identified by SNH for fulmar were East Caithness Cliffs and North Caithness Cliffs. However, fulmar forage over long distances (mean max. range 311 km) therefore several other SPAs may also contribute to the birds observed on the Site; Hoy, Troup Pennan and Lion's Head, Copinsay, Rousay, Calf of Eday, and West Westray. Therefore these SPAs were also included in the apportioning calculations (Table 3.2).

¹ Web reference: <http://seabird.wikispaces.com> (accessed 27/05/13)

Table 3.2: Calculation of Proportion of on Site Fulmar from SPAs

SPA	Population (ind.)	Distance to Site (km)	Proportion of Sea within Foraging Range	Weight	SPA Proportion
East Caithness Cliffs	28,404	11	0.813	288.7	0.835
North Caithness Cliffs	27,900	29	0.832	39.9	0.115
Hoy	39,172	57	0.847	14.2	0.041
Troup, Pennan and Lion's Head	3,200	62	0.782	1.1	0.003
Copinsay	3,260	63	0.851	1.0	0.003
Rousay	2,060	94	0.866	0.3	0.001
Calf of Eday	3,564	97	0.871	0.4	0.001
West Westray	1,354	107	0.873	0.1	0.000

35. On the basis of the apportioning calculations, East Caithness Cliffs SPA contributed 83.5% of the on Site population and North Caithness Cliffs SPA a further 11.5%.
36. Applying the proportions calculated in Table 3.2 to the individual and cumulative total abundances on the Wind Farm Sites (Table 3.3), the only SPA for which more than 1% of its population was estimated to be present on the Wind Farm Sites was East Caithness Cliffs, with between 2.03% and 4.46% of its fulmar population estimated to be at risk of displacement across the four totals (Wind Farm alone to Scenario 3).
37. Thus the potential for an LSE was predicted for the East Caithness Cliffs fulmar population. The potential effects of displacement at the range of levels shown are assessed below (Section 3.4.2.1).
38. The SPA with the next largest proportion of its population estimated to be present on the Wind Farm Sites was North Caithness Cliffs. However, at a maximum proportion of this population on the Wind Farm Sites of 0.63% (Scenario 3, Table 3.3) no adverse effect on the integrity of the North Caithness Cliffs SPA is predicted due to displacement of fulmar caused by the Wind Farm alone or in combination with the Moray Firth Round 3 Zone wind farms.

Table 3.3: Proportion of Each SPA's Fulmar Population Present on the Wind Farm Sites on the Basis of the Proportions in Table 3.2 (SPA populations estimated to have more than 1% of their population present are highlighted in bold.)

	Wind Farm	Scenario 1	Scenario 2	Scenario 3
On Site Abundance	691	998	1285	1516
SPA	Proportion of SPA on Site(s)			
East Caithness Cliffs	0.0203	0.0293	0.0378	0.0446
North Caithness Cliffs	0.0029	0.0041	0.0053	0.0063
Hoy	0.0007	0.0010	0.0014	0.0016
Troup, Pennan and Lion's Head	0.0007	0.0010	0.0012	0.0015
Copinsay	0.0006	0.0009	0.0011	0.0013
Rousay	0.0003	0.0004	0.0005	0.0006
Calf of Eday	0.0002	0.0004	0.0005	0.0005
West Westray	0.0002	0.0003	0.0004	0.0004

3.3.2 GANNET

39. No SPAs with gannet included as qualifying features were identified by SNH as having connectivity with the Moray Firth Wind Farms therefore no further assessment is presented in this Report. Effects on the wider population have been considered in the ES Addendum (Sections 7.6.2.2, 7.6.3.2, 7.6.4.2 and 7.6.5.1).

3.3.3 KITTIWAKE

40. Kittiwake is considered to be at potential risk of both collision and displacement effects, therefore both effects were considered here.
41. The SPAs identified by SNH for kittiwake were East Caithness Cliffs and North Caithness Cliffs. However, kittiwake forage over sufficiently long distances (mean max. range 68 km) that several other SPAs may also contribute to the birds observed on the Site; Hoy, Troup Pennan and Lion's Head and Copinsay. Therefore these SPAs were also included in the apportioning calculations (Table 3.4).

Table 3.4: Calculation of Proportion of on Site Kittiwake from SPAs

SPA	Population (ind.)	Distance to Site (km)	Proportion of Sea within Foraging Range	Weight	SPA Proportion
East Caithness Cliffs	80280	11	0.813	816.1	0.951
North Caithness Cliffs	20294	29	0.832	29.0	0.034
Hoy	794	57	0.847	0.3	0.000
Troup, Pennan and Lion's Head	29792	62	0.641	12.1	0.014
Copinsay	3552	63	0.87	1.0	0.001

42. On the basis of the apportioning calculations, East Caithness Cliffs SPA contributed 95.1% of the on Site population and North Caithness Cliffs SPA a further 3.4%.
43. Applying the proportions calculated in Table 3.4 to the individual and cumulative total abundances on the Wind Farm Sites (Table 3.5), no SPAs were predicted to have more than 0.87% of their population at risk of displacement. Therefore no adverse effect on the integrity of the SPAs assessed is predicted due to displacement of kittiwake caused by the Wind Farm alone or in combination with the Moray Firth Round 3 Zone wind farms.

Table 3.5: Proportion of Each SPA's Kittiwake Population Present on the Wind Farm Sites on the Basis of the Proportions in Table 3.4 (SPA populations estimated to have more than 1% of their population present are highlighted.)

	Wind Farm	Scenario 1	Scenario 2	Scenario 3
On Site Abundance	384	559	631	732
SPA	Proportion of SPA on Site(s)			
East Caithness Cliffs	0.0046	0.0066	0.0075	0.0087
North Caithness Cliffs	0.0006	0.0009	0.0011	0.0012
Hoy	0.0002	0.0002	0.0003	0.0003
Troup, Pennan and Lion's Heads	0.0002	0.0003	0.0003	0.0003
Copinsay	0.0001	0.0002	0.0002	0.0002

44. Applying the proportions calculated in Table 3.4 to the individual and cumulative total collision mortality estimated on the Wind Farm Sites (at an avoidance rate of 99%; Table 3.6), no SPAs were predicted to have more than 0.07% of their population at risk of collision mortality. At an avoidance rate of 98%, the estimated mortality is doubled and the proportion of the SPA populations at risk is therefore also doubled. Thus, at an avoidance rate of 98% no SPA would have more than 0.14% of its population at risk of collision mortality. Therefore no adverse effect on the integrity of the SPAs assessed is predicted due to collision mortality of kittiwake caused by the Wind Farm alone or in combination with the Moray Firth Round 3 Zone wind farms.

Table 3.6: Proportion of Each SPA's Kittiwake Population at risk of Collision on the Wind Farm sites on the Basis of the Proportions in Table 3.5 (SPA populations estimated to have more than 1% of their population at risk of collision are highlighted.)

	Wind Farm	Scenario 1	Scenario 2	Scenario 3
Collision Mortality (at an avoidance rate of 99%)	11	37	52	63
SPA	Proportion of SPA on Site(s)			
East Caithness Cliffs	0.0001	0.0004	0.0006	0.0007
North Caithness Cliffs	0.0000	0.0001	0.0001	0.0001
Hoy	0.0000	0.0000	0.0000	0.0000
Troup, Pennan and Lions Head	0.0000	0.0000	0.0000	0.0000
Copinsay	0.0000	0.0000	0.0000	0.0000

3.3.4 GREAT BLACK-BACKED GULL

45. Great black-backed gull is not considered to be at risk of effects due to displacement from offshore wind farms, therefore only collision effects were considered in this Report.
46. The only SPA identified by SNH for great black-backed gull was East Caithness Cliffs. Since no other SPAs were considered for this species there was no need to estimate relative proportions. The proportion of this population at risk of collision (at an avoidance rate of 99%) for each scenario is provided in Table 3.7.

Table 3.7: Proportion of the East Caithness Cliffs SPA Great Black-Backed Gull Population at Risk of Collision on the Wind Farm Sites (Proportions greater than 1% are highlighted.)

	Wind Farm	Scenario 1	Scenario 2	Scenario 3
Collision Mortality (at an avoidance rate of 99%)	25	32	37	39
SPA	Proportion of SPA on Site(s)			
East Caithness Cliffs	0.0714	0.0914	0.1057	0.1114

47. The proportion of the East Caithness Cliffs population predicted to be at risk of collisions increased from 7.1% for the Wind Farm alone to 11.1% for Scenario 3 (the equivalent proportions at an avoidance rate of 98% are doubled to 14.2% for the Wind Farm alone and 22.2% for Scenario 3). Thus the potential for an LSE was predicted for the East Caithness Cliffs great black-backed gull population. The

potential effects of collision mortality at the range of levels shown are assessed below (Section 3.4.2.2).

3.3.5 HERRING GULL

48. Herring gull is not considered to be at risk of effects due to displacement from offshore wind farms, therefore only collision effects were considered in this Report.
49. The only SPA identified by SNH for herring gull was East Caithness Cliffs. Since no other SPAs were considered for this species there was no need to estimate relative proportions. The proportion of this population at risk of collision for each scenario is provided in Table 3.8.

Table 3.8: Proportion of the East Caithness Cliffs SPA Herring Gull Population at Risk of Collision on the Wind Farm Sites (Proportions greater than 1% are highlighted.)

	Wind Farm	Scenario 1	Scenario 2	Scenario 3
Collision Mortality (at an avoidance rate of 99%)	10	12	13	14
SPA	Proportion of SPA on Site(s)			
East Caithness Cliffs	0.0015	0.0017	0.0019	0.0020

50. The proportion of the East Caithness Cliffs population predicted to be at risk of collisions increased from 0.15% for the Wind Farm alone to 0.20% for Scenario 3 (the equivalent proportions at an avoidance rate of 98% are doubled to 0.3% for the Wind Farm alone and 0.4% for Scenario 3). Therefore no adverse effect on the integrity of the East Caithness Cliffs SPA is predicted due to collision mortality of herring gull caused by the Wind Farm alone or in combination with the Moray Firth Round 3 Zone wind farms.

3.3.6 GUILLEMOT

51. Guillemot is not considered to be at risk of effects due to collisions at offshore wind farms, therefore only displacement effects were considered in this Report. The SPAs identified by SNH for guillemot were East Caithness Cliffs and North Caithness Cliffs. However, guillemot forage over sufficiently long distances (mean max. range 61 km) that several other SPAs may also contribute to the birds observed on the Site; Hoy and Troup, Pennan and Lion's Head. Therefore these SPAs were also included in the apportioning calculations (Table 3.9).

Table 3.9: Calculation of Proportion of on Site Guillemot from Candidate SPAs

SPA	Population (ind.)	Distance to Site (km)	Proportion of Sea within Foraging Range	Weight	SPA Proportion
East Caithness Cliffs	158985	11	0.813	1616.1	0.936
North Caithness Cliffs	70154	29	0.832	100.3	0.058
Hoy	9020	57	0.847	3.3	0.002
Troup, Pennan and Lion's Head	16325	62	0.641	6.6	0.004

52. On the basis of the apportioning calculations, East Caithness Cliffs SPA contributed 93.6% of the on Site population and North Caithness Cliffs SPA a further 5.8%.

53. Applying the proportions calculated in Table 3.9 to the individual and cumulative total abundances on the Wind Farm Sites (Table 3.10), the only SPA for which more than 1% of its population was estimated to be present on the Wind Farm Sites was East Caithness Cliffs, with between 3.5% and 6.5% of its guillemot population estimated to be at risk of displacement across the four scenarios (the Wind Farm alone to Scenario 3). Thus the potential for an LSE was predicted for the East Caithness Cliffs guillemot population. The potential effects of displacement at the range of levels shown are assessed below (Section 3.4.2.3).
54. The SPA with the next largest proportion of its population estimated to be present on the Wind Farm Sites was North Caithness Cliffs. However, at a maximum proportion of this population on the Wind Farm Sites of 0.9% (Scenario 3, Table 3.10) no adverse effect on the integrity of the North Caithness Cliffs SPA is predicted due to displacement of guillemot caused by the Wind Farm alone or in combination with the Moray Firth Round 3 Zone wind farms.

Table 3.10: Proportion of Each SPA Population Present on the Wind Farm Sites on the Basis of the Proportions in Table 3.9 (SPA populations estimated to have more than 1% of their population present are highlighted in bold.)

	Wind Farm	Scenario 1	Scenario 2	Scenario 3
On Site Abundance	6014	8167	9757	10972
SPA	Proportion of SPA on Site(s)			
East Caithness Cliffs	0.0354	0.0481	0.0575	0.0646
North Caithness Cliffs	0.0050	0.0068	0.0081	0.0091
Hoy	0.0013	0.0017	0.0021	0.0023
Troup, Pennan and Lion's Heads	0.0014	0.0019	0.0023	0.0026

3.3.7 RAZORBILL

55. Razorbill is not considered to be at risk of effects due to collisions at offshore wind farms, therefore only displacement effects were considered in this Report.
56. The SPAs identified by SNH for razorbill were East Caithness Cliffs and North Caithness Cliffs (Table 3.11).

Table 3.11: Calculation of Proportion of on Site Razorbill from Candidate SPAs.

SPA	Population (ind.)	Distance to Site (km)	Proportion of Sea within Foraging Range	Weight	SPA Proportion
East Caithness Cliffs	17830	11	0.813	181.2	0.981
North Caithness Cliffs	2466	29	0.832	3.5	0.019

57. On the basis of the apportioning calculations, East Caithness Cliffs SPA contributed 98.1% of the on Site population and North Caithness Cliffs SPA the remaining 1.9%.
58. Applying the proportions calculated in Table 3.11 to the individual and cumulative total abundances on the Wind Farm Sites (Table 3.12), both SPAs had more than 1% of their populations estimated to be present on the Wind Farm Sites. For East Caithness Cliffs between 4.2% and 9.5% of its razorbill population was estimated to

be at risk of displacement across the four scenarios (the Wind Farm alone to Scenario 3). For North Caithness Cliffs between 0.6% and 1.3% of its razorbill population was estimated to be at risk of displacement across the four scenarios (the Wind Farm alone to Scenario 3). Thus the potential for LSE was predicted for both SPA's razorbill populations. The potential effects of displacement at the range of levels shown are assessed below (Sections 3.4.2.4 and 3.5.3.1).

Table 3.12: Proportion of Each SPA Population Present on the Wind Farm Sites on the Basis of the Proportions in Table 3.11 (SPA populations estimated to have more than 1% of their population present are highlighted in bold.)

	Wind Farm	Scenario 1	Scenario 2	Scenario 3
On Site Abundance	768	1214	1471	1726
SPA	Proportion of SPA on Site(s)			
East Caithness Cliffs	0.0423	0.0668	0.0809	0.0950
North Caithness Cliffs	0.0059	0.0094	0.0114	0.0134

3.3.8 PUFFIN

59. Puffin is not considered to be at risk of effects due to collisions at offshore wind farms, therefore only displacement effects were considered in this Report.
60. The SPAs identified by SNH for puffin were East Caithness Cliffs and North Caithness Cliffs (Table 3.13).

Table 3.13: Calculation of Proportion of on Site Puffin from Candidate SPAs

SPA	Population (prs.)	Distance to Site (km)	Proportion of Sea within Foraging Range	Weight	SPA Proportion
East Caithness Cliffs	274	11	0.813	2.8	0.216
North Caithness Cliffs	7071	29	0.832	10.1	0.784

61. On the basis of the apportioning calculations, East Caithness Cliffs SPA contributed 21.6% of the on Site population and North Caithness Cliffs SPA 78.4%.
62. Estimates of puffin abundance calculated from the boat survey data revealed a peak in numbers during August in both years (Original ES, Section 13.3.2, Plate 13.11). This is consistent with post-breeding dispersal and aggregation of immature birds which occurs at this time of year (Snow and Perrins, 1998). Since birds present at this time are not subject to the same pressures as breeding adults with respect to foraging areas, the average peak abundance for the Site was recalculated without the August abundance. This reduced the maximum number of birds at risk of displacement on the Beatrice Wind Farm from 1,603 to 390. On the basis that a similar reduction (i.e. 75%) would apply to the abundance on the Moray Firth Round 3 Zone, the peak numbers for the three Moray Firth Round 3 Zone wind farms were similarly adjusted. The same displacement rate (40%) used for assessing effects on the total population (ES Addendum Section 7.6.2.6) was then applied. Thus the total number of puffins at risk of displacement was estimated to be: 116, 197, 294 and 349 for respectively the Wind Farm alone, Scenario 1, Scenario 2 and Scenario 3.

63. Applying the proportions calculated in Table 3.13 to the individual and cumulative total abundances on the Wind Farm Sites (Table 3.14), both the East Caithness Cliffs and North Caithness Cliffs SPAs had more than 1% of their populations estimated to be present on the Wind Farm Sites. For East Caithness Cliffs SPA the proportions present increased from 4.6% to 13.8% (the Wind Farm alone to Scenario 3), while the respective scenarios yielded proportions from 0.6% to 1.9% for North Caithness Cliffs. Thus the potential for LSEs was predicted for both the East Caithness Cliffs SPA puffin population and the North Caithness Cliffs SPA puffin population. The potential effects of displacement at the range of levels shown are assessed below (Sections 3.5.2.5 and 3.5.3.2).

Table 3.14: Proportion of each SPA Population Present on the Wind Farm Sites on the Basis of the Proportions in Table 3.13 (SPA populations estimated to have more than 1% of their population present are highlighted in bold.)

	Wind Farm	Scenario 1	Scenario 2	Scenario 3
On Site Abundance	116	197	294	349
SPA	Proportion of SPA on Site(s)			
East Caithness Cliffs	0.046	0.078	0.116	0.138
North Caithness Cliffs	0.006	0.011	0.016	0.019

3.3.9 ARCTIC SKUA

64. The only SPA identified by SNH for Arctic skua was Hoy, for which the most recent breeding population estimate is 12 pairs. This is lower than the peak population recorded on the Beatrice Wind Farm survey area (88; Original ES Section 13.3.2.2). Arctic skuas are specialist kleptoparasites; they obtain food by chasing other species and forcing them to disgorge their food which they then steal. Consequently, breeding birds forage in the vicinity of seabird colonies; foraging birds on Foula have rarely been seen more than 2 km from the coast (Furness, 1978). It is therefore unlikely that breeding Arctic skua from the Hoy SPA (> 57 km away) would forage on the Wind Farm Sites.
65. Furthermore, in Scotland egg-laying occurs from mid-May, while adults leave the breeding grounds and head south from early August (Snow and Perrins, 1998). Given the timing of observations of Arctic skua in the boat surveys of the Site (predominantly May and August), this indicates that the birds observed on the Site are on passage, not making foraging trips, and may therefore originate from any of several SPAs located further north in Orkney or Shetland. As a consequence of the above, no attempt was made to apportion the on Site population among candidate breeding colonies.
66. This species is not considered at risk of displacement effects due to the Wind Farm and the Moray Firth Round 3 Zone, due to its foraging behaviour which constrains breeding birds to locations closer to shore.
67. Furthermore, since very low collision mortality was predicted for Arctic skua (maximum of 6 for the Wind Farm, none for Moray Firth Round 3 Zone), and it is very unlikely all of these would be confined to a single SPA, no potential for an LSE was predicted for the Hoy SPA Arctic skua population.

3.3.10 GREAT SKUA

68. The only SPA identified by SNH for great skua was Hoy, for which the most recent breeding population estimate is 1,346 pairs. Great skua have a varied diet, with kleptoparasitism, trawler discards and other seabirds all included (although individuals appear to specialise; Votier et al., 2004). Individuals tracked from breeding sites in Shetland varied between patrolling nearby (<2 km) seabird colonies and following fishing vessels up to 10 km from the coast (Votier et al., 2004).
69. In Scotland egg-laying occurs around mid-May, and young birds fledge by late August (Snow and Perrins, 1998). This period coincides with the main period when great skuas were observed on the Site. However, given this species' dietary preferences whilst breeding and the distance of the Wind Farm Sites (> 57 km) from the Hoy SPA, it seems unlikely that breeding great skua from the Hoy SPA colony would forage regularly on the Wind Farm Sites.
70. The origin of the birds seen on the Site is therefore unclear. However, from their fifth year birds show attachment to breeding colonies over the summer, even though they may not begin breeding until their 12th year (Klomp and Furness, 1992). It seems probable that many of the individuals seen during the breeding season on the Wind Farm Site are immature birds, since these individuals are not constrained by the demands of incubation and provisioning young and can therefore forage more widely. As a consequence of the above, no attempt was made to apportion the on Site population among candidate breeding colonies.
71. This species is not considered at risk of displacement effects due to the Moray Offshore Wind Farms, due to its foraging behaviour which constrains breeding birds to locations closer to shore.
72. Furthermore, since very low numbers of collisions were predicted (maximum of 13 for the Wind Farm, none for Moray Firth Round 3 Zone), and these appear unlikely to be confined to breeding birds from the Hoy SPA, no potential for an LSE was predicted for the Hoy SPA great skua population.

3.3.11 SUMMARY OF EFFECTS CONSIDERED

73. Table 3.15 summarises the SPA qualifying features which have been assessed for the potential for LSEs and the results of this assessment. Those features for which an LSE was identified are assessed in further detail below.

Table 3.15: Summary of SPA Qualifying Features Assessed for LSEs

SPA	Qualifying Feature Assessed	Effect Considered	LSE Identified	HRA Section
East Caithness Cliffs	Fulmar	Displacement	Yes	1.4.2.1
	Kittiwake	Collision	No	N/A
	Kittiwake	Displacement	No	N/A
	Great black-backed gull	Collision	Yes	1.4.2.2
	Herring gull	Collision	No	N/A
	Guillemot	Displacement	Yes	1.4.2.3
	Razorbill	Displacement	Yes	1.4.2.4
North Caithness Cliffs	Puffin	Displacement	Yes	1.2.4.5
	Kittiwake	Collision	No	N/A
	Kittiwake	Displacement	No	N/A
	Guillemot	Displacement	No	N/A
	Razorbill	Displacement	Yes	1.4.3.1
Hoy	Puffin	Displacement	Yes	1.4.3.2
	Arctic skua	Collision	No	N/A
	Arctic skua	Displacement	No	N/A
	Great skua	Collision	No	N/A
	Great skua	Displacement	No	N/A

3.4 APPRAISAL OF EFFECTS ON CONSERVATION OBJECTIVES AND INTEGRITY OF SPAS

74. The previous section estimated which SPA qualifying features (i.e. bird populations) recorded during bird surveys of the Wind Farm Site had the potential for LSEs. This section predicts the SPA population level effects of the potential adverse effects identified. This assessment has been undertaken using stochastic population models described below (Section 3.4.1). These models are the same as those used in the ornithological ES Addendum (Section 7.5.2).
75. Initial population sizes used in the model were the SPA population estimates (Table 3.1) while the number of individuals estimated to be at risk of displacement or collision effects from each SPA was calculated as the product of the SPA proportions, calculated in the preceding section (Section 3.3), multiplied by the total collision or displacement numbers (both for the Wind Farm alone and in combination with the three stages of the Moray Firth Round 3 Zone development).
76. In this manner, the viability of the SPA populations as integral components of each SPA was addressed.

3.4.1 POPULATION MODELLING

3.4.1.1 Description of Population Modelling

77. The stochastic population models developed for the HRA followed best practice methods, as described in WWT (2012). The models were based on the best available demographic data (Table 3.16).
78. Closed populations were assumed since there is no information on rates of exchange (i.e. immigration and emigration) between the breeding colonies being assessed. Similarly there is no information on which to base density dependent population regulation, hence the models were density independent. While this is

clearly unrealistic in the longer term, for the benefits of short-term modelling of small populations, the risks from violating this assumption were considered to be small.

79. The populations were modelled on an annual time step, with one year age classes up to adults which are a multi-age class for all individuals of this age and older. Only the final age class breeds and the models were based on a post-breeding census structure (i.e. each census of the modelled population occurs immediately after the breeding season).
80. Environmental stochasticity was modelled using the mean rates and the standard deviations as listed in Table 3.16. Survival rates were drawn from a beta distribution, and brood sizes from a stretched beta distribution. These distributions were used as they generate random numbers with characteristics appropriate to the demographic rates (i.e. survival rates between 0 and 1, and brood sizes which lie between pre-defined limits).
81. Demographic stochasticity on survival was modelled using a binomial process, whereby the number of individuals which survive from one time step to the next was estimated using a binomial function (Akçakaya, 1991). Thus, the number of individuals alive at time $t+1$ is generated by a 'coin-toss' process, using the number of individuals alive at time t and the randomly generated survival rate for that time step (as described in the preceding point).
82. It is noted that the difference between environmental and demographic stochasticity can be thought of as follows: Environmental stochasticity generates random values for the probability of survival from one time step to the next. Demographic stochasticity generates random numbers of individuals which survive from one time step to the next for any given survival probability. Thus environmental stochasticity models variable environments (e.g. weather effects) while demographic stochasticity models the effects of chance, which are increasingly important as the population size falls.
83. Additional mortality was applied to each age class in proportion to their presence in the population. In order to reflect the fact that collision mortality would be more likely to operate as a per capita rate, rather than an absolute value, the total number killed at each time step was proportional to the population size. Thus, additional mortality remained at the same proportional level relative to the population size throughout the simulation, whether the population increased or decreased.
84. Displacement effects were modelled by reducing the breeding population size by twice the number of individuals predicted to be displaced. This accounted for the worst case scenario whereby each displaced individual represents a failed pair (this was a necessary step as the models are based on individuals, not pairs).
85. For each modelled range of effects (collision or displacement), the median population growth rate, probabilities of population decline within the simulated period and proportions of simulation which were smaller than the baseline median final population size (i.e. that achieved in the absence of additional mortality) were calculated across all simulations (10,000).

Table 3.16: Demographic Rates used in the Seabird Populations Models*(Sources provided in table footnote)*

Species (ref.)	Age at First Breeding	Mean Survival Rates (standard deviation)					Fledglings/pr.	Brood Size Range (min-max)
		Adult	Year 1	Year 2	Year 3	Year 4		
Fulmar ^{1,2,3}	9	0.972 (0.067) [applies to all age classes up to 8]					0.19 (0.126)	0 - 1
Great Black-Backed Gull ^{2,3,4,5,6,7,8,9}	5	0.93 (0.025)	0.82 (0.03)				0.74 (0.297)	0 - 2
Guillemot ^{3,10,11}	5	0.965 (0.01)	0.56 (0.014)	0.792 (0.03)	0.917 (0.017)	0.938 (0.017)	0.335 (0.113)	0 - 2
Razorbill ^{3,4,10,12,13}	4	0.9 (0.028)	0.937 (0.028)			NA	0.38 (0.085)	0 - 2
Puffin ^{3,4,14}	5	0.924 (0.01)					0.345 (0.111)	0 - 2

1 - Dunnet and Ollason, 1978; 2 - Maclean et al., 2007; 3 - Mavor et al., 2008; 4 - Robinson, 2005; 5 - Garthe and Huppopp, 2004; 6 - Wanless et al., 1996; 7 - Calladine and Harris, 1996; 8-Reeves and Furness, 2002; 9 - Poot et al., 2011; 10 - Harris et al., 2007; 11 - Birkhead and Hudson, 1977; 12 - Lloyd and Perrins, 1977; 13 - Chapdelaine, 1997; 14 - Harris et al., 1997

86. The population models used for this assessment were stochastic and density independent. Discussion of population modelling at the meeting with SNH on 4th September 2012 concerned a request by SNH that the models should incorporate realistic recent population trends. This argument is based on the premise that the baseline model for any given species should generate predictions which match the recent trend in the population of interest. While this is a reasonable request, it presupposes that the underlying reasons for such trends have been studied and are well understood.
87. This is rarely the case. Most population models are, of necessity, based on demographic rates derived either from different populations or at some time in the past (or often both). Indeed in many instances there are few data on which to base the trends themselves. Population change occurs due to a wide range of factors, some intrinsic (i.e. population regulation through competition for resources, often referred to as density dependence), some extrinsic (e.g. weather conditions), and these two also interact so that intrinsic effects may be greater during periods of unfavourable weather. Without knowing the main drivers of such changes (which is usually the case), simply modifying the survival or reproductive rates in order that the population model generates a prediction in line with the estimated population trend without understanding what has really caused observed changes has the potential to render the model very unreliable as a predictive tool. In addition, some population change may be due to movements of individuals between locations (i.e. immigration and emigration), unrelated to change in demographic rates.
88. In such circumstances the most robust approach for modelling is to avoid the temptation to include density dependence, since this is likely to be based on the premise that 'it must be present, therefore we will apply it', even if the mechanism is unknown. Furthermore this highlights that the most appropriate means for considering model outputs is relatively; for example the change in the population

growth rate predicted to occur as a result of a given effect, not the absolute rate of change itself which has a high likelihood of being inaccurate. In this way, the onus on the absolute reliability of the model is eased and instead focus is directed towards assessment of the relative magnitudes of a range of predicted effects.

89. The above points were made during the discussion with SNH at a meeting on 4th September 2012 and it was agreed that on consideration of the above it was reasonable and defensible to assess effects using density independent models.

3.4.1.2 *Determination of Adverse Effects on Site Integrity from Population Model Outputs*

90. To determine if an adverse effect on site integrity would be predicted, the increase in the probability of triggering population declines (relative to the baseline prediction) was used. Table 3.17 provides a guide to the thresholds applied and the level at which an adverse effect would be concluded.

Table 3.17: Thresholds of Increase in Risk of Probability of Decline below Specific Threshold Population Sizes and Level at Which Adverse Effects on Site Integrity would be Concluded

Population Decline Relative to Baseline	Increase in Probability		
	>2	>5	>10
10	No adverse effect	No adverse effect	Adverse effect
20	No adverse effect	Adverse effect	Adverse effect
50	Adverse effect	Adverse effect	Adverse effect

91. The above thresholds were defined by JNCC and Natural England for use in the assessment of the potential effects on Sandwich tern due to the proposed Triton Knoll offshore wind farm. They represent alternative thresholds of risk rather than a sliding scale, hence the only distinction obtained is no adverse effect/adverse effect (in HRA terms).
92. An effect which triggers increases in the probability of a population decline which are smaller than the thresholds in Table 3.17 is one which ensures that the primary conservation objective identified in Section 3.2 (maintenance of the population as a viable component of the site) is not violated. Conversely, an effect which exceeds one or more of the thresholds in Table 3.17 would be taken as a prediction of an adverse effect on site integrity.
93. For this assessment, a period of 25 years has been used for all population simulations, as this represents a reasonable compromise between generating useful predictions and minimising the propagation of errors due to uncertainty in demographic rates used.
94. The increase in the probability that the final population size (i.e. after 25 years) will be smaller than the median baseline one has also been provided on request by Marine Scotland. However, these have not been used to determine the presence of adverse effects on site integrity since considering effects in this way has no precedence for offshore wind farms. Furthermore, considering effects in this

manner considerably amplifies their apparent magnitude. This occurs because even a small effect, which may only reduce the population growth rate by a small amount, can result in a large increase in the probability the population will be less than the baseline median value. Indeed, any effect will cause the final population size to be smaller than that predicted in the absence of the effect, thus this approach is considered to be too sensitive for reliable and robust assessment.

3.4.2 EAST CAITHNESS CLIFFS

3.4.2.1 Fulmar

95. The East Caithness Cliffs SPA fulmar population is estimated to comprise 14,202 pairs. The predicted number of individuals from this SPA at risk of displacement due to the Wind Farm alone and the three scenarios was: 577, 833, 1,073 and 1,266 respectively (calculated as 83.5% of the total number at risk of displacement). Using these values in the fulmar population model, the following predictions of population decline were obtained (Table 3.18 and Annex 7A, Figure 14, Annex 7B, Tables 33 and 34 of the ES Addendum).

Table 3.18: Predicted Increase in Probabilities of East Caithness Cliffs Fulmar Population Decline during 25 Year Simulation and in Final Year of Simulation due to Displacement from the Wind Farm Alone and the Moray Firth Round 3 Zone Wind Farms

Thresholds of Population Decline (% reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Displacement Scenario (used for HRA)				Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Displacement (not used HRA but included at request of MS)			
	Wind Farm	Scenario 1	Scenario 2	Scenario 3	Wind Farm	Scenario 1	Scenario 2	Scenario 3
10	0.008	0.005	0.013	0.018	0.046	0.064	0.098	0.11
20	0.002	<0.001	0.003	0.008	0.038	0.052	0.076	0.088
50	<0.001	<0.001	<0.001	<0.001	0.004	0.006	0.011	0.014

96. At these levels of displacement, the additional probability (above that predicted in the absence of displacement) of the East Caithness Cliffs fulmar population declining by more than 10% increased across a range from 0.8% (the Wind Farm alone) to 1.8% (Scenario 3). The increase in the probability of decline below 20% increased from 0.2% (the Wind Farm alone) to 0.8% (Scenario 3) and the increase in the probability of decline below 50% was less than 0.1% for all scenarios.
97. All of these increases in the risk of population decline are below the thresholds defined in Table 3.17.
98. Consequently no adverse effect is predicted on the integrity of the East Caithness Cliffs SPA due to displacement of fulmar caused by the Wind Farm alone or in combination with the Moray Firth Round 3 Zone wind farms.

3.4.2.2 Great Black-Backed Gull

99. The East Caithness Cliffs SPA great black-backed gull population is estimated to comprise 175 pairs. The predicted number of individuals from this SPA at risk of

collision (at an avoidance rate of 99%) due to the Wind Farm alone and the three cumulative Scenarios was: 25, 32, 37 and 39 respectively.

100. However, the number of birds estimated to be in collision during the breeding season expected to be from the East Caithness Cliffs SPA population is almost certainly much smaller than these estimates. Over 20 % of great black-backed gulls observed during the boat surveys were aged (as either adults or immature birds) on the basis of plumage. Across all surveys the percentage of adult birds (i.e. breeding birds) was 39.5% while during the breeding months (May - August inc.) this was 37.5%. Therefore, on this basis only 37.5% of the 39 individuals at risk of collision would be expected to be breeding adults, which equates to 15 individuals.
101. Furthermore, a proportion of these adults are likely to be non-breeding individuals. Compared to other seabird species such as skuas (Cstry et al., 1998) and auks (Harris and Wanless, 1994), gulls typically have relatively large proportions of non-breeders in a population. Calladine and Harris (1996) estimated that within a lesser black-backed gull colony at the Isle of May, east of Scotland, 34% of adults in 1993, and 40% in 1994 did not breed. This was considered to be a 'normal' period, unaffected by culling measures which occurred in some other years. These results are similar to those from other studies of gull populations. Kadlec and Drury (1968) estimated that 15-30% of adult North American herring gulls did not breed in any one year, and Pugesek and Diem (1990) estimated that 36% of Californian gulls did not breed in any given year. Samuels and Ladino (1984) estimated that 45% of herring gulls did not breed in a North American study.
102. It could therefore be reasonably concluded that as a conservative estimate, for every two breeding birds recorded, another non-breeding individual is present within the SPA population. Since the SPA population estimate is based on breeding pairs, this effectively increases the East Caithness Cliffs SPA population from 350 individuals to around 525. This would mean that approximately one in three adult birds at risk of collision would be a non-breeder, assuming that all birds from the SPA use the site equally. In reality it is very likely that the proportion of non-breeders encountered will increase with distance offshore, since these individuals are not constrained by the demands of incubation and feeding chicks. Therefore non-breeders are more likely to spend longer periods of time farther away from the colony, and range more widely than breeders.
103. Consequently, conservative estimates of the predicted number of breeding individuals from this SPA at risk of collision (at an avoidance rate of 99%) due to the Wind Farm alone and the three scenarios would fall to: 9, 12, 14 and 15 respectively.
104. Using these values in the great black-backed gull population model, the following predictions of population decline were obtained (Table 3.19 and Annex 7A, Figure 15, Annex 7B, Tables 35 and 36 of the ES Addendum).

Table 3.19: Predicted Increase in Probabilities of East Caithness Cliffs Great Black-Backed Gull Population Decline during 25 Year Simulation and in Final Year of Simulation due to Collisions on the Wind Farm Alone and Moray Firth Round 3 Zone Wind Farms

Thresholds of Population Decline (% reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Displacement Scenario (used for HRA)				Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Displacement (not used HRA but included at request of MS)			
	Wind Farm	Scenario 1	Scenario 2	Scenario 3	Wind Farm	Scenario 1	Scenario 2	Scenario 3
10	0.023	0.031	0.037	0.040	0.428	0.509	0.543	0.559
20	0.002	0.003	0.004	0.004	0.420	0.525	0.584	0.613
50	0	0	0	0	0.095	0.188	0.270	0.311

105. At these levels of collision, the additional probability (above that predicted in the absence of collision mortality) of the East Caithness Cliffs great black-backed gull population declining by more than 10% increased from 2.3% (the Wind Farm alone) to 4.0% (Scenario 3). The increase in the probability of decline below 20% increased from 0.2% (the Wind Farm alone) to 0.4% (Scenario 3) and the increase in the probability of decline below 50% was zero for all scenarios.
106. If an avoidance rate of 98% is applied the number at risk of collision are doubled, and the risks of population decline are also approximately doubled (see Section 7.9.6.4 of the ES Addendum). Therefore, none of the increases in the risk of population decline exceed the thresholds defined in Table 3.17.
107. Consequently no adverse effect is predicted on the integrity of the East Caithness Cliffs SPA due to collision mortality of great black-backed gull caused by the Wind Farm alone or in combination with the Moray Firth Round 3 Zone wind farms.

3.4.2.3 *Guillemot*

108. The East Caithness Cliffs SPA guillemot population is estimated to comprise 158,985 individuals. The predicted number of individuals from this SPA at risk of displacement due to the Wind Farm alone and the three scenarios was: 5,629, 7,644, 9,133 and 10,270 respectively (calculated as 93.6% of the total number at risk of displacement). Using these values in the guillemot population model, the following predictions of population decline were obtained (Table 3.20 and Annex 7A, Figure 16, Annex 7B, Tables 37 and 38 of the ES Addendum).

Table 3.20: Predicted Increase in Probabilities of East Caithness Cliffs Guillemot Population Decline during 25 Year Simulation and in Final Year of Simulation due to Displacement from the Wind Farm and Moray Firth Round 3 Zone Wind Farms

Thresholds of Population Decline (% reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Displacement Scenario (used for HRA)				Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Displacement (not used HRA but included at request of MS)			
	Wind Farm	Scenario 1	Scenario 2	Scenario 3	Wind Farm	Scenario 1	Scenario 2	Scenario 3
10	<0.001	<0.001	<0.001	<0.001	0.272	0.39	0.485	0.54
20	0	0	0	0	0.086	0.149	0.21	0.262
50	0	0	0	0	0	0	0	0

109. At these levels of displacement, the additional probability (above that predicted in the absence of displacement) of the East Caithness Cliffs guillemot population declining by more than 10% was less than 0.1% for all levels of predicted displacement and was zero for declines of 20% and 50%.
110. All of these increases in the risk of population decline are below the thresholds defined in Table 3.17.
111. Consequently no adverse effect is predicted on the integrity of the East Caithness Cliffs SPA due to displacement of guillemot caused by the Wind Farm alone or in combination with the Moray Firth Round 3 Zone wind farms.

3.4.2.4 Razorbill

112. The East Caithness Cliffs SPA razorbill population is estimated to comprise 17,830 individuals. The predicted number of individuals from this SPA at risk of displacement due to the Wind Farm and the three scenarios was: 753, 1,191, 1,443 and 1,693 respectively (calculated as 98.1% of the total number at risk of displacement). Using these values in the razorbill population model, the following predictions of population decline were obtained (Table 3.21 and Annex 7A, Figure 17, Annex 7B, Tables 39 and 40 of the ES Addendum).

Table 3.21: Predicted Increase in Probabilities of East Caithness Cliffs Razorbill Population Decline during 25 Year Simulation and in Final Year of Simulation due to Displacement from the Wind Farm and Moray Firth Round 3 Zone Wind Farms

Thresholds of Population Decline (% reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Displacement Scenario (used for HRA)				Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Displacement (not used HRA but included at request of MS)			
	Wind Farm	Scenario 1	Scenario 2	Scenario 3	Wind Farm	Scenario 1	Scenario 2	Scenario 3
10	0.001	0.002	0.003	0.004	0.48	0.64	0.68	0.70
20	0	0	0	0	0.41	0.98	0.78	0.84
50	0	0	0	0	0.007	0.04	0.09	0.21

113. At these levels of displacement, the additional probability (above that predicted in the absence of displacement) of the East Caithness Cliffs razorbill population declining by more than 10% increased from 0.1% for the Wind Farm alone to 0.4% for Scenario 3 and was zero for declines of 20% and 50%.
114. All of these increases in the risk of population decline are below the thresholds defined in Table 3.17.
115. Consequently no adverse effect is predicted on the integrity of the East Caithness Cliffs SPA due to displacement of razorbill caused by the Wind Farm alone or in combination with the Moray Firth Round 3 Zone wind farms.

3.4.2.5 Puffin

116. The East Caithness Cliffs SPA puffin population is estimated to comprise 274 pairs. The predicted number of individuals from this SPA at risk of displacement due to the Wind Farm alone and the three scenarios was: 25, 43, 63 and 75 respectively. Using these values in the puffin population model, the following predictions of population decline were obtained (Table 3.22 and Annex 7A, Figure 18, Annex 7B, Tables 41 and 42 of the ES Addendum).

Table 3.22: Predicted Increase in Probabilities of East Caithness Cliffs Puffin Population Decline during 25 Year Simulation and in Final Year of Simulation due to Displacement from the Wind Farm and Moray Firth Round 3 Zone Wind Farms

Thresholds of Population Decline (% reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Displacement Scenario (used for HRA)				Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Displacement (not used HRA but included at request of MS)			
	Wind Farm	Scenario 1	Scenario 2	Scenario 3	Wind Farm	Scenario 1	Scenario 2	Scenario 3
10	<0.001	0.001	0.003	0.008	0.44	0.67	0.73	0.74
20	0	0	0	0	0.33	0.67	0.88	0.90
50	0	0	0	0	0.001	0.012	0.086	0.22

117. Thus at these levels of displacement, the additional probability (above that predicted in the absence of displacement) of the East Caithness Cliffs puffin population declining by more than 10% increased across a range from <0.1% (the Wind Farm alone) to 0.8% (Scenario 3). There was no increase in the probability of decline below 20% or 50%.
118. All of these increases in the risk of population decline are below the thresholds defined in Table 3.17.
119. Consequently no adverse effect is predicted on the integrity of the East Caithness Cliffs SPA due to displacement of puffin caused by the Wind Farm alone or in combination with the Moray Firth Round 3 Zone wind farms.

3.4.3 NORTH CAITHNESS CLIFFS

3.4.3.1 Razorbill

120. The North Caithness Cliffs SPA razorbill population is estimated to comprise 17,830 individuals. The predicted number of individuals from this SPA at risk of displacement due to the Wind Farm alone and the three scenarios was: 15, 23, 28, and 33 respectively. Using these values in the razorbill population model, the following predictions of population decline were obtained (Table 3.23 and Annex 7A, Figure 19, Annex 7B, Tables 43 and 44 of the ES Addendum).

Table 3.23: Predicted Increase in Probabilities of North Caithness Cliffs Razorbill Population Decline during 25 Year Simulation and in Final Year of Simulation due to Displacement from the Wind Farm and Moray Firth Round 3 Zone Wind Farms

Thresholds of Population Decline (% reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Displacement Scenario (used for HRA)				Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Displacement (not used HRA but included at request of MS)			
	Wind Farm	Scenario 1	Scenario 2	Scenario 3	Wind Farm	Scenario 1	Scenario 2	Scenario 3
10	<0.001	<0.001	<0.001	<0.001	0.169	0.197	0.252	0.279
20	0	0	0	0	0.115	0.142	0.178	0.203
50	0	0	0	0	<0.001	<0.001	0.001	0.001

121. At these levels of displacement, the additional probability (above that predicted in the absence of displacement) of the North Caithness Cliffs razorbill population declining by more than 10% was less than 0.1% for all Scenarios and was zero for declines of 20% and 50%.

122. All of these increases in the risk of population decline are below the thresholds defined in Table 3.17.

123. Consequently no adverse effect is predicted on the integrity of the North Caithness Cliffs SPA due to displacement of razorbill caused by the Wind Farm alone or in combination with the Moray Firth Round 3 Zone wind farms.

3.4.3.2 Puffin

124. The North Caithness Cliffs SPA puffin population is estimated to comprise 7,071 pairs. The predicted number of individuals from this SPA at risk of displacement due to the Wind Farm alone and the three scenarios was: 91, 154, 230 and 274 respectively. Using these values in the puffin population model, the following predictions of population decline were obtained (Table 3.24 and Annex 7A, Figure 20, Annex 7B, Tables 45 and 46 of the ES Addendum).

Table 3.24: Predicted Increase in Probabilities of North Caithness Cliffs Puffin Population Decline during 25 Year Simulation and in Final Year of Simulation due to Displacement from the Wind Farm and Moray Firth Round 3 Zone Wind Farms

Thresholds of Population Decline (% reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Displacement Scenario (used for HRA)				Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Displacement (not used HRA but included at request of MS)			
	Wind Farm	Scenario 1	Scenario 2	Scenario 3	Wind Farm	Scenario 1	Scenario 2	Scenario 3
10	<0.001	<0.001	<0.001	<0.001	0.053	0.096	0.0147	0.174
20	0	0	0	0	0.034	0.055	0.085	0.10
50	0	0	0	0	0	0	<0.001	<0.001

125. Thus at these levels of displacement, the additional probability (above that predicted in the absence of displacement) of the North Caithness Cliffs puffin population declining by more than 10% is less than 0.1% for all scenarios and there was no increase in the risk of decline by more than 20% or 50%.
126. All of these increases in the risk of population decline are below the thresholds defined in Table 3.17.
127. Consequently no adverse effect is predicted on the integrity of the North Caithness Cliffs SPA due to displacement of puffin caused by the Wind Farm alone or in combination with the Moray Firth Round 3 Zone wind farms.

3.4.4 SUMMARY OF PREDICTED EFFECTS ON SPA INTEGRITY

3.4.4.1 East Caithness Cliffs SPA

128. The potential for LSE were determined for East Caithness Cliffs SPA for the following interests (and effects):
- Fulmar (displacement);
 - Great black-backed gull (collision);
 - Guillemot (displacement);
 - Razorbill (displacement); and
 - Puffin (displacement).
129. Population modelling was used to assess the likelihood of adverse effects on the integrity of the East Caithness Cliffs SPA due to reductions in the populations of these species as a result of the effects identified. The outputs from the population models constitute information to inform an Appropriate Assessment for these qualifying features.
130. The assessment has shown that the proposed wind farm developments will not prevent the maintenance of the populations of these species as viable components of the site.
131. Therefore the Conservation Objectives of the East Caithness Cliffs SPA will not be undermined as a consequence of the construction, operation or decommissioning of the proposed Beatrice Wind Farm Site, either alone or in-combination with other

projects and, therefore, there will be no adverse effects on the integrity of the East Caithness Cliffs SPA or its qualifying features.

3.4.4.2 North Caithness Cliffs SPA

132. The potential for a LSE was predicted for North Caithness Cliffs SPA for the following interest:
- Razorbill (displacement); and
 - Puffin (displacement).
133. Population modelling was used to assess the likelihood of an adverse effect on the integrity of the North Caithness Cliffs SPA due to reductions in the population of these species as a result of the effects identified. The outputs from the population models constitute information to inform an Appropriate Assessment for these qualifying features.
134. The assessment has shown that the effects of the proposed wind farm developments will not prevent the maintenance of the populations of these species as viable components of the site.
135. Therefore the Conservation Objectives of the North Caithness Cliffs SPA will not be undermined as a consequence of the construction, operation or decommissioning of the proposed Beatrice Wind Farm Site, either alone or in-combination with other projects and, therefore, there will be no adverse effects on the integrity of the North Caithness Cliffs SPA or its qualifying features.

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4 MARINE MAMMAL ECOLOGY

4.1 NATURA 2000 SITES AND QUALIFYING INTEREST FEATURES

162. SNH and JNCC have provided advice with respect to addressing the question of whether the Wind Farm and OfTW are likely to have connectivity with, and therefore the potential to have an LSE on the qualifying interests of any SACs either alone or in combination with other plans or projects (SNH/JNCC Scoping Advice, 14 May 2010). Within the Original ES and the ES Addendum for this project, effects on marine mammals have been assessed by considering the worst case scenarios associated with the construction, operation and decommissioning activities of the Wind Farm and OfTW and these are presented in Sections 12: Wind Farm Marine Mammals and 24: OfTW Marine Mammals of the Original ES respectively, and Section 6: Marine Mammals of the ES Addendum.

163. There were two designated sites identified by SNH in their scoping opinion for the Wind Farm and OfTW assessments which need to be considered in this Report, these include:

- Moray Firth SAC (37.3 km from the Wind Farm Site); and,
- Dornoch Firth and Morrich More SAC (64.5 km from the Wind Farm Site).

164. A summary of these sites is given in Table 4.1 followed by a full description of the citation features. Their locations are displayed (labelled by numbers 34 and 31 respectively) on Figures 1.1b and 1.1c.

Table 4.1: Site Summary of SACs for Marine Mammals Considered in this Report

Site Information	Moray Firth SAC	Dornoch Firth and Morrich More SAC
Site Code	UK0019808	UK0019806
Location	Latitude 57 49 01 N; Longitude 03 43 32 W	Latitude: 57 51 00 N; Longitude 04 02 30 W
Site Area	151347.17 ha	8700.53 ha
Administrative Regions	Scotland- Highland and Moray	Scotland- Highland
Qualifying Features	The SAC is designated for its Annex I habitats present as a qualifying feature, but not a primary reason for selection of this site; includes Sandbanks which are slightly covered by sea water all the time. Annex II species that are a primary reason for selection of this site includes the bottlenose dolphin <i>Tursiops truncatus</i> .	The SAC is designated for its Annex I habitats that are a primary reason for selection of this site. The marine qualifying features include Estuaries, Mudflats and sandflats not covered by seawater at low tide, Reefs, and Sandbanks which are slightly covered by seawater all the time. There are also a number of terrestrial Annex I habitats, which are not considered further in this assessment. Annex II species that are a primary reason for selection of this site include otter <i>Lutra lutra</i> and harbour (or common) seal <i>Phoca vitulina</i> .

165. Due to the potential for grey seals to forage over large distances, and following consultation with JNCC and SNH, six further grey seal SACs in Scotland were initially considered in Section 12: Wind Farm Marine Mammals of the Original ES. These included: the Trenhish Isles (Strathclyde), the Monach Isles (Outer Hebrides), North Rona (Outer Hebrides), Faray and Holm of Faray (Orkney), the Isle of May (Firth of Forth) and the Berwickshire and North Northumberland Coast (which crosses the border between Scotland and England on the east coast).
166. A review of published studies relating to grey seal movements at-sea showed that, while grey seals often forage close to shore in areas local to the sites they are using to haul out, they also make long distance movements (McConnell et al., 1999). The results of tagging studies on grey seals from different SAC locations in Scotland showed a high probability that grey seals, using the Moray Firth and/or the Wind Farm site as foraging grounds, would haul out at some point at one or more of the six Scottish grey seal SAC sites (Russell, 2011). The ES concluded that whilst there may be some displacement of grey seals at sea, with individuals from these SACs having the potential to experience effects, these effects were considered to be negligible due to the wide ranging nature of this species, their lack of site fidelity, and their ability to move to other unaffected areas during the period of disturbance. Consequently, these SACs have been scoped out of the HRA.

4.1.1 MORAY FIRTH SAC

4.1.1.1 Bottlenose Dolphins (Tursiops truncatus)

167. The Moray Firth SAC contains the only known resident population of bottlenose dolphins in the North Sea. Whilst estimates for the SAC population size have varied over the years, the data show that from year to year a substantial proportion (~50%) of the total Moray Firth population regularly uses the SAC (Cheney et al., 2012a), suggesting that this is an important area for the resident population. Consequently, the Moray Firth population estimates are also used to represent the size of the SAC bottlenose dolphin population.
168. The most recent estimate for the Moray Firth population, based on photo-identification work collected between 2006 and 2007, is 195 individuals, 95% Confidence Interval: 162-253 (Cheney et al., 2012b). Whilst previous work showed that there was a reduction in the use of the SAC by dolphins during the late 1990s, this was followed by a slight increase during the 2002-2004 reporting period (Thompson et al., 2006). The current conservation status assessment of the population is 'Stable (increasing)' (Cheney et al., 2012b) and the site condition of the SAC for bottlenose dolphin is assessed as being Favourable (Recovered) (SNH 2010).
169. Site-specific surveys were undertaken for the EIA to provide additional baseline information on the distribution, seasonal variation, abundance, density and movement between the Wind Farm Site and the Moray Firth SAC. These included boat-based and aerial visual surveys, passive acoustic monitoring and telemetry studies (see Section 12: Wind Farm Marine Mammals of the Original ES).

170. In summary, the distribution map provided from these surveys showed that there is a high probability of encountering bottlenose dolphins in the SAC but that the probability of bottlenose dolphin encounter is lower in the outer Moray Firth and in the vicinity of the Wind Farm Site (Figure 4.1). Bottlenose dolphins are more likely to be encountered around the southern coastal areas and inner reaches of the Moray Firth (Figure 4.1). Therefore, there are considered to be more important links between the SAC population and the southern part of the Moray Firth, which includes the OfTW landfall, than with the Wind Farm Site (see Section 24:OfTW Marine Mammals of the ES). Areas of importance appear to include Spey Bay, Chanonry Point and Sutors (Figure 4.2) and these are thought to be key foraging locations (Hastie et al., 2004; Bailey and Thompson, 2011; Thompson, 2012). Full details, along with analyses, are presented in Section 12: Wind Farm Marine Mammals and Annex 12A of the Original ES.

4.1.2 DORNOCH FIRTH AND MORRICH MORE SAC

*4.1.2.1 Harbour (Common) Seal (*Phoca vitulina*)*

171. Baseline data on harbour seals were collated using tracking data collected over two decades (recorded using VHF, Satellite and GSM telemetry), together with habitat association modelling to predict the occurrence of seals within the Moray Firth (Figure 4.3).
172. The Dornoch Firth supports the most northerly haul-out and breeding population of harbour seals, representing almost 2% of the UK population (JNCC, 2011). The population status of harbour seals in the Dornoch Firth and Morrich More SAC has been assessed three times during the last reporting cycle (SNH, 2005). There were 405 seals in 2000, 220 seals in 2002 (although this is considered an undercount because the survey was undertaken more than two hours after low tide), and 290 seals in 2003. These data, along with previous counts made in 1992 (662), 1994 (542) and 1997 (593), indicate that the number of harbour seals within the SAC during the moulting season has decreased over the reporting cycle. Conversely, over this same time period there has been a gradual increase in the number of harbour seals recorded in Loch Fleet (albeit not as steep as the opposing decrease) suggesting a slight shift in the population to favouring the Loch Fleet area (Cordes et al., 2011). The SAC is considered to be 'Unfavourable (recovering)' for the harbour seal feature and a management plan is now in place which is addressing one of the reasons believed to be behind the historic decline (shooting of seals mainly to protect salmon and sea trout fisheries) (SNH, 2005).
173. Harbour seals are present in the Moray Firth all year round and use haul-out sites to rest between foraging trips, to breed in June/July and to moult in August/September (Bailey and Thompson, 2011). The main haul-out site in the Dornoch Firth and Morrich More SAC lies 67 km to the southwest of the Wind Farm Site. The closest haul-out site to the Wind Farm Site is at Helmsdale, approximately 37 km to the west of the Wind Farm Site (see Plate 12.9, Section 12: Wind Farm Marine Mammals of the Original ES). The Loch Fleet National Nature Reserve (NNR), which lies approximately 65 km southwest of the Wind Farm Site, appears to have become increasingly important over the last 20 years, relative to the

Dornoch Firth SAC, as a haul-out site during the breeding season. In 2008, Loch Fleet NNR accounted for 37% of all mother-pup pairs counted in the Loch Fleet and Dornoch Firth estuaries (Cordes et al., 2011).

174. The tracking studies described in the ES illustrate that harbour seals from the Dornoch Firth and Morrich More SAC (and the Loch Fleet NNR) are distributed widely across the study area and that areas of the Wind Farm Site are likely to constitute important foraging grounds for individuals of this species with the Moray Firth (Bailey and Thompson, 2011).
175. In addition to the links with the Dornoch Firth and Morrich More SAC, tagging surveys of small numbers of harbour seals in other Scottish SACs (e.g. Sanday in Orkney) have highlighted the possibility that individuals from these areas may infrequently venture to the Moray Firth, presumably to forage, including areas within the Wind Farm Site (SMRU, 2011). However, given the low frequency of visits and harbour seal's fidelity to the same haul-out site, the other Scottish SACs containing harbour seals are scoped out of this assessment.

4.2 CONSERVATION OBJECTIVES

4.2.1 MORAY FIRTH SAC

176. The Conservation Objectives of relevance to marine mammals for the Moray Firth SAC are (SNH, 2006):
- *“To avoid deterioration of the habitats of the qualifying species (Bottlenose dolphin *Tursiops truncatus*) 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 (FCS) for the qualifying interest”*
 - *“To ensure for the qualifying species that the following are established then maintained in the long-term:*
 - *Population of the species as a viable component of the site;*
 - *Distribution of the species within the site;*
 - *Distribution and extent of habitats supporting the species;*
 - *Structure, function and supporting processes of habitats supporting the species;*
 - *No significant disturbance of the species.”*
177. Whilst it is clear from the Conservation Objectives and definition of favourable conservation status that the aim of the HRA is to assess the long-term effects, it is important to determine this in light of the short and medium-term effects on the Conservation Objectives, which will contribute to the long-term viability of the SAC. Therefore, the information presented here looks at potential effects over the timescale relevant to the duration of the activity itself (e.g. piling) and to the longer term biophysical changes that may arise from short or medium-term changes in the population, and which could affect the long-term population viability.
178. Based on the Conservation Objectives of the Moray Firth SAC, SNH/JNCC have requested that the following will need to be addressed:
- Will the proposal cause any deterioration to habitats within the Moray Firth SAC which support bottlenose dolphin?

- Will it affect the extent or distribution of any of these habitats in the SAC?
- Will it affect the structure and function of these habitats or any of their supporting processes?
- Will the proposal cause significant disturbance to bottlenose dolphin while they are in the SAC, and will it cause any change to their distribution within the site?
- Will the proposal cause significant disturbance to bottlenose dolphin while they are out with the SAC such that the viability of this SAC population is affected?
- Will the proposal in any way affect the population viability of the bottlenose dolphins of the Moray Firth SAC?

4.2.2 DORNOCH FIRTH AND MORRICH MORE SAC

179. The Conservation Objectives of relevance to marine mammals for the Dornoch Firth and Morrich More SAC are (SNH, 2005):

- *“To avoid deterioration of the habitats of qualifying species (Otter *Lutra lutra* and Common seal *Phoca vitulina*) 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 each of the qualifying interests.”*
- *“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 the site;*
- *Distribution and extent of habitats supporting the species;*
- *Structure, function and supporting processes of habitats supporting the species;*
- *No significant disturbance of the species.”*

180. Based on the similarity of the Conservation Objectives of the Dornoch Firth and Morrich More SAC to the Moray Firth SAC, the considerations are similar and SNH/JNCC have requested that the same questions as listed above for the Moray Firth SAC will need to be answered in respect of potential effects on harbour seals of the SAC.

4.3 SCREENING – IDENTIFICATION OF LIKELY SIGNIFICANT EFFECTS

181. To determine whether the Wind Farm would result in LSE it was necessary to identify potential effects and subsequent effects on the qualifying features and designated sites in light of the site’s Conservation Objectives. LSE screening was carried out on the basis of effects identified at an early stage in the assessment process, taking account of SNH, Marine Scotland and other consultees' views (some of which were expressed during EIA Scoping). The effects were assessed in detail in Section 12 of the Original ES and Section 6: Marine Mammals of the ES Addendum, but are briefly summarised in the following sections. It is important to note the cumulative assessment provided in the Original ES and ES Addendum is referred to as an in-combination assessment within this Report to ensure compliance with the terminology required for HRAs.

4.3.1 TEST OF LIKELY SIGNIFICANCE ON THE QUALIFYING FEATURES OF THE MORAY FIRTH SAC

182. As identified during EIA Scoping, and following consultation with SNH and Marine Scotland, there is the possibility for the following potential effects to occur during the construction and operation of the Wind Farm to result in LSE on bottlenose dolphin as a qualifying species of the Moray Firth SAC:

- Injury, disturbance and displacement of bottlenose dolphin as a result of noise emissions during pile-driving;
- Increased suspended solids concentrations during the construction process (e.g., during cable burial) resulting in impaired foraging efficiency;
- Indirect effects on bottlenose dolphin as a result of the temporary loss of foraging area and/or a reduction in prey species;
- Noise disturbance from operational turbines and maintenance vessels;
- Increased vessel activity during the operational period, increasing the collision risk and leading to physical injury/mortality;
- Presence of subsea cables leading to behavioural effects as a result of electromagnetic field (EMF) emissions; and
- Indirect effects arising from changes in prey resources and tidal regimes due to the presence of turbine structures.

183. Table 4.2 presents the findings of the screening assessment. The screening assessment test of likely significance indicated that the potential effects (including the sum of all effects) have the potential to result in a likely significant effect on the marine mammal features of the Moray Firth SAC and as such have been taken forward for consideration in the information to inform the Appropriate Assessment (Section 4.6).

4.3.2 TEST OF LIKELY SIGNIFICANCE ON THE QUALIFYING FEATURES OF THE DORNOCH FIRTH AND MORRICH MORE SAC

184. As identified during EIA Scoping, and following consultation with SNH and Marine Scotland, there is the possibility for the following potential effects to occur during the construction and operation of the Wind Farm to result in LSE on harbour seal as a qualifying species of the Moray Firth SAC:

- Injury, disturbance and displacement of harbour seal as a result of noise emissions during pile-driving;
- Increased vessel activity during the construction and operation phases leading to increased collision risk and potential physical injury/mortality from ship strike, particular from vessel using ducted propellers;
- Increased suspended solids concentrations during the construction process (e.g., during cable burial) resulting in impaired foraging efficiency;
- Indirect effects on harbour seal due to the temporary loss of foraging area and/or a reduction in prey species;
- Noise disturbance from operational turbines and maintenance vessels;
- Presence of subsea cables leading to behavioural effects as a result of electromagnetic field (EMF) emissions; and

- Indirect effects arising from changes in prey resources and tidal regimes due to the presence of turbine structures.

185. Table 4.3 presents the findings of the screening assessment. The screening assessment test of likely significance indicated that the potential effects (including the sum of all effects) have the potential to result in a likely significant effect on the marine mammal features of the Dornoch Firth and Morrich More SAC and as such have been taken forward for consideration in the information to inform the Appropriate Assessment (Section 4.6).

4.3.3 TEST OF LIKELY SIGNIFICANCE OF IN-COMBINATION EFFECTS

186. As identified during EIA Scoping, there is also potential for in-combination effects of the Wind Farm with other developments located in the area including:

- Beatrice OfTW;
- Moray Firth Round 3 Zone Eastern Development Area (EDA);
- Moray Firth Round 3 Zone Western Development Area (WDA);
- Moray Firth Round 3 Zone OFTW;
- Relevant oil and gas activities;
- Proposed Scottish Hydro Electric Transmission Ltd (SHETL) cable and offshore hub;
- Relevant port and harbour developments in the Moray Firth;
- Relevant military and aviation activity;
- Other relevant offshore renewable development outside the Moray Firth;
- Dredging and sea disposal in the Moray Firth; and
- Marine energy developments in the Pentland Firth and Orkney waters.

187. Section 12: Wind Farm Marine Mammals of the Original ES discussed the potential in-combination effects between the Wind Farm and associated OfTW and the afore listed developments, many of which were subsequently screened out, with a full explanation provided in the Original ES (Section 12.9.2.3). Potential in-combination effects on both SACs are similar to those described previously for the Wind Farm alone (see Section 4.3.1 and 4.3.2). However, the magnitude of some effects on SACs, such as those associated with piling noise, are likely to be greater for the Wind Farm in-combination with other developments compared with the Wind Farm alone and the duration of effects may occur over a longer time period (as shown in the EIA).

188. Table 4.2 and Table 4.3 present the findings of the screening assessment. The screening assessment test of likely significance indicated that all in-combination effects (including the sum of all effects) have the potential to result in a likely significant effect on the marine mammal features of the Moray Firth SAC and the Dornoch Firth and Morrich More SAC and as such have been taken forward for consideration in the information to inform the Appropriate Assessment (Section 4.6).

Table 4.2: Screening Matrix for the Moray Firth SAC

Qualifying Feature	Conservation Objectives	Potential Effects	Wind Farm LSE	LSE In-Combination	Proposed Generic Mitigation Measures
Bottlenose Dolphin <i>Tursiops truncatus</i>	<p>To avoid deterioration of the habitats of the qualifying species (Bottlenose dolphin <i>Tursiops truncatus</i>) 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 interest.</p> <p>To ensure for the qualifying species that the following are established then maintained in the long-term:</p> <ul style="list-style-type: none"> • Population of the species as a viable component of the site; • Distribution of the species within the site; • Distribution and extent of habitats supporting the species; and • Structure, function and supporting processes of habitats supporting the species. • No significant disturbance of the species. 	<p>Noise generated during pile driving has potential to cause injury and displacement.</p> <p>Increase in suspended solids arising from construction works impairing foraging efficiency.</p> <p>Indirect effects during construction works due to loss of foraging area as well as a change or reduction of prey species.</p> <p>Noise disturbance due to operational turbines and maintenance vessels.</p> <p>Risk of physical injury/mortality due to ship strike.</p> <p>Behavioural effects arising from EMF along export cable route.</p> <p>Indirect effects arising from changes in prey resources and tidal regimes due to presence of turbine structures.</p>	Likely Significant Effects	Likely Significant Effects	<p>Use of soft-start and monitored zone</p> <p>If concurrent piling operations are undertaken, vessels will operate at no more than 5 km from each other. The purpose of this will be to reduce the potential area of ensouffication from that presented in the worst case, and the use of two vessels should also decrease the installation programme (see Section 4.4.3.1)</p>

Table 4.3: Screening Matrix for Dornoch Firth and Morrich More SAC

Qualifying Feature	Conservation Objectives	Potential Effects	Wind Farm LSE	LSE In-Combination	Proposed Generic Mitigation Measures
Harbour Seal <i>Phoca vitulina</i>	<p>To avoid deterioration of the habitats of the qualifying species (common seal <i>Phoca vitulina</i>) 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.</p> <p>To ensure for the qualifying species that the following are established then maintained in the long-term:</p> <ul style="list-style-type: none"> • Population of the species as a viable component of the site; • Distribution of the species within the site; • Distribution and extent of habitats supporting the species; and • Structure, function and supporting processes of habitats supporting the species. • No significant disturbance of the species. 	<p>Noise generated during pile driving has potential to cause injury and displacement.</p> <p>Collision risk which has the potential to cause injury/ mortality from increased vessel activity during construction and operation.</p> <p>Increase in suspended solids arising from construction works impairing foraging efficiency.</p> <p>Indirect effects during construction works due to loss of foraging area as well as a change or reduction of prey species.</p> <p>Noise disturbance due to operational turbines and maintenance vessels.</p> <p>Behavioural effects arising from EMF along export cable route.</p> <p>Indirect effects from changes in prey resources and tidal regimes due to presence of turbine structures.</p>	Potential for Likely Significant Effects	Potential for Likely Significant Effects	<p>Use of soft-start and monitored zone</p> <p>If concurrent piling operations are undertaken, vessels will operate at no more than 5 km from each other. The purpose of this will be to reduce the potential area of ensonification from that presented in the worst case, and the use of two vessels should also decrease the installation programme (see Section 4.4.3.1)</p>

4.4 APPRAISAL OF EFFECTS ON CONSERVATION OBJECTIVES AND INTEGRITY OF SACs

189. The impact assessment presented in the ES considered that there would be short to medium-term negative effects on populations of bottlenose dolphin in the Moray Firth SAC and on populations of harbour seal in the Dornoch Firth and Morrich More SAC during pile-driving, which could result in a LSE (Table 4.2 and Table 4.3). The relevant Conservation Objectives that could be adversely affected in both SACs involve:

- Maintaining the population of the species as a viable component of the site in the long-term;
- Maintaining the distribution of the species within the site in the long-term; and
- Ensuring no significant disturbance of the species in the long-term.

190. The impact assessment presented in the ES also considered that there would be negligible to small magnitude negative effects on qualifying features of the Moray Firth SAC and the Dornoch Firth and Morrich More SAC, from other effects unrelated to piling noise (e.g. short-term increased suspended sediment concentrations (SSC), increased vessel collision risk), during both the construction and operation of the Wind Farm. The effects considered to result in a LSE, and where Appropriate Assessment is required, have been identified (Table 4.2 and Table 4.3). These effects were considered to have the potential to adversely affect the Conservation Objectives outlined in Section 4.2.

191. In the long-term, populations of bottlenose dolphin in the Moray Firth SAC and populations of harbour seal in the Dornoch Firth and Morrich More SAC were considered likely to recover from piling noise-related effects. However, to improve certainty regarding predictions of the long-term effects on the SAC populations, further noise modelling work (in the ES Addendum) to that presented in the Original ES was undertaken for both species. The results of this additional modelling work are presented below together with the potential effects of each effect on the Conservation Objectives of the Moray Firth SAC and the Dornoch Firth and Morrich More SAC.

4.4.1 MORAY FIRTH SAC

192. With reference to the Conservation Objectives (listed in Section 4.2), the Wind Farm is not expected to cause any deterioration to habitats, reduction in extent of habitat or changes to the structure and function of habitats in the SAC. Therefore this study considers the effects specifically with respect to disturbance to bottlenose dolphins both within and out with the SAC as well as any direct or indirect effects (e.g. degradation or loss of supporting habitats and species out with the SAC) that may affect the viability of the bottlenose dolphin population of the SAC both in the short-term and the long-term.

193. The effects considered to result in a LSE, and where Appropriate Assessment is required, were identified in Table 4.2. The potential effects of each effect on the

Conservation Objectives of the Moray Firth SAC and the overall site integrity are summarised below.

44.1.1 *Summary of the Assessment of Effects Arising from the Construction/ Decommissioning of Wind Farm Alone*

Injury, Disturbance and Displacement from Noise Emissions during Pile-Driving

194. Bottlenose dolphins are sensitive to a broad bandwidth of frequencies (150 Hz to 160 kHz), with specialised clicks used in echolocation for prey detection and navigation generated at the highest frequency end of the spectrum (>100 kHz) (Southall et al., 2007). Pile-driving activities (associated with offshore wind farm construction) are therefore of special concern as they generate very high sound pressure levels which are relatively broad-band (20 Hz to >20 kHz; Madsen et al., 2006). The effects of underwater sound on marine mammals are described under three categories: physical (non-auditory) injury and mortality, auditory injury (either permanent or temporary) and behavioural responses. The area over which each of these effects would be experienced from pile-driving activity during construction of the Wind Farm was modelled for bottlenose dolphin using two different modelling approaches (Southall et al., 2007 and Nedwell et al., 2007) and, in agreement with the statutory authorities, the most appropriate method was selected for each noise threshold. Further details on the two modelling approaches are given in Annex 7A and Section 12: Wind Farm Marine Mammals of the Original ES and the areas of effect are given in Table 4.4. This table shows the results of two pile-driving scenarios modelled for the Wind Farm: a single piling event and two piling events. These scenarios represent the worst case both temporally (i.e. single piling) and spatially (i.e. two simultaneous pile driving activities) since a single piling event would continue over a longer duration (up to three years) and two simultaneous pile driving activities would extend over a greater area spatially (see Table 4.4).

Table 4.4: Results of INSPIRE Modelling Exercise for Bottlenose Dolphin at the Wind Farm Site (The thresholds are as follows: i) death/mortality – 220 dBht; ii) PTS fleeing – 198 dB re. 1 μ Pa; and iii) behavioural effects – up to 75 dBht)

Scenario	Threshold	Radius of threshold around each piling operation (m)	Total affected area (km ²)
BOWL 1: One pile driving event at Wind Farm Site location B	Death/injury	60	0.01
	Permanent Threshold Shift (PTS): fleeing	500	0.63
	Behaviour	43,440	3,938
BOWL 2: Two pile driving events at Wind Farm Site locations A and B	Death/injury	60	0.02
	PTS: fleeing	500	1.1
	Behaviour	43,440	4,449

195. The construction method has been designed to incorporate mitigation measures that will reduce effects of pile-driving on animals. Pile-driving will not commence at full power, but will instead build up to full power over a period of at least 20

minutes, as recommended by JNCC (JNCC, 2010). This 'soft-start' procedure allows animals to flee the area before piling at full power commences.

196. In terms of physical injury and mortality, noise modelling suggests that there is only a small area (60 m) within which lethal effects could occur (Table 4.4). Auditory injury may occur over a larger area, but realistically, with animals fleeing the area during the soft start piling, any auditory effect is likely to occur up to 500 m from the noise source (Table 4.4). The number of animals predicted to experience PTS is based on the SAFESIMM approach, which is precautionary in its assessment of the speed at which animals leave the affected area (see Table 6.2 in the ES Addendum). The Revised Harbour Seal Framework (see Annex 6A of the ES Addendum) presents the approach adopted in the SAFESIMM model. The relationship between the noise level and proportional displacement followed the dose-response relationship described by Finneran et al. (2005). In summary, for this approach sound field data generated by the INSPIRE noise model (Figure 4.4) is overlaid on predictions of bottlenose dolphin densities² across the Moray Firth, and the number of animals predicted to experience PTS is modelled based on the proportional response as given in the dose-response curve (see Plate 12.2 of the Original ES). For all construction scenarios, the SAFESIMM model predicted that no animals would be affected by PTS (Table 2 in Annex 6A of the ES Addendum) and therefore, in the long-term, there would be no effect on the population.
197. Behavioural effects were modelled using Nedwell et al. (2007), which is based on a frequency weighting system related to the hearing threshold of the species under consideration. This approach assumes that individuals will show a strong avoidance reaction to levels at and above 90 dBht and milder reactions to levels of 75 dBht and above. However, because individuals are unlikely to respond at consistent received levels, it is more appropriate to consider responses in terms of a curve that describes the relationship between sound level and the proportion of animals predicted to respond rather than a simple step-change threshold (e.g. 75 or 90 dBht) (Thompson et al., 2011). In order to address this, a dose-response curve relationship was developed from Finneran et al. (2005) using empirical data extrapolated from a study of harbour porpoise response to piling noise by Brandt et al. (2011) to predict responses to varying levels of noise across a wide range of dBht levels (see Plate 12.12 in Section 12: Wind Farm Marine Mammals of the Original ES) (Thompson et al., 2011). Thus, the noise maps for behavioural displacement show the noise level experienced by bottlenose dolphin in 5 dBht increments across the area of effect (Figure 4.5). Using harbour porpoise as a proxy for bottlenose dolphin to model behavioural response was considered conservative as harbour porpoise as a species are likely to be more noise sensitive than bottlenose dolphin. For example, for non-pulsed sound harbour porpoise exhibit a moderate behavioural response (based on the Southall et al., 2007, severity scoring criteria) such as changes in swim speed, locomotion, dive profile, and acoustic behaviour, at received levels of 80 to 180 dB re 1 µPa. In contrast, mid-frequency cetaceans, such

² Derived from the probability of occurrence maps for bottlenose dolphin (Section 6: Wind Farm Marine Mammals of the ES Addendum for further details).

as bottlenose dolphin, are less sensitive, showing moderate behavioural responses to non-pulsed sound from 120 to 180 dB re 1 μ Pa (Southall et al., 2007).

198. Behavioural responses can include changes in surfacing and breathing patterns, cessation of vocalisations and/or active avoidance or escape from the ensonified area. The noise modelling showed that behavioural effects at the 75 dBht contour are predicted out to a distance of 43.4 km from each piling activity, covering an area of 3,938 km² for single piling and 4,449 km² for concurrent piling (Table 4.4). However, the noise contours do not reach the boundary of the Moray Firth SAC so there is not predicted to be an effect on bottlenose dolphin whilst within the SAC.
199. Outside of the SAC boundary, the predicted number of bottlenose dolphins displaced is approximately 19 and 20 individuals for the single and concurrent piling scenarios respectively, based on the best-fit dose-response curve (Table 4.5). This corresponds to 9.6% and 10.3% of the SAC population of bottlenose dolphins. The effect of varying the dose-response curves (upper, best and lower fit) for the prediction of the proportion of the population excluded from the area was also investigated. The outputs of the different construction scenarios, for the upper, best and lower fit dose-response, are presented in Table 4.5, and show as a worst case that up to 33 individuals may be displaced and as a best case only one individual may be displaced during piling activity.

Table 4.5: Estimated Numbers (and % of the population) of Bottlenose Dolphin Predicted to be Behaviourally Displaced from Different Construction Scenarios

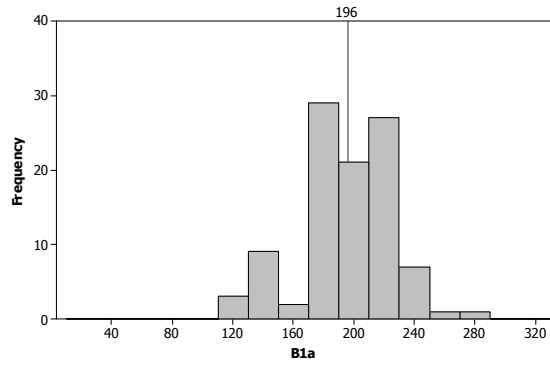
Scenario	Upper		Best		Lower	
	n	%	n	%	n	%
BOWL 1	32	16.3	19	9.6	1	0.4
BOWL 2	33	17.0	20	10.3	1	0.5

200. With regards to the effect of piling noise on bottlenose dolphin out with the SAC, there are several reasons why an adverse effect on the integrity of the SAC is considered to be unlikely. First, the probabilities of encountering bottlenose dolphin decreases with increasing distance offshore such that even within the outmost 5 dBht contour of behavioural effects (75 to 80 dBht) the probability of encounter is likely to be low (<10%) (Figure 4.6). Second, the behavioural noise threshold (75 dBht) does not overlap the areas that are considered to be the most important for populations of bottlenose dolphin within the Moray Firth, namely Spey Bay, Chanonry Point and Sutors along the south coast and inner reaches of the Moray Firth (Figure 4.2). Finally, bottlenose dolphin are known to range widely from the Moray Firth to Fife and whilst 50% of the estimated Moray Firth SAC population are estimated to use the SAC each year (Cheney et al., 2012 b) they are clearly not restricted to the Moray Firth SAC and surrounding waters (Thompson, 2012). For example, individuals from the Moray Firth have been sighted as far south as Whitley Bay and the Tyne River mouth. This suggests that, instead of being site-faithful, bottlenose dolphin from the Moray are highly mobile and appear to have a broad potential range around the UK coast and beyond (Thompson, 2012).

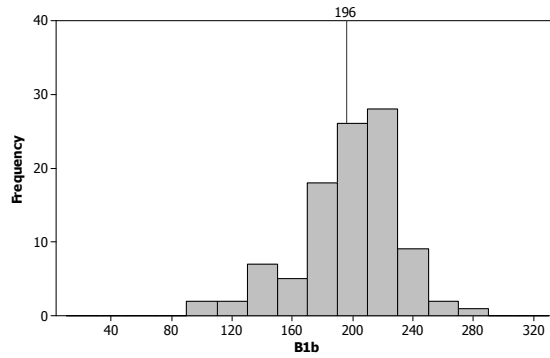
201. The consequences of temporary behavioural displacement over the noise effect area containing habitat which is not critical to bottlenose dolphin is considered to be of relatively low concern since individuals are unlikely to lose key foraging areas through this displacement. In addition, the assessment concluded that indirect effects due to reduction in prey species would be temporary and not be significant as marine mammals were predicted to avoid foraging in affected areas over the same timeframe.
202. It should be noted that there are two main uncertainties associated with this assessment; these are considered in turn below, followed by a description of the approach to addressing the uncertainties. First, the biological significance of an individual's response to a given noise level is not fully understood, and therefore assumptions have had to be made as to the possible effect of displacement on, for example, fitness. The consequences of displacing an individual from any particular area cannot be clearly shown even though, as discussed above, there is a high probability that the ensonified area is not important to bottlenose dolphin. This uncertainty was addressed by taking a precautionary approach throughout the assessment methodology. This extended from the worst case scenarios considered in the Rochdale Envelope, through the noise modelling work and to the assumptions made about potential effects on individuals. Table 6.2 in the ES Addendum provides a summary of the precautionary approaches adopted throughout the assessment.
203. The second uncertainty relates to the population-level effect of excluding bottlenose dolphins from a large proportion of their potential range. If animals respond by moving to other areas to feed and do not suffer reduced fecundity then it can be assumed that there are unlikely to be long-term effects on the viability of the population. For example, the harbour seal population model (Thompson et al., 2011) showed that even for a 'closed' population of seals, the population is likely to recover rapidly (after 2 years), returning to the same point in its population growth at which it would have been had the piling not taken place (Plate 12.14 in the Original ES). Following response from statutory consultees on the draft ES, the uncertainty relating to long-term population-level effects was addressed through additional population modelling for bottlenose dolphin.
204. The bottlenose dolphin population VORTEX model uses a population viability analysis (PVA) model described in Thompsen et al. (2000) to predict the distribution of population size after 25 years following exposure of the population to the single piling (temporal worst case) and concurrent piling scenario (spatial worst case) at the Wind Farm (see Annex 6A of the ES Addendum). The model was run for a 25 year period to reflect the potential operational lifespan of the Wind Farm, however, this should not be interpreted as 25 years being the time to recovery, which is predicted to occur within three years. The model was based on the best available demographic and life history parameters and assumed a stable or increasing population as the baseline in line with the latest Site Condition Monitoring Report for the Moray Firth SAC (Cheney et al., 2012a).

205. It was assumed that displacement would result in a reduction in reproduction (implemented by 'harvesting' calves) that was proportional to the proportion of the population that were displaced in any one year. The VORTEX model was then run to simulate the population dynamics over 25 years in order to determine the long-term effects of a reduction in reproduction on the population compared with a predicted baseline population after 25 years. The output of the model is a frequency distribution showing the predicted population from each of the 100 model runs. To maintain the current baseline level, the plot will therefore show the highest frequency centred around 196 on the x axis.
206. The calculation of the reproductive status of the population was based upon there being an average of four female and four male calves produced each year from a stable population of 196 individuals. The VORTEX model included a precautionary approach with respect to always rounding up the estimates of calves taken, and always harvesting more female calves if there were an odd number of calves.
207. For both construction scenarios, and for the upper, best and lower fit dose-response curves, the model showed that after 25 years the baseline level of 196 individuals would be reached suggesting that there would be no long-term effect on the bottlenose dolphin population (Plate 4.1 and Plate 4.2)
208. Based on the potential ecological effects on the bottlenose dolphin population in the Moray Firth, and evidence from studies of operational wind farms in the North Sea, full recovery (to baseline levels) is likely to occur over the medium-term (<3 years) with animals returning to the disturbed area immediately following cessation of the piling.

a) lower



b) best



c) upper

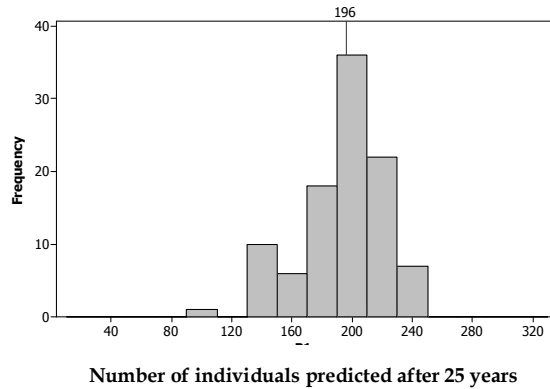
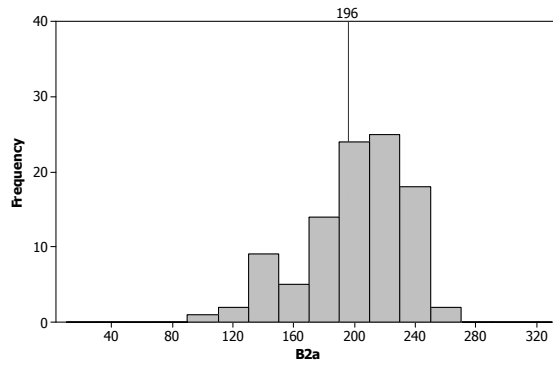


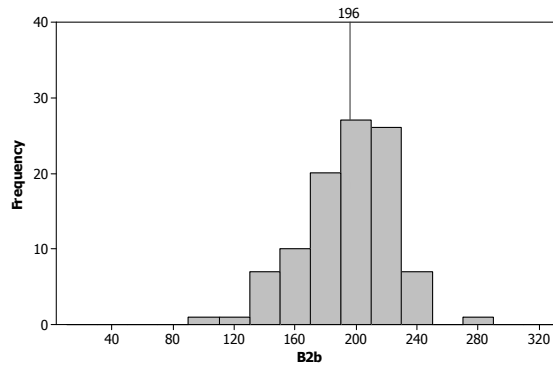
Plate 4.1: Results of the Bottleneck Population Modelling for BOWL 1

(single piling at location A over a 3 year construction period showing the output for the model using the a) lower, b) best and c) upper-fit for the dose response curve)

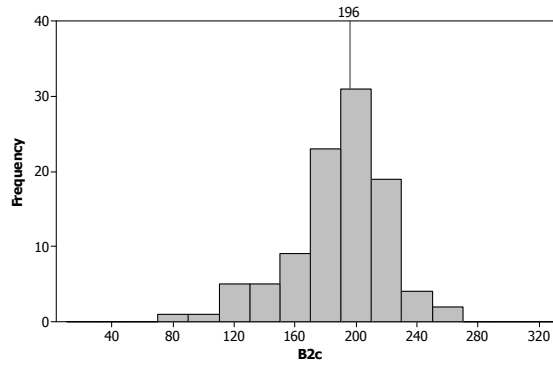
a) lower



b) best



c) upper



Number of individuals predicted after 25 years

Plate 4.2: Results of the Bottleneck Population Modelling for BOWL 2

(Concurrent piling at locations A and B over a 2 year construction period showing the output for the model using the a) lower, b) best and c) upper-fit for the dose response curve)

209. In summary, with respect to the Conservation Objectives, the likely effect of piling noise on the SAC population has the potential for behavioural disturbance of a small proportion of the bottlenose dolphin population out with the SAC boundary. Any effects that do occur are predicted to be temporary in nature, occurring during the piling period (two to three years), which is itself short in relation to both the reproductive cycle and life-time of individual females. Based on the precautionary assumptions adopted in this assessment, there are no long-term effects on bottlenose dolphin predicted. Consequently no long-term adverse effect on the integrity of the European site is predicted as a result of the Wind Farm alone.

Suspended Solids Impairing Foraging Efficiency

210. The Original ES, Section 9: Wind Farm Physical Processes and Geomorphology, predicted an elevation in suspended solids of a maximum of 21 mg⁻¹ and 25 mg⁻¹ during dredging and drilling operations, respectively, which are within the range of natural variation in suspended solids within the Moray Firth. Elevated levels of suspended solids were projected to occur over a very localised area (50 to 100 m) and to be of short-term duration (up to one hour) before reducing to <4 mg⁻¹. Material deposited on the seabed would be re-suspended and typically result in elevations of suspended solids of <1 mg⁻¹ and 1-2 mg⁻¹ for dredging and drilling operations, respectively. Any sediment re-deposition would be of small magnitude (<1 mg⁻¹). The Original ES, Section 12: Wind Farm Marine Mammals (Section 12.5.1.3) subsequently discussed the highly mobile nature of marine mammals and their ability to easily avoid areas of turbidity.
211. Cetaceans have sensory adaptations, such as an acute sense of touch and acute hearing, allowing them to live in marine environments where vision is often restricted. It was envisaged that the increase in suspended sediments was likely to occur over a very small proportion of the range of marine mammals in the Moray Firth, and in the worst case scenario there would only be two small areas (representing the two simultaneous turbine installations) that animals would be likely to avoid.
212. On the basis of the assessment of impairment of foraging efficiency arising from worst case increase in suspended solids provided in the Original ES, no adverse effect on the bottlenose dolphin population or habitats that support this population are predicted. Therefore, no adverse effect on the integrity of the Moray Firth SAC has been identified as a result of the Wind Farm alone.

Indirect Effects due to Temporary Loss of Foraging Area/Reduction in Prey Species

213. The Original ES, Section 12: Wind Farm Marine Mammals (Section 12.5.1.4), discussed the indirect effects of temporary loss of foraging area / reduction in prey species on marine mammals. Key prey species were identified which could be potentially vulnerable to injury or displacement, resulting in less prey for marine mammals. However, any reduction in prey availability was predicted to be offset through a reduction of predation in potentially affected areas. For most of the prey species found within the study area the effect was assessed as being of small magnitude, and of negligible to minor significance, with slightly higher significance

(minor to moderate) for hearing sensitive species that spawn and have nursery habitat within the area (including herring and sprat) (Section 11: Wind Farm Fish and Shellfish Ecology of the Original ES). However, as these areas only represent a very small proportion of the wider North Sea spawning/nursery area, any long-term effects on the populations of these species was considered unlikely. In addition, since marine mammals are capable of exploiting a suite of different prey species, they were considered unlikely to experience reduced prey availability through declines in just one or two of their potential prey item.

214. On the basis of the assessment of indirect effects due to temporary loss of foraging area/reduction in prey species provided in the Original ES and ES Addendum, no adverse effect on the bottlenose dolphin population or habitats that support this population is predicted. Therefore, no adverse effect on the integrity of the Moray Firth SAC has been identified as a result of the Wind Farm alone.

4.4.1.2 *Summary of the Assessment of Effects Arising from the Operation of the Wind Farm Alone*
Disturbance due to Operational Noise

215. The Original ES, Section 12: Wind Farm Marine Mammals (Section 12.5.2.1), assessed the effects of operational noise and vibration associated with turbine rotation. The data indicated that marine mammals would be unlikely to be excluded from any area of sea ($0 \text{ km}^2\text{hr}^{-1}$) during the operational phase. The assessment concluded that it is certain/near certain that no effects are predicted on marine mammals.

216. On the basis of the assessment of disturbance due to operational noise provided in the ES, no adverse effect on the bottlenose dolphin population or the habitats that support this population is predicted. Therefore, no adverse effect on the integrity of the Moray Firth SAC has been identified as a result of the Wind Farm alone.

Noise Disturbance from Maintenance Vessels

217. The effects of noise from maintenance vessels was also assessed and the effects on marine mammals was considered to be limited because maintenance vessels would be operating at slow speeds and due to the relatively high level of vessel activity already taking place within the Moray Firth (up to 4,380 vessels annually), marine mammals are likely to exhibit some degree of habituation to existing noise levels (Original ES, Section 12.5.2.2). Noise generated from crew transport vessels (18-20 m in length) was considered more likely to cause disturbance to marine mammals as these travelled at faster speeds, although potential disturbance was predicted to be of short-term duration and intermittent i.e. during crew transfer times and most likely to result in avoidance behaviour and possibly auditory masking for individuals that are sensitive. However, as background noise levels from existing vessel activity also included many smaller vessels operating at speeds, adverse effects were considered unlikely on marine mammals in the Moray Firth due to their apparent habituation to vessel noise.

218. On the basis of the assessment of noise disturbance from maintenance vessels provided in the Original ES, there is no adverse effect on the bottlenose dolphin population or the habitats that support this population. Therefore, no likely adverse

effect on the integrity of the Moray Firth SAC has been identified as a result of the Wind Farm alone.

Collision Risk of Physical Injury/Mortality from Ship Strike

219. The Original ES, Section 12: Wind Farm Marine Mammals (Section 12.5.2.3) discussed potential collision risk from vessel strikes during operation and considered this to be low on marine mammals, due to the existing level of vessel activity in the Moray Firth (see Section 18: Wind Farm Shipping and Navigation of the Original ES) and due to negligible increase in vessel activity due to the Wind Farm alone. In addition, it is likely that the noise generated by the operational vessels would deter marine mammals from the immediate vicinity and therefore collision with these vessels in the proximity of turbine locations was considered unlikely.
220. On the basis of the assessment of collision risk of physical injury/mortality from ship strike provided in the Original ES, no adverse effect on the bottlenose dolphin population or the habitats that support this population is predicted. Therefore, no adverse effect on the integrity of the Moray Firth SAC has been identified as a result of the Wind Farm alone

Behavioural Effects Arising from Electromagnetic Fields (EMF)

221. Behavioural effects arising from EMF are described in detail in the Original ES, Section 12: Wind Farm Marine Mammals (Section 12.5.2.4). Theoretical evidence suggests that some species of cetaceans may use the Earth's magnetic field to aid long distance migration, location of feeding areas, reproduction and refugia (Normandeau et al., 2011). The Centre for Marine and Coastal Studies (CMACS) suggest that the magnetic effects of subsea cables is unlikely to affect magnetically sensitive species to any great extent and is most likely to be perceived as a variation to the Earth's natural field (Normandeau et al., 2011). In addition, magneto-sensitive species are unlikely to respond to magnetic fields from AC cables because of the rate of change of the field (polarity reversal) is too rapid for a behavioural response to occur. Thus, only a localised effect was considered likely, with a possible temporary change in swimming direction or slight deviation from transit route.
222. On the basis of the assessment of behavioural effects arising from EMF provided in the Original ES, no adverse effect on the bottlenose dolphin population or the habitats that support this population is predicted. Therefore, no adverse effect on the integrity of the Moray Firth SAC has been identified as a result of the Wind Farm alone.

Indirect Effects Arising from Changes in Prey Resources and Tidal Regimes due to Presence of Turbine Structures

223. The presence of turbine structures resulting in indirect effects on prey resources and tidal regimes was discussed in detail in the Original ES, Section 12: Wind Farm Marine Mammals (Section 12.5.2.5). The presence of turbine structures on the seabed has the potential to alter the seabed topography and change the tidal regime within the Wind Farm Site. As marine mammals commonly exploit high energy

environments while foraging for prey, a change in the tidal regime can have implications for foraging activity.

224. A second indirect effect of turbine structure is the long-term loss of seabed habitat and creation of new habitat. Effects were assessed in terms of loss of key prey items due to habitat loss and the potential of attracting prey items to the turbine structures as they become colonised by invertebrate communities and subsequently attract fish populations.
225. Section 9: Wind Farm Physical Processes and Geomorphology of the Original ES determined that there would be no significant change in current speed, water levels or current direction of the tidal regime. Therefore the indirect effect on the foraging activity of marine mammals was assessed as not significant.
226. Section 11: Fish and Shellfish Ecology of the Original ES (Wind Farm Fish and Shellfish Ecology) and Chapter 5 of the Addendum concluded that the effect of loss of habitat on fish and shellfish receptors would be of negligible magnitude and of negligible significance for all species, except sandeel *Ammodytidae* sp. where the effect was considered to be of minor significance. Similarly there was predicted to be a negligible magnitude effect arising from changes in the tidal regime and this would be of negligible significance on fish and shellfish populations. The effect of the introduction of new habitat was discussed in relation to a potential increase in abundance and aggregation of species around turbine structures, although this was shown not to occur in every case. The most apparent benefit was considered to be colonisation by shellfish. Based on the evidence provided in the fish and shellfish report, this was assessed as being a positive effect of minor significance and probable. Whilst shellfish are not key prey items of marine mammals in the study area, there is a possibility that the turbine structures may act as fish aggregating devices (FADs) which could have a positive effect on marine mammals. For bottlenose dolphin, however, which tend to forage along the coast, positive effects from the FADs were considered unlikely.
227. On the basis of the assessment of indirect effects arising from changes in prey resources and tidal regimes due to presence of turbine structures provided in the Original ES and ES Addendum, no adverse effects on the bottlenose dolphin population or the habitats that support this population have been predicted. Therefore, no adverse effect on the integrity of the Moray Firth SAC has been identified as a result of the Wind Farm alone.

4.4.1.3 *Summary of all Effects (Total Effects)*

228. The assessment of total (or inter-related) effects arising from all potential effects on bottlenose dolphin considered in the Original ES is presented in the ES Addendum (Section 6.6.1.3). The potential for all effects to combine during construction, operation or decommissioning to create an effect of greater magnitude than the effect of each effect alone is considered to be unlikely (Table 6.5 of the Addendum). As there is no change in the overall significance of effects from those presented for each of the effects alone, no adverse effects are predicted on the Conservation Objectives and the overall site integrity for the bottlenose dolphin population of the

Moray Firth SAC. The sum of all effects would not prevent the SAC from making an appropriate contribution to achieving favourable conservation status.

4.4.1.4 *Summary of In-Combination Effects from the Wind Farm and Moray Firth Round 3 Zone during Construction/Decommissioning*

In-Combination Injury, Disturbance and Displacement from Noise Emissions during Pile-Driving

229. Three different in-combination construction scenarios were modelled which represented the worst case temporally (seven consecutive years of piling), the worst case spatially (eight concurrent piling events) and a scenario in-between these two extremes (Table 4.6).

Table 4.6: Construction Scenarios Modelled for the In-Combination Assessment

Construction Scenario	Description
Cumulative A (MORL 8)	BOWL A+B for two years (2014 & 2015) followed immediately by MORL 1+5 for three years (2016 - 2018) Five years in total
Cumulative B (MORL 9) Temporal worst case	BOWL A for three years (2014 - 2016) concurrently for the final year with MORL 1 for five years (2016 - 2020) Seven years in total
Cumulative C (MORL 10) Spatial worst case	BOWL A+B for two years concurrently with MORL (1, 2, 3, 4, 5 & 6) for two years (2016 - 2017) Two years in total

230. There is also potential for noise disturbance from offshore wind farms further afield to affect bottlenose dolphins. The construction programme for the Firth of Forth Offshore Wind Farm (phased development between 2015 and 2019) coincides with the Beatrice Offshore Wind Farm construction programme and therefore bottlenose dolphin may be temporarily excluded from a larger proportion of their range. The scope of the cumulative assessment of in the Original ES and ES Addendum, and the in-combination effects in this Report, has been agreed in consultation with Marine Scotland and SNH.
231. The modelling approaches employed and assumptions relating to the sensitivity of bottlenose dolphin are described above (Section 4.4.1.1). For the worst case spatial scenario of concurrent pile-driving within the Moray Firth at two locations within the Wind Farm and six locations in the Moray Firth Round 3 Zone EDA the noise modelling estimated the ranges of effect for bottlenose dolphin for each of the noise thresholds (Table 4.7).
232. As before the noise modelling incorporated a soft start scenario, for which the most realistic assumption is that animals will flee the area before piling at full power commences.

Table 4.7: Results of INSPIRE In-Combination Modelling Exercise for Bottlenose Dolphin at Eight Locations at the Wind Farm Site and Moray Firth Round 3 Zone EDA (The thresholds are as follows: i) death/mortality – 220 dB_{ht}; ii) PTS fleeing – 198 dB re. 1 µPa; iii) behavioural effects – up to 75 dB_{ht})

Scenario	Threshold	Radius of threshold around each piling operation (m)	Total affected area (km ²)
Wind Farm Site locations A and B plus Moray Firth Round 3 Zone EDA locations M1 to M6	Death/injury	BOWL – 60 Moray Firth Round 3 Zone – 80	0.14
	PTS: fleeing	2,250	510
	Behaviour	43,150	7,793

233. As with the effect of the Wind Farm alone, it was considered unlikely that bottlenose dolphin within the study area would suffer injury/death from any of the in-combination scenarios since the areas within which the thresholds for these effects occur are small and therefore do not overlap areas within which bottlenose dolphin are predicted to be present (Figure 4.7).
234. The number of bottlenose dolphin estimated to experience PTS and behavioural displacement during these different scenarios was estimated using SAFESIMM model, which applied the dose-response curve within the modelled noise thresholds as described previously (Section 4.4.1.1). As for the Wind Farm alone, the in-combination assessment showed that for all scenarios considered, no animals were predicted to experience PTS (see Annex 6A of the ES Addendum).
235. Due to the mainly coastal distribution of bottlenose dolphin within the Moray Firth, the most likely effect was considered to be due to behavioural disturbance. Whilst the noise contours for cumulative behavioural effects from the Wind Farm and Moray Firth Round 3 Zone EDA overlap to a very large extent, the area of effect is nonetheless greater for the Wind Farm and Moray Firth Round 3 Zone EDA in combination (7,793 km²; Table 4.7) compared with the Wind Farm alone (4,449 km²; Table 4.4). Importantly, the outer behavioural threshold (75 dB_{ht}) extends further towards the southern coastline of the Moray Firth, where bottlenose dolphins have a higher probability of being detected compared with areas further offshore. However, it should be remembered that the 75 dB_{ht} is the outer limit of the noise disturbance threshold and therefore not all individuals will be behaviourally affected according to the dose response curve (see Section 4.4.1.1 above and Plate 12.12 of the Original ES).
236. The largest number of individual bottlenose dolphins displaced at any one time is predicted for the worst case spatial scenario of concurrent piling at eight locations for two years in the Moray Firth. This could lead to between 7 to 82 individuals displaced each year during the two years of piling activity, accounting for 3.6 to 41.8% of the SAC population (Table 4.8). The worst case temporally would displace fewer individuals (0 to 35 in any one year) but the effects would occur for approximately seven years, Table 4.8).

Table 4.8: Estimated Numbers (and % of the Moray Firth population) of Bottlenose Dolphin Predicted to be Displaced by each of the Different In-Combination Scenarios Showing with Numbers Presented for Each Year of Construction (the range of values presented are for the predictions based on the lower, best and upper fit dose-response curves)

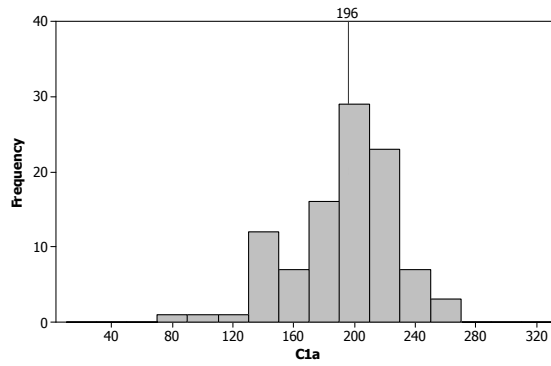
		Year 1			Year 2			Year 3			Year 4			Year 5			Year 6			Year 7		
		Lower	Best	Upper	Lower	Best	Upper	Lower	Best	Upper	Lower	Best	Upper	Lower	Best	Upper	Lower	Best	Upper	Lower	Best	Upper
Cumul A	N	1	20	33	1	20	33	1	19	33	1	19	33	1	19	33	-	-	-	-	-	-
	%	0.5	10.3	17.0	0.5	10.3	17.0	0.3	9.7	16.8	0.3	9.7	16.8	0.3	9.7	16.8	-	-	-	-	-	-
Cumul B	N	1	19	32	1	19	32	1	21	35	0	17	31	0	17	31	0	17	31	0	17	31
	%	0.4	9.6	16.3	0.4	9.6	16.3	0.4	10.7	17.8	0.2	8.9	15.7	0.2	8.9	15.7	0.2	8.9	15.7	0.2	8.9	15.7
Cumul C	N	7	67	82	7	67	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	%	3.6	34.2	41.8	3.6	34.2	41.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

237. One of the effects of behavioural displacement is that breeding success may be affected since individual fitness is an important component of successful reproduction and is dependent on resource availability throughout the breeding cycle, amongst other factors (Clutton-Brock, 1983). Very conservatively, it has been assumed that during the maximum seven-year in-combination piling period, all females within the population would suffer reproductive failure as they may suffer reduced fitness if feeding is affected. This amounts to two potential breeding cycles during a seven-year in-combination piling period, as inter-birth intervals for bottlenose dolphin are between three to five years (Mitcheson, 2008). This has the potential to have consequences for the long-term viability of the population. Over their breeding lifespan, female dolphins have the potential to produce many calves since they produce their first calf between ages six to fifteen years (Wells et al., 1987; Mann, et al., 2000) and can live up to 50 years (Scott et al., 1990; Whitehead and Mann, 2000). Therefore, assuming that feeding behaviour (and consequently fitness) returns to normal following cessation of the piling activities, it is likely that females within the population will continue to reproduce. The effect of breeding failure on the long-term viability of the population has been explored through population modelling for bottlenose dolphin, as discussed below.
238. In the worst case spatial scenario (Cumulative C), a large extent of the potential range of the Moray Firth bottlenose dolphin population out with the SAC will be affected for up to two years. Individuals that suffer behavioural effects within the Moray Firth could be potentially excluded from a key foraging area at Spey Bay during the period of cumulative piling and may also be prevented from moving through this disturbed area to reach other parts of their range along the coast (i.e. a barrier to migration). In addition, there is potential for additional exclusion from another, albeit small, proportion of their potential range during construction of the Firth of Forth Offshore Wind Farm.
239. Spey Bay is one of a number of key foraging areas regularly used by animals in the Moray Firth and whilst there may be noise disturbance in this area, the quality of the foraging habitat will not be affected. Given the current levels and range of background noise in the Moray Firth at different sea states to which marine mammals have habituated, it is considered likely that many animals will continue foraging in disturbed areas. For example, bottlenose dolphin commonly experience background levels of up to 66 dB_{ht} in sea state 1 (Annex 7A of the Original ES). Quantitative measurements are lacking, but Subacoustech's SPEAR model highlights that noise in excess of 70 dB_{ht} may arise from large ships and recreational vessels as they transit the Moray Firth. However, if displacement does occur, and if alternative foraging areas are unavailable, then this may effect on animals by affecting their reproductive fitness (for example, by extending their inter-calf intervals or reducing growth rates).
240. As with the Wind Farm alone, the potential for displacement during piling activity for each of the in-combination scenarios to result in long-term population-level effects was investigated through population modelling. As described previously (Section 4.4.1.1), the bottlenose dolphin VORTEX model uses a PVA model to

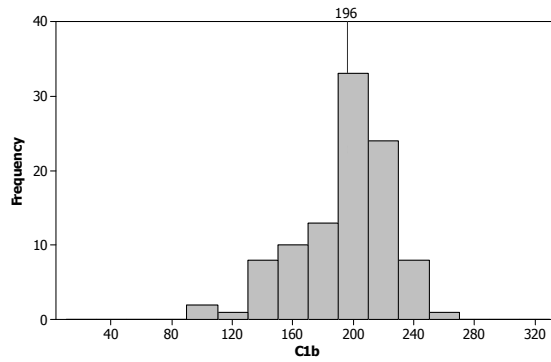
predict the distribution of population size after 25 years following exposure of the population to each of the construction scenarios in Table 4.6. The baseline population is taken from the most recent estimates of the Moray Firth SAC bottlenose dolphin population of 196 individuals in a stable or increasing population (Cheney et al., 2012a).

241. The results of the population modelling for bottlenose dolphin show that for each cumulative scenario, and for the upper, best and lower fit dose-response curves, after 25 years the baseline level of 196 individuals is the most frequently predicted population level, suggesting that there would be no long-term effect on the bottlenose dolphin population (Plates 4.3, 4.4 and 4.5). Although the model is run over a 25 year period, this does not reflect the time to recovery. Based on studies of marine mammals at offshore wind farms in the North Sea (e.g. Tougaard et al 2009; Thompson et al 2010; Brandt et al 2011) recovery of the population is predicted to start following cessation of the piling, and based on the potential ecological effects on the bottlenose dolphin population, and evidence from operational wind farms, full recovery to baseline conditions is likely to occur over the medium-term (<3 years).

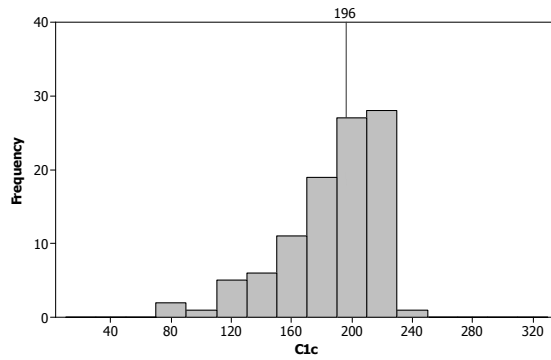
a) lower



b) best



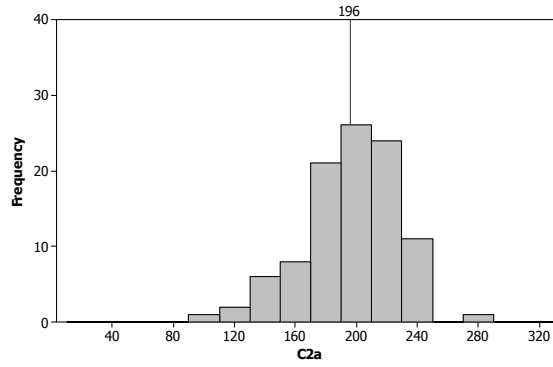
c) upper



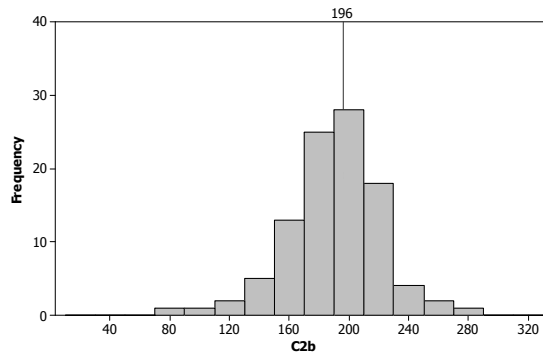
Number of individuals predicted after 25 years

Plate 4.3: Results of the Bottleneck Population Modelling for Cumulative Scenario A (BOWL A+B for two years followed immediately by MORL 1+5 for three years showing the output for the model using the a) lower, b) best and c) upper-fit for the dose response curve)

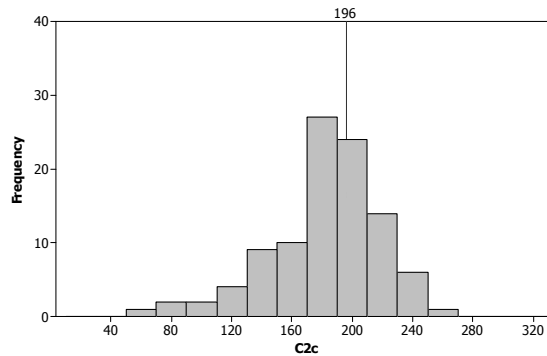
a) lower



b) best



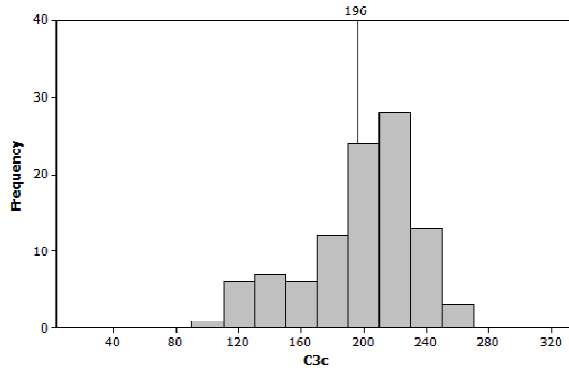
c) upper



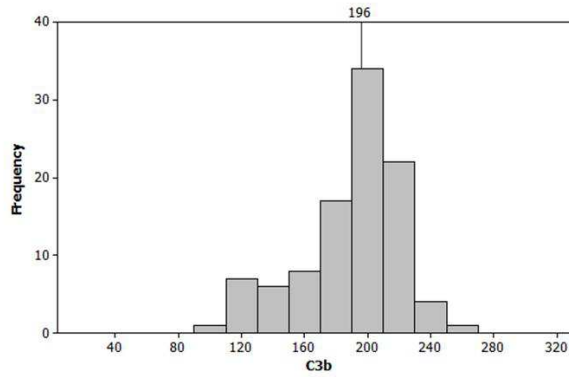
Number of individuals predicted after 25 years

Plate 4.4: Results of the Bottleneck Population Modelling for Cumulative Scenario B (BOWL A for three years and MORL 1 for five years with a one year overlap showing the output for the model using the a) lower, b) best and c) upper-fit for the dose response curve)

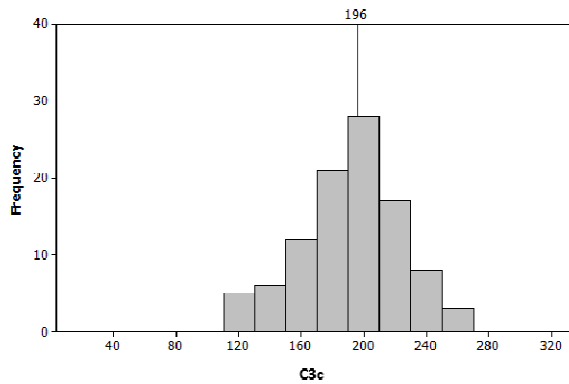
a) lower



b) best



c) upper



Number of individuals predicted after 25 years

Plate 4.5: Results of the Bottleneck Population Modelling for Cumulative Scenario C (BOWL A+B for two years overlapping with MORL 1-6 for two years showing the output for the model using the a) lower, b) best and c) upper-fit for the dose response curve)

242. In summary, it is considered that cumulative piling noise will lead to a medium-term effect of behavioural displacement of bottlenose dolphin, over two to seven years, depending on which piling scenario is employed. This could lead to medium-term disturbance of the qualifying species while they are out with the SAC. The key issue for the purposes of HRA is whether these medium-term disturbance effects would have longer term consequences for the SAC population (i.e. due to possible breeding failure) and consequently compromise the Conservation Objectives. Based on the population modelling undertaken and acknowledging the precautionary approach taken throughout this assessment, it is considered likely that the population will recover following cessation of the piling. Consequently no long-term adverse effect on the integrity of the SAC is predicted from the in-combination effects of piling noise.

In-Combination Collision Risk and Physical Injury/Mortality from Ship Strike

243. The Original ES (Section 12.9.5.3) assessed the potential effects of physical injury / mortality from ship strike on marine mammals as a result of the Wind Farm and Moray Firth Round 3 Zone. Due to the considerable daily and seasonal variation in vessel movements the Moray Firth, minimum figures represent a negligible increase in vessel movements. At the maximum levels, the vessel movements may represent a slight increase in the risk of collision. As the type of vessels will be similar to those used during construction and concentrated in just a small area of the Moray Firth, any effects would be localised and temporary in nature.

244. On the basis of the assessment of in-combination collision risk and physical injury/mortality from ship strike provided in the Original ES, no adverse effect on the bottlenose dolphin population or the habitats that support this population was predicted. Therefore, no adverse effect on the integrity of the Moray Firth SAC has been identified as a result of the Wind Farm in combination with the Moray Firth Round 3 Zone development.

In-Combination Suspended Solids Impairing Foraging Efficiency

245. Changes to the SSC were considered in relation to the Wind Farm and Moray Firth Round 3 Zone from foundation installation, inter-array cable burial, and export cable burial; the oil and gas foundation installation; and the SHETL cable installation. In the Original ES, Section 9: Wind Farm Physical Processes and Geomorphology, concluded that due to the localised nature of the sediment plumes, SSCs would not rise above the level predicted for the Wind Farm alone (i.e. $<30 \text{ mg}^{-1}$). The ranges of SSC would also be consistent with the natural range of variability for the area and this effect would be of short-term duration and very localised.

246. On the basis of the assessment of in-combination suspended solids impairing foraging efficiency provided in the ES, no adverse effect on the bottlenose dolphin population or the habitats that support this population was predicted. Therefore, no adverse effect on the integrity of the Moray Firth SAC has been identified as a result of the Wind Farm alone in combination with the Moray Firth Round 3 Zone development.

In-Combination Indirect Effects due to Temporary Loss of Foraging Area/Reduction in Prey Species

247. In the Original ES, and subsequently updated in Section 5: Fish and Shellfish Ecology of the ES Addendum the in-combination effects on fish and shellfish were considered for a range of potential effects during construction and operation. In particular, Section 5: Fish and Shellfish Ecology of the ES Addendum re-evaluated the potential effects on those species for which significant effects (above minor) were identified in the Original ES, whether from the Wind Farm alone or cumulatively with other projects. These species included salmon *Salmo salar*, sea trout *Salmo trutta*, cod *Gadus morhua*, herring *Clupea harengus* and sandeels.
248. For increased suspended sediment and sediment re-deposition the effects were considered to be short-term, localised and of small magnitude and therefore the in-combination effects were of minor significance for all species (Table 5.22 of the ES Addendum). Due to the uncertainties identified in relation to potential migration routes through the Moray Firth and the use of the area for spawning, the assessment has taken a precautionary approach and concluded that for piling noise there will be moderate effects for all species (Table 5.22 of the ES Addendum). During operation, the in-combination effects of loss of habitat, introduction of new habitat, EMF, operational noise and changes in fishing activity were predicted to result in effects of negligible to minor significance for all species, and not significant under the EIA Regulations (Table 5.22 of the ES Addendum).
249. Since marine mammals exploit a suite of different species as a food resource, it was considered unlikely that they would be adversely affected through declines in just one or two of their potential prey item. However, since bottlenose dolphin may exploit the Atlantic salmon on migration through Spey Bay and up into the Spey River, there is the potential for some minor effects on this species, although there are other key foraging areas for bottlenose dolphin within the Moray Firth.
250. On the basis of the assessment of in-combination indirect effects due to temporary loss of foraging area/reduction in prey species provided in the Original ES and ES Addendum, no adverse effect on the bottlenose dolphin population or the habitats that support this population was predicted. Therefore, no adverse effect on the integrity of the Moray Firth SAC has been identified as a result of the Wind Farm in combination with the Moray Firth Round 3 Zone development.

44.15 *Summary of In-Combination Effects from the Wind Farm and Moray Firth Round 3 Zone during Operation*

In-Combination Disturbance due to Operational Noise

251. Operational noise in relation to the turbines installed at the Wind Farm alone was assessed in Section 12: Wind Farm Marine Mammals of the Original ES as being negligible and subsequently there is no potential for in-combination effects with other developments. Therefore no adverse effect is predicted on Conservation Objectives (i.e. in relation to the population, distribution and disturbance effects) and the overall site integrity for the bottlenose dolphin population of the Moray Firth SAC.

252. On the basis of the assessment of in-combination disturbance due to operational noise provided in the Original ES, no adverse effect on the bottlenose dolphin population or the habitats that support this population is predicted. Therefore, no adverse effect on the integrity of the Moray Firth SAC has been identified as a result of the Wind Farm in combination with the Moray Firth Round 3 Zone development.

In-Combination Noise Disturbance Associated with Other Activities in the Moray Firth

253. The Original ES assessed the in-combination effects of noise disturbance from the Wind Farm and Moray Firth Round 3 Zone developments (Section 12.9.5.2). The effects are the same as those described previously (Section 4.4.1.2). Given the large number of vessels already operating in the area against the uplift in vessel numbers due to these developments, the type of vessels, operating speeds and habituation by marine mammals, it is considered unlikely that an increase in vessel activity will have a significant effect.

254. On the basis of the assessment of in-combination noise disturbance associated with other activities in the Moray Firth provided in the Original ES, no adverse effect on the bottlenose dolphin population or the habitats that support this population is predicted. Therefore, no adverse effect on the integrity of the Moray Firth SAC has been identified as a result of the Wind Farm in combination with the Moray Firth Round 3 Zone development.

In-Combination Collision Risk and Physical Injury/Mortality from Ship Strike

255. The Original ES (Section 12.9.5.3) assessed the potential effects of physical injury / mortality from ship strike on marine mammals as a result of the Wind Farm and Moray Firth Round 3 Zone. Due to the considerable daily and seasonal variation in vessel movements the Moray Firth, minimum figures represent a negligible increase in vessel movements. At the maximum levels, the vessel movements may represent a slight increase in the risk of collision. As the type of vessels will be similar to those used during construction and concentrated in just a small area of the Moray Firth, any effects would be localised and temporary in nature.

256. On the basis of the assessment of in-combination collision risk and physical injury/mortality from ship strike provided in the Original ES, no adverse effect on the bottlenose dolphin population or the habitats that support this population is predicted. Therefore, no adverse effect on the integrity of the Moray Firth SAC has been identified as a result of the Wind Farm in combination with the Moray Firth Round 3 Zone development.

In-Combination Behavioural Effects Arising from EMF

257. The Original ES (Section 12.9.5.4) discussed the potential for in-combination effects from EMF arising from the Wind Farm, Moray Firth Round 3 Zone and the SHETL cable. The effects on marine mammals from EMF were described previously (Section 4.4.1.2) and these were described as being very localised and unlikely to result in a significant effect. For in-combination effects, which could extend over a greater area, these were also considered unlikely to cause a negative effect on marine mammals or populations. Furthermore, the effects were not considered to be additive in terms of increasing the magnitude of the magnetic field itself. The

extent to which effects would occur was described as being dependent on other factors including burial depth, proximity to other cables and alignment with the earth's geomagnetic field. It was envisaged that there was a greater potential for effects to occur closer to the shore in shallower water depths where marine mammals may move closer to the cables. The locations at which the cable enters shallower water (i.e. near the landfall points) are at Fraserburgh or Rattray Head for the Moray Firth Round 3 Zone, at Portgordon in Spey Bay for SHETL and the OfTW.

258. On the basis of the assessment of in-combination behavioural effects arising from EMF provided in the Original ES, no adverse effect on the bottlenose dolphin population or the habitats that support this population is predicted. Therefore, no adverse effect on the integrity of the Moray Firth SAC has been identified as a result of the Wind Farm in combination with the Moray Firth Round 3 Zone development.

In-Combination Indirect Effects due to Changes in Prey Resources and Tidal Regimes due to Presence of Turbine Structures

259. The Original ES, Section 9: Wind Farm Physical Processes and Geomorphology scoped out in-combination effects of all other projects/developments in the Study Area with the exception of the development of the Wind Farm and Moray Firth Round 3 Zone. Changes to the tidal regime as a result of these two developments were subsequently assessed as being negligible and not significant (see Section 9: Wind Farm Physical Processes and Geomorphology of the Original ES).

260. Similarly the introduction of new habitat was not considered to be significant in terms of in-combination effects on fish and shellfish populations in the study area. The potential effects on marine mammals from changes in tidal regime and creation of new habitat were described previously (see Section 4.4.1.2).

261. On the basis of the assessment of in-combination indirect effects due to changes in prey resources and tidal regimes due to presence of turbine structures provided in the Original ES, no adverse effect on the bottlenose dolphin population or the habitats that support this population is predicted. Therefore, no adverse effect on the integrity of the Moray Firth SAC has been identified as a result of the Wind Farm in combination with the Moray Firth Round 3 Zone development.

4.4.1.6 *Summary of all In-Combination Effects (Total Effects)*

262. The potential for all in-combination effects described previously to combine during construction, operation or decommissioning to create an effect of greater magnitude than the effect of each in-combination effect alone is considered to be unlikely. During the construction phase in particular, the displacement of marine mammal species from the area during piling events at the Wind Farm and Moray Firth Round 3 Zone will potentially reduce the exposure to the other in-combination effects, namely increased suspended sediment concentrations and increased vessel strike risk. As there is no change in the overall significance of effects from those presented for each of the in-combination effects alone, no adverse effects are predicted on the Conservation Objectives of bottlenose dolphin and the overall site integrity of the Moray Firth SAC. The sum of all in-combination effects would not

prevent the SAC from making an appropriate contribution to achieving favourable conservation status.

4.4.2 DORNOCH FIRTH AND MORRICH MORE SAC

263. With reference to the Conservation Objectives (listed in Section 4.2), the proposal is not expected to cause any negative effects on the habitats of the Dornoch Firth and Morrich More SAC. The HRA therefore considers the effects on harbour seals, including indirect effects from degradation or loss of supporting habitats and species, outwith the SAC.

264. The effects considered to result in a LSE, or where Appropriate Assessment is required, were identified (Table 4.3). The potential effects of each effect on the Conservation Objectives of the Dornoch Firth and Morrich More SAC are summarised below.

4.4.2.1 *Summary of the Assessment of Effects arising from the Construction/Decommissioning of the Wind Farm Alone*

Injury, Disturbance and Displacement from Noise Emissions during Pile-Driving

265. Harbour seals are sensitive to frequencies within the range 75 Hz to 175 kHz. Unlike cetaceans, seals do not use echolocation to detect prey species. Harbour seals are present throughout the Moray Firth including the Wind Farm Site. The areas over which physical (non-auditory) injury and mortality, auditory injury (either permanent or temporary) and behavioural responses were modelled using the two different approaches described previously (Section 4.4.1.1). The extent of each noise threshold for harbour seals is shown in Table 4.9 and Plate 4.8 and Plate 4.9 show the modelled noise contours for pinnipeds generated by the SAFESIMM model where the dose-response curve was applied to PTS and behavioural avoidance for pinnipeds. The noise contours were subsequently overlaid on the density maps and harbour seal haul-out sites to illustrate the potential effects on the Moray Firth and SAC population of harbour seals (Plate 4.10). At sea, individuals are likely to be affected by noise disturbance from the piling operations but their year-round haul-out locations in the inner Moray Firth are unlikely to be affected as they fall out-with the ensonified area (Plate 4.10).

Table 4.9: Results of INSPIRE Modelling Exercise for Harbour Seal at the Wind Farm Site (The thresholds are as follows: i) death/mortality – 220 dB_{hit}; ii) PTS fleeing – 198 dB re. 1 μ Pa; and iii) behavioural effects – up to 75 dB_{hit})

Scenario	Threshold	Radius of Threshold around each Piling Operation (m)	Total Affected Area (km ²)
One pile driving event at the Wind Farm Site location B	Death/injury	60	0.01
	PTS: fleeing	2,570	13.1
	Behaviour	56,680	6,065
Two pile driving events at Wind Farm Site locations A and B	Death/injury	60	0.02
	PTS: fleeing	2,570	20.8
	Behaviour	56,680	6,708

266. The density maps show that individuals may be affected within each of the noise thresholds (i.e. physical injury and mortality, auditory injury and behavioural) and the threshold for behavioural disturbance extends over a very large proportion of the Moray Firth although does not overlap the SAC. Behavioural disturbance or displacement is important for harbour seals in particular as they have been shown to demonstrate high levels of site-fidelity (Cordes et al.,2011). Foraging ranges may thereby become concentrated around their breeding and haul-out sites creating increased competition for food and, for those individuals displaced, this could lead to greater energetic costs of foraging or reduced foraging (Thompson et al.,2011).
267. As described above for bottlenose dolphin (Section 4.4.1.1), individuals are unlikely to respond consistently at a given noise threshold for behavioural effects (75 or 90 dB_{hit}) and therefore the dose-response curve was useful in determining the proportion of the harbour seal population responding within each 5 dB_{hit} incremental increase in noise level (see Plate 12.2 in the Original ES).
268. Based on the potential effects on the harbour seal population the EIA predicted that piling noise has the potential to lead to a short-term, high magnitude effect of major significance for harbour seals out with the SAC (Section 12: Wind Farm Marine Mammals of the Original ES). Due to the high magnitude of this effect a population model was developed to determine whether this short-term high magnitude effect could lead to a longer-term effect on the viability of the population (see Section 12: Wind Farm Marine Mammals of the Original ES). The model initially applied a PTS threshold of 198 dB SEL for harbour seal since it was considered that the threshold of 186 dB SEL proposed by Southall et al. (2007) was overly conservative, and based on limited scientific evidence. However, following consultation with the statutory authorities it was agreed that, since the threshold may lie between these two received noise levels, a precautionary approach should be adopted and therefore the threshold for PTS for pinnipeds in water taken forward in the revised Harbour Seal Framework Assessment was 186 dB SEL (Annex 6A of the ES Addendum; see also Table 6.2 of the Addendum).
269. As part of the model development, a number of assumptions were required to be made regarding demographic/biological parameters and how these could be

affected by each type of potential effect. A conservative approach was deemed appropriate in the development of these assumptions in order to provide a worst case scenario (see Table 12.11 of the Original ES). For example, for PTS the model assumed that 25% of the population would be at risk of mortality with the remaining 75% at risk of behavioural disturbance. The assumption for behavioural disturbance was that individuals affected would suffer 100% breeding failure as a result of reduced fitness. In addition, the model assumed that harbour seals typically spend 75% of their time at sea, but this value is known to be much lower during the breeding season (Thompson et al.,2011).

270. Based on these conservative assumptions, the question was posed as to whether the potential loss of individuals arising from injury/death and PTS together with the potential breeding failure arising from displacement over this period would have a long-term effect on the harbour seal population within the Moray Firth, and consequently whether the Conservation Objectives of the SAC would be compromised. The two scenarios considered are the same as those modelled for bottlenose dolphin, with a single piling vessel operating over three years or two piling vessels operating concurrently over two years. The model showed that under normal conditions (no piling) the population would continue to rise over four years from the 2010 estimate of 1,183 individuals before starting to tail off and reach a peak at around 2,000 individuals. With piling introduced into this scenario the population would rise initially before decreasing by 162 individuals (single piling) to 168 individuals (concurrent piling) after 5 years and then recover rapidly following cessation of the piling (within two years) to the same point at which it would have been had the piling not taken place (Plate 4.6 and Plate 4.7). It should be noted that the numbers of individuals predicted to be affected gives rise to a precautionary estimate of the magnitude of effect subject to the assumptions and limitations of the model discussed in Section 12: Wind Farm Marine Mammals of the Original ES.

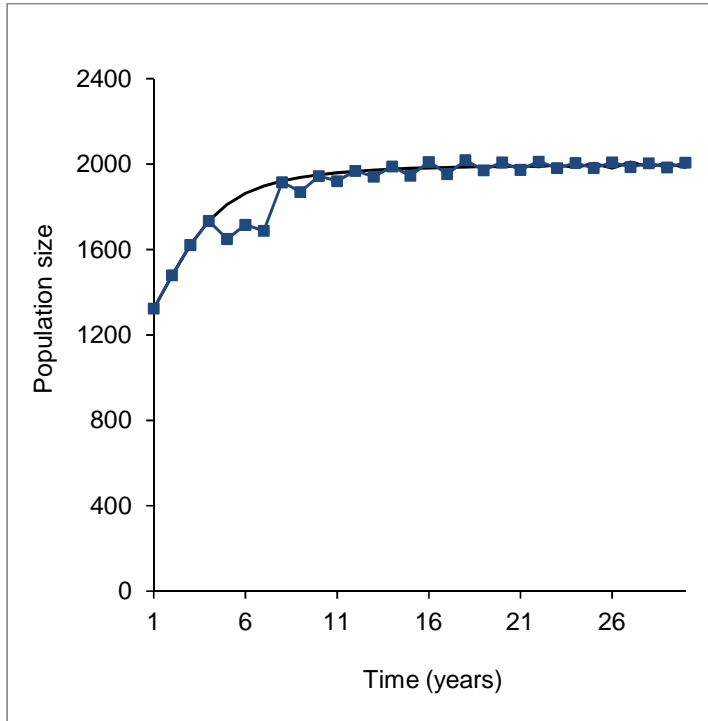


Plate 4.6: Population Model Predicting the Normal Increase in Harbour Seals within the Moray Firth (black line) Compared with the Population Increase after the Single Piling Scenario at the Wind Farm Site

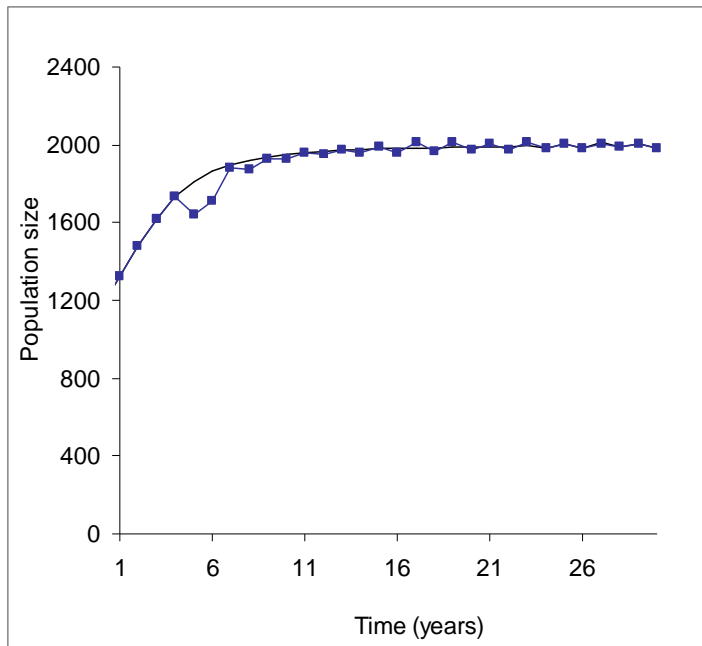
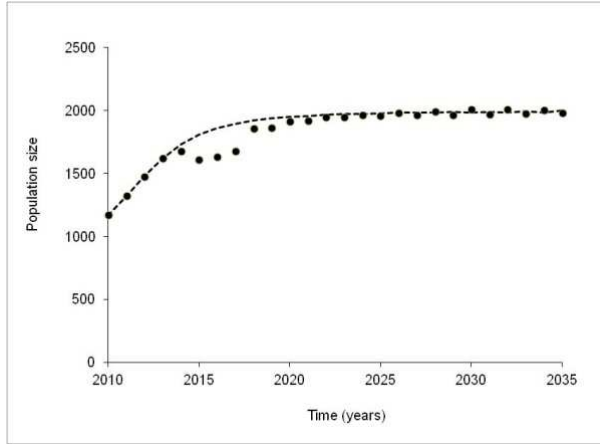


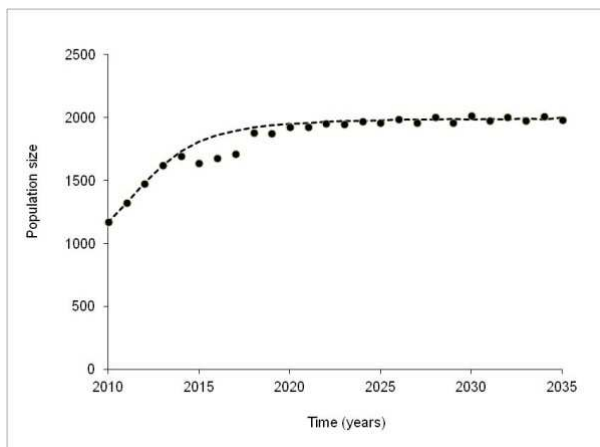
Plate 4.7: Population Model Predicting the Normal Increase in Harbour Seals within the Moray Firth (black line) Compared with the Population Increase after the Two-Simultaneous Piling Scenario at the Wind Farm Site

271. One of the issues raised by statutory consultees in response to the Original ES, was the robustness of the model predictions based on variations in the model parameters. Specifically, the question arises as to what the effect on the long-term population of harbour seal would be if the assumptions regarding 1) the survival rate resulting from PTS, and 2) the carrying capacity of the Moray Firth harbour seal population were to change. These questions were addressed through additional modelling work within the harbour seal framework (see Annex 6A of the ES Addendum).
272. The effect of decreasing mortality rate arising from PTS is a smaller predicted reduction in the population size in the short to medium-term. Thus, as the mortality rate is increased from 10 to 30%, so the amount by which the population decreases over the short-medium-term (a three to four year period out of the modelled 25 years) is seen to slightly increase (Plate 4.8). However, over 25 years the population returns to the predicted baseline levels. Similarly, neither varying the carrying capacity (K) of the harbour seal population from K=2,000 to K=1,000 (Plate 4.9), nor varying the dose-response (Plate 4.10) has any apparent effect on the long-term viability of the population, although as before there are some slight differences over the three to four year period where the population is predicted to decrease before returning to the predicted baseline levels.

a) 30%



b) 20%



c) 10%

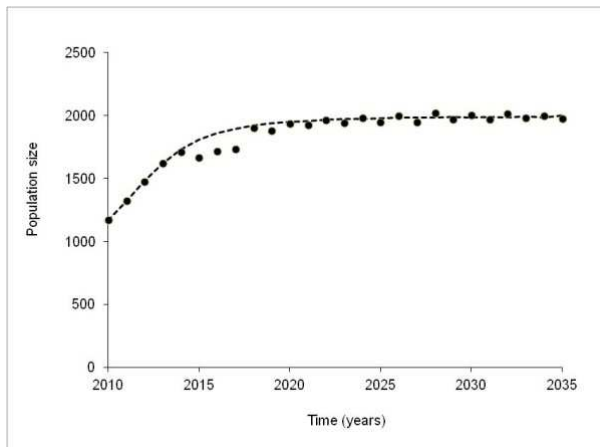


Plate 4.8: Variation in the Long-Term Effect on the Population of Harbour Seals from Single Piling at BOWL A based on Mortality Rates of a) 30%, b) 20% and c) 10% (Figures showing the concurrent piling scenario are very similar and are presented in Annex 6A of the ES Addendum)

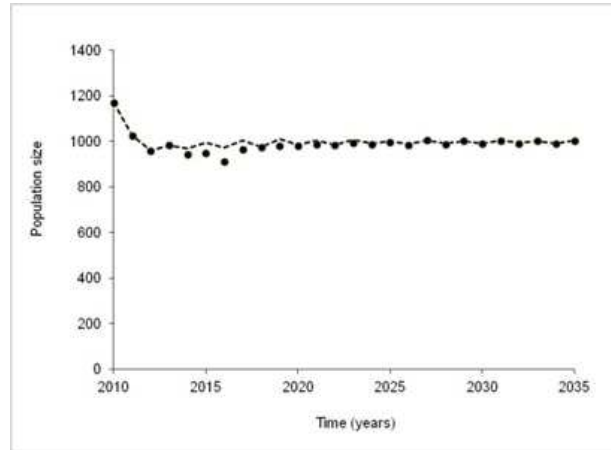
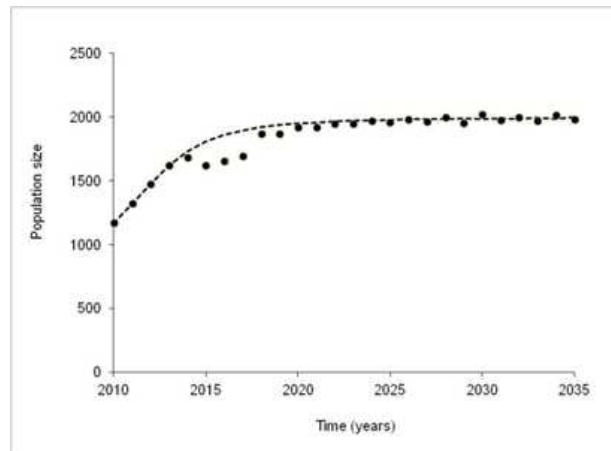
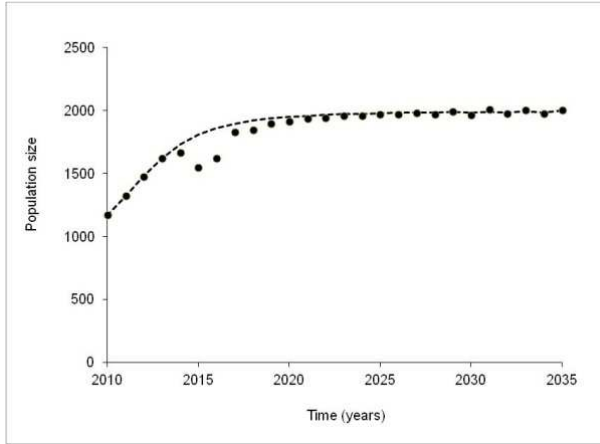
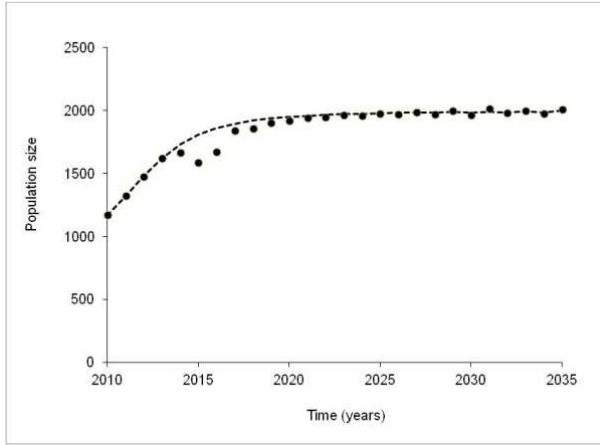
a) $K=1000$ b) $K=2000$ 

Plate 4.9: Comparison of the Effects of Varying the Carrying Capacity (K) on the Long-Term Viability of the Harbour Seal Population from Single Piling based on a) $K=1000$ and b) $K=2000$ (Figures presented are based on the best-fit dose-response curve. Figures showing the concurrent piling scenario are very similar and are presented in Annex 6A of the ES Addendum)

a) Upper



b) Best



c) Lower

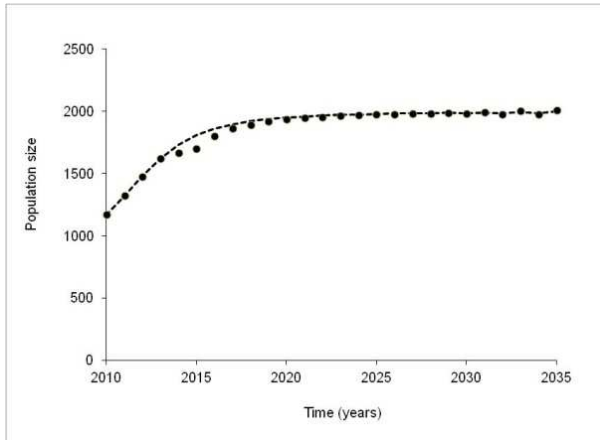


Plate 4.10: Comparison of the Effects of Varying the Dose-Response Curve on the Long-Term Viability of the Harbour Seal Population from Single Piling based on a) upper, b) best, and c) lower fit curves (Figures presented are based on a carrying capacity of K=2000. Figures showing the concurrent piling scenario are very similar and are presented in Annex 6A of the ES Addendum)

273. In summary, with respect to the Conservation Objectives, the likely effect of piling noise from the Wind Farm on the SAC population is the potential for medium-term (one to two years) injury or behavioural disturbance to a large proportion of the harbour seal population outwith the SAC boundary. These effects are predicted to be temporary in nature and reversible; based on the evidence from the harbour seal population model, the population will recover and there is unlikely to be any long-term adverse effect on its viability. Therefore, the assessment concludes that even with the short-term injury or disturbance of the harbour seal population as a result of the Wind Farm alone, no adverse effect on the integrity of the Dornoch Firth and Morrich More SAC in the long-term is predicted.

Collision Risk and Physical Injury/Mortality from Ship Strike, Particular those Using Ducted Propellers

274. The Original ES (Section 12.5.1.2), discussed potential collision risk from vessel strikes during construction and considered this to be low due to the high levels of vessel activity in the Moray Firth, to which marine mammals appear to have habituated and the relatively small uplift in vessel numbers arising from construction. The Original ES, further discussed the causal link between corkscrew injuries from ducted propellers and seal mortality which remains unproven, speculative and requiring further research. Furthermore, the Original ES highlighted that there are no confirmed cases of seals with corkscrew injuries from within the Moray Firth despite the extensive use of ducted propellers in this area (Thompsen et al., 2010). The issue of vessel strike and potential injury from ducted propellers has been discussed during the EIA process with statutory consultee and BOWL will continue to monitor research being carried out in respect of corkscrew injuries.

275. On the basis of the assessment of collision risk and physical injury/mortality from ship strike (including ducted propellers) provided in the Original ES, no adverse effect on the harbour seal population or the habitats that support this population is predicted. Therefore, no adverse effect on the integrity of the Dornoch Firth and Morrich More SAC has been identified as a result of the Wind Farm alone.

Suspended Solids Impairing Foraging Efficiency

276. Environmental changes arising from an increase in suspended solids was described previously in (Section 4.4.1.1). Pinnipeds are highly adapted to living in turbid environments, using sensory whiskers, known as vibrissae, to navigate and detect prey items.

277. On the basis of the assessment of suspended solids impairing foraging efficiency provided in the ES, no adverse effects are predicted on the harbour seal population or the habitats that support this population. Therefore, no adverse effect on the integrity of the Dornoch Firth and Morrich More SAC has been identified as a result of the Wind Farm.

Indirect Effects due to Temporary Loss of Foraging Area/Reduction in Prey Species

278. The indirect effects due to temporary loss of foraging area/ reduction in prey species was described previously (Section 4.4.1.1).

279. On the basis of the assessment of indirect effects due to temporary loss of foraging area/reduction in prey species provided in the Original ES, no adverse effects are predicted on the harbour seal population or the habitats that support this population. Therefore, no adverse effect on the integrity of the Dornoch Firth and Morrich More SAC has been identified as a result of the Wind Farm alone.

4.4.2.2 *Summary of the Assessment of Effects arising from the Operation of the Wind Farm Alone*
Disturbance due to Operational Noise

280. The Original ES, Section 12: Wind Farm Marine Mammals (Section 12.5.2.1), assessed the effects of operational noise and vibration associated with turbine rotation. The data indicated that marine mammals would not be excluded during the operational phase

281. On the basis of the assessment of disturbance due to operational noise provided in the Original ES, no adverse effect is predicted on the harbour seal population or the habitats that support this population. Therefore, no adverse effect on the integrity of the Dornoch Firth and Morrich More SAC has been identified as a result of the Wind Farm alone.

Noise Disturbance from Maintenance Vessels

282. Noise disturbance from maintenance vessels was previously discussed (Section 4.4.1.2). As the effects are predicted to be the same on all marine mammals, no likely significant effect is envisaged on the relevant harbour seal Conservation Objectives (i.e. population, distribution and disturbance) for the Dornoch Firth and Morrich More SAC.

283. On the basis of the assessment of noise disturbance from maintenance vessels provided in the Original ES, no adverse effect on the harbour seal population or the habitats that support this population is predicted. Therefore, no adverse effect on the integrity of the Dornoch Firth and Morrich More SAC has been identified as a result of the Wind Farm alone.

Collision Risk and Physical Injury/Mortality from Ship Strike

284. Collision risk during the operational phase is described in detail in the Original ES, Section 12: Wind Farm Marine Mammals (Section 12.5.2.3) and summarised above (see Section 4.4.1.2). These assessments predict only a small proportion of marine mammals would be intermittently affected, although this was considered unlikely.

285. On the basis of the assessment of collision risk and physical injury/mortality from ship strike provided in the Original ES, no adverse effects are predicted on the harbour seal population or the habitats that support this population. Therefore, no adverse effect on the integrity of the Dornoch Firth and Morrich More SAC has been identified as a result of the Wind Farm alone.

Behavioural Effects Arising from EMF

286. Behavioural effects arising from EMF are described in detail in the Original ES, Section 12: Wind Farm Marine Mammals (Section 12.5.2.4) and summarised above (see Section 4.4.1.2). Although, the assessment generally refers to the more sensitive

cetacean species, the behavioural effects described could equally occur in seals and therefore an effect, which will be localised and reversible, is predicted.

287. On the basis of the assessment of behavioural effects arising from EMF provided in the Original ES, no adverse effect on the harbour seal population or the habitats that support this population is predicted. Therefore, no adverse effect on the integrity of the Dornoch Firth and Morrich More SAC has been identified as a result of the Wind Farm alone.

Indirect Effects Arising from Changes in Prey Resources and Tidal Regimes due to Presence of Turbine Structures

288. The indirect effects resulting from changes in prey resources and tidal regimes on marine mammals, due to the presence of turbine structures are described in detail in the Original ES, Section 12: Wind Farm Marine Mammals (Section 12.5.2.5) and above (see Section 4.4.1.2). Consequently, a similar effect is envisaged on seals, whereby a negligible effect is envisaged due to changes in the tidal regime and a small-negligible positive effect on seals which could benefit from a potential increase in fish species around the turbine structures.

289. On the basis of the assessment of behavioural effects arising from EMF provided in the ES, no adverse effect on the harbour seal population or the habitats that support this population is predicted. Therefore, no adverse effect on the integrity of the Dornoch Firth and Morrich More SAC has been identified as a result of the Wind Farm alone.

4.4.2.3 *Summary of All Effects (Total Effects)*

290. The assessment of total (or inter-related) effects arising from all potential effects on harbour seal considered in the Original ES is presented in the ES Addendum (Section 6.6.1.3). The potential for all effects to combine during construction, operation or decommissioning to create an effect of greater magnitude than the effect of each effect alone is considered to be unlikely (Table 6.7 of the ES Addendum). As there is no change in the overall significance of effects from those presented for each of the effects alone, no adverse effects are predicted on the Conservation Objectives for harbour seal of the Dornoch Firth and Morrich More SAC and, therefore, the overall integrity of the site. The sum of all effects would not prevent the SAC from making an appropriate contribution to achieving favourable conservation status.

4.4.2.4 *Summary of In-Combination Effects from the Wind Farm and Moray Firth Round 3 Zone during Construction/Decommissioning*

In-Combination Injury, Disturbance and Displacement from Noise Emissions during Pile-Driving

291. Three different in-combination construction scenarios were modelled for the Wind Farm and Moray Firth Round 3 Zone which represented the worst case temporally (seven consecutive years of piling), the worst case spatially (eight concurrent piling events) and a scenario in-between these two extremes (see Table 4.6). This therefore considers both the spatial and temporal worst case in-combination scenarios. The

modelling approaches employed and sensitivity of harbour seals has been described above.

292. There is also potential for noise disturbance from offshore wind farms and other renewable developments further afield to affect harbour seals. The construction programme for the Firth of Forth Offshore Wind Farm (phased development between 2015 and 2019) coincides with the Beatrice Offshore Wind Farm construction programme and there are also two offshore renewable developments planned in the Pentland Firth and Orkney waters, although construction schedules were not available for these. However, since harbour seal is not a wide-ranging species, individuals from the Moray Firth are unlikely to frequently visit these areas and therefore the in-combination effects of these other developments are considered to be negligible in the context of the Moray Firth harbour seal population. The in-combination noise assessment for harbour seal therefore focussed on the pile-driving activity in the Moray Firth.
293. For the worst case spatially, noise modelling for the eight simultaneous pile-driving events showed that the total area affected for each noise threshold was greater than that for the Wind Farm alone (Plate 4.11; Table 4.10). The area over which death/injury could occur was 0.14 km² for the Wind Farm and Moray Firth Round 3 Zone EDA compared with 0.02 km² for the two pile-driving scenario at the Wind Farm Site alone (Table 4.10). Similarly, the range of effect for permanent auditory injury extended over 1,191 km² in the cumulative scenario compared with 20.8 km² at the Wind Farm Site alone. The area over which behavioural effects could occur was also greater for the cumulative scenario (10,881 km² compared with 6,708 km²), although there was a large degree of overlap between the noise contours for the Wind Farm and Moray Firth Round 3 Zone EDA. Therefore, over the two year piling phase the in-combination piling could adversely affect harbour seal, and the risks of either physical or auditory injury would be considerably greater in this scenario than for the Wind Farm alone due to the greater area potentially affected.

Table 4.10: Results of INSPIRE Cumulative Modelling Exercise for Harbour Seal at the Wind Farm Site and Moray Firth Round 3 Zone EDA (The thresholds are as follows: i) death/mortality – 220 dB_{hit}; ii) PTS fleeing – 198 dB re. 1 μPa; and iii) behavioural effects – up to 75 dB_{hit})

Scenario	Threshold	Radius of Threshold around each Piling Operation (m)	Total Affected Area (km ²)
Wind Farm locations A and B plus Moray Firth Round 3 Zone EDA locations M1 to M6	Death/injury	BOWL – 60 Moray Firth Round 3 Zone – 80	0.14
	PTS: fleeing	9,000	1,191
	Behaviour	59,050	10,881

294. The worst case temporally is also greater for the in-combination piling compared with the Wind Farm alone. For in-combination piling, effects on harbour seal would occur over a period of seven consecutive years compared with a maximum of three years for the Wind Farm alone.

295. As with the assessment of the Wind Farm alone, the issue of the long-term viability of the harbour seal population was addressed using a population model (Section 12: Wind Farm Marine Mammals of the Original ES), which was subsequently updated in Section 6: Marine Mammals of the ES Addendum following responses from statutory consultees on the Original ES. As described above, the revised Harbour Seal Framework adopted a more precautionary estimate for PTS of 186 dB re. 1 μ Pa. Even with this more conservation threshold the population model showed that, for both the worst case spatially and the worst case temporally, the harbour seal population in the Moray Firth could recover after an initial decrease in the population growth trend (Plate 4.11 and Plate 4.12).
296. As described for the Wind Farm alone, additional modelling was carried out to explore the effects of changing the carrying capacity of the population and the effect of varying the dose response curves (upper, best and lower fit) for the prediction of the proportion of animals excluded from the area. The effect of varying the mortality rate of individuals exposed to PTS was not explored for the cumulative scenarios since the modelling for the two Wind Farm scenarios showed only minimal differences in the population over time. The results of this modelling are similar to those predicted for the Wind Farm alone: varying the carrying capacity and dose-response curve has no effect on the long-term viability of the harbour seal population (Plate 4.13 and 4.14).

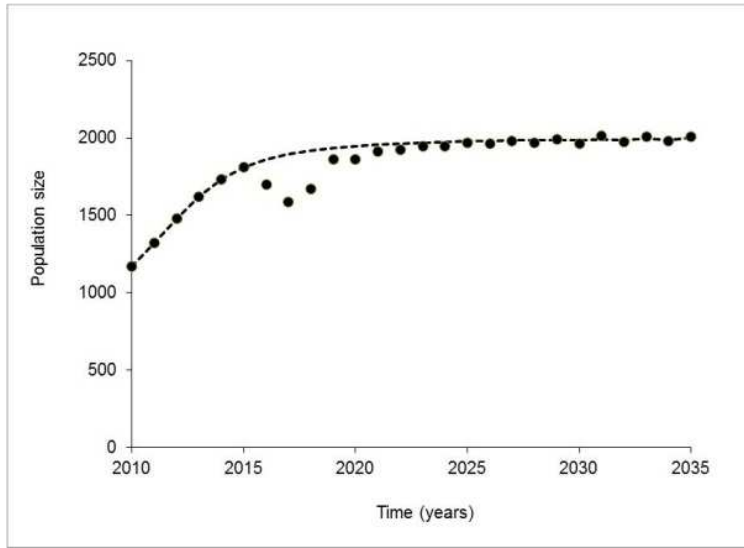


Plate 4.11: Population Model Predicting the Normal Increase in Harbour Seals within the Moray Firth (black line) Compared with the Population Increase after the Eight Simultaneous Piling Scenario (for two years) at the Wind Farm Site and Moray Firth Round 3 Zone EDA

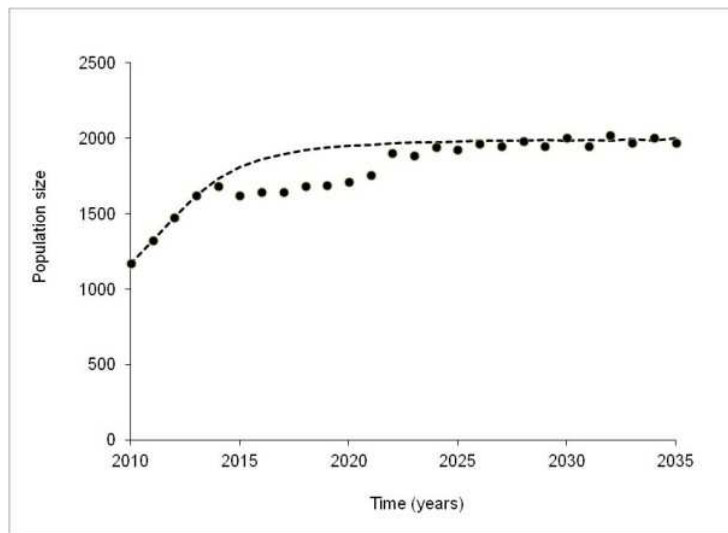


Plate 4.12: Population Model Predicting the Normal Increase in Harbour Seals within the Moray Firth (black line) Compared with the Population Increase after the Worst Case Temporal Piling Scenario at the Wind Farm Site and Moray Firth Round 3 Zone EDA (BOWL A for three years (2014-2016) overlapped with MORL 1 five years (2016-2020))

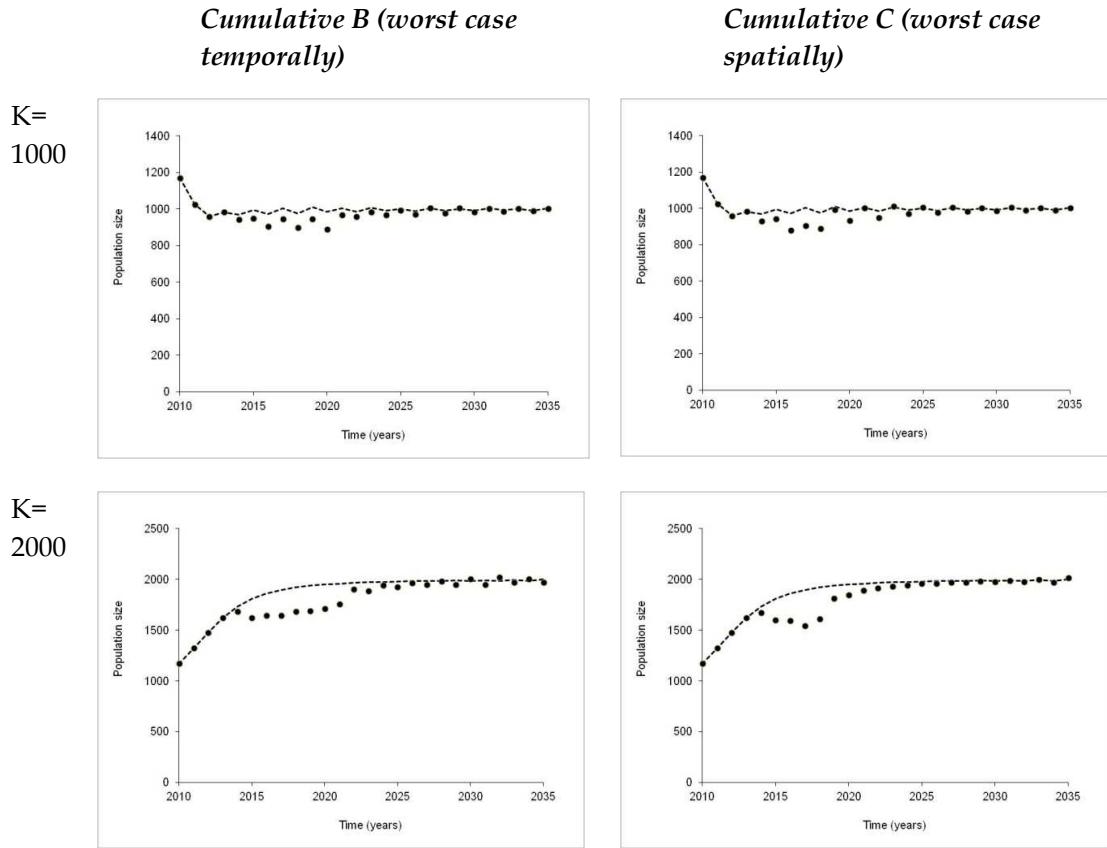


Plate 4.13: Comparison of the Effects of Varying the Carrying Capacity (K) on the Long-Term Viability of the Harbour Seal Population from Cumulative Scenario B (worst-case temporally) and C (worst case spatially) based on a) K=1000 and b) K=2000 (Figures presented here are based on the best-fit dose-response curve. Figures for the lower and upper fit dose-response curve are presented in Annex 6A in the ES Addendum)

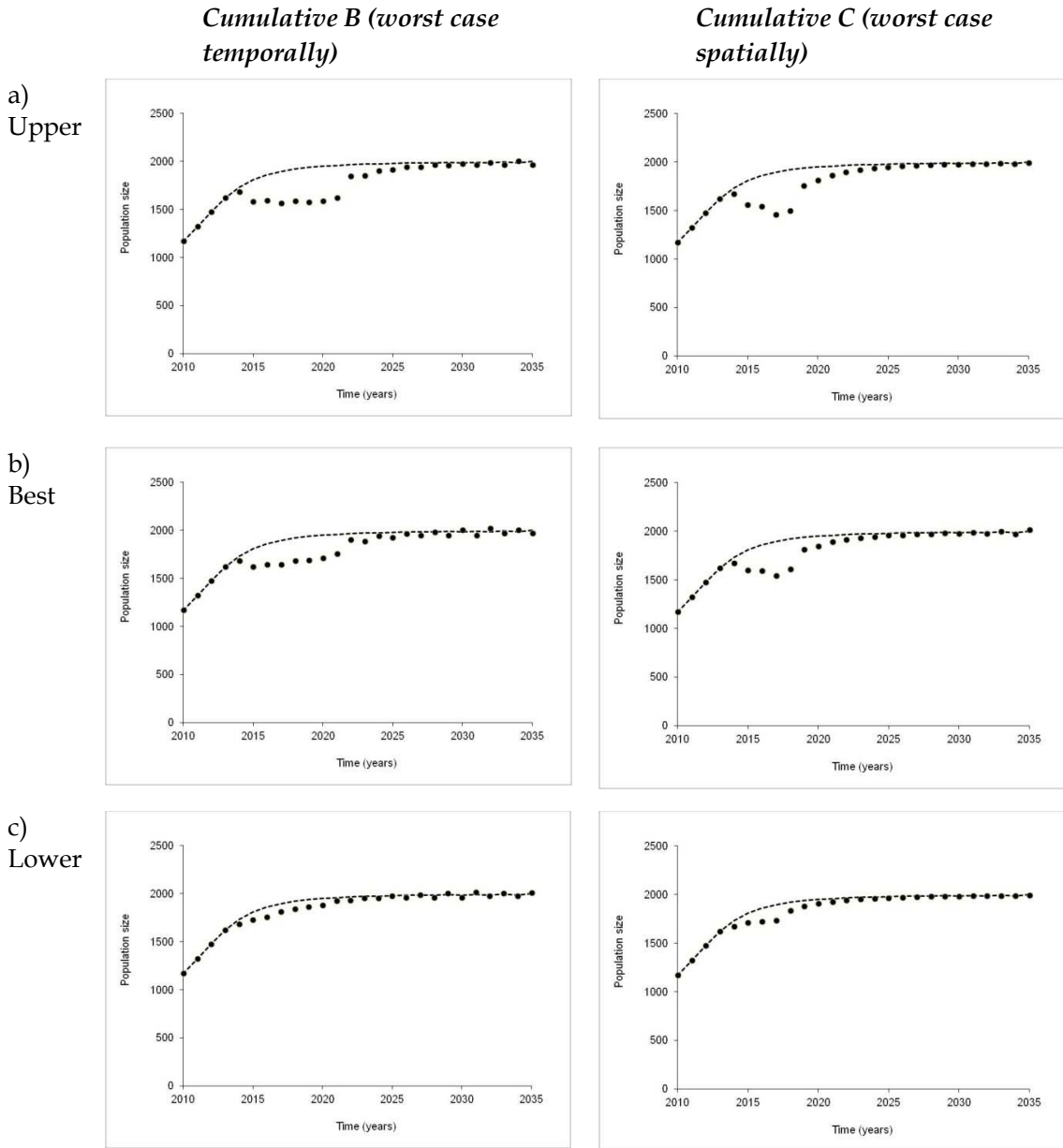


Plate 4.14: Comparison of the Effects of Varying the Dose-Response Curve on the Long-Term Viability of the Harbour Seal Population from Cumulative Scenario B (worst case temporally) and C (worst case spatially) based on a) upper, b) best, and c) lower fit curves (Figures presented here are based on a carrying capacity of $K=2000$. Figures for a carrying capacity of $K=1000$ are presented in Annex 6A)

297. In summary, with respect to the Conservation Objectives, in-combination piling is predicted to lead to a medium-term effect (two to seven years depending on which piling scenario is employed) of injury or behavioural disturbance to a large proportion of the harbour seal population out with the SAC boundary which could affect a greater number of individuals than for the Wind Farm alone. These effects are predicted to be temporary in nature and reversible since, based on the evidence from the harbour seal population model, the population will recover with no long-term effect predicted. Consequently no long-term adverse effect on the integrity of the SAC is predicted from the in-combination effects of piling noise.

In-Combination Risk and Physical Injury/Mortality from Ship Strike, Particular those Using Ducted Propellers

298. The Original ES (Section 12.5.1.2), discussed potential collision risk from vessel strikes during construction and considered this to be low due to the high levels of vessel activity in the Moray Firth, to which marine mammals appear to have habituated and the relatively small uplift in vessel numbers arising from construction. The Original ES further discussed the causal link between 'corkscrew' injuries from ducted propellers and seal mortality which remains unproven, speculative and requiring further research. Furthermore, the Original ES highlighted that there are no confirmed cases of seals with corkscrew injuries from within the Moray Firth despite the extensive use of ducted propellers in this area (Thompson et al.,2010). The issue of vessel strike and potential injury from ducted propellers has been discussed during the EIA process with statutory consultees and BOWL will continue to monitor research being carried out in respect of corkscrew injuries.

299. On the basis of the assessment of in-combination risk and physical injury/mortality from ship strike (including ducted propellers) provided in the Original ES, no adverse effect on the harbour seal population or the habitats that support this population is predicted. Therefore, no adverse effect on the integrity of the Dornoch Firth and Morrich More SAC has been identified as a result of the Wind Farm in combination with the Moray Firth Round 3 Zone development.

In-Combination Suspended Solids and Impairment of Foraging Efficiency

300. Impairment of foraging efficiency due to an increase in suspended solids was described previously. Pinnipeds are highly adapted to living in turbid environments, using sensory whiskers, known as vibrissae, to navigate and detect prey items. As the resulting effect of increased suspended solids on harbour seal is considered to be of negligible significance, it is anticipated that there would be no adverse effect on the Conservation Objectives for harbour seal for the Dornoch Firth and Morrich More SAC. Thus, ensuring the overall site integrity is maintained and this effect would not prevent the SAC from making an appropriate contribution to achieving favourable conservation status
301. On the basis of the assessment of in-combination suspended solids and impairment of foraging efficiency provided in the Original ES, no adverse effect on the harbour seal population or the habitats that support this population is predicted. Therefore,

no adverse effect on the integrity of the Dornoch Firth and Morrich More SAC has been identified as a result of the Wind Farm in combination with the Moray Firth Round 3 Zone development.

In-Combination Indirect Effects due to Temporary Loss of Foraging Area/Reduction in Prey Species

302. The indirect effects due to temporary loss of foraging area/ reduction in prey species was described previously and in light of the assessment provided in the Original ES, no adverse effect is predicted on all the Conservation Objectives established for the species and supporting habitats of the Dornoch Firth and Morrich More SAC. Thus, no adverse effect is anticipated on the overall site integrity and this effect is not expected to prevent the site from making an appropriate contribution to achieving favourable conservation status
303. On the basis of the assessment of in-combination indirect effects due to temporary loss of foraging area/reduction in prey species provided in the ES, no adverse effect on the harbour seal population or the habitats that support this population is predicted. Therefore, no adverse effect on the integrity of the Dornoch Firth and Morrich More SAC has been identified as a result of the Wind Farm in combination with the Moray Firth Round 3 Zone development.

4.4.2.5 *Summary of In-Combination Effects from the Wind Farm and Moray Firth Round 3 Zone During Operation*

In-Combination Operational Noise from Turbines

304. Disturbance due to operational noise was described previously and as the effects are predicted to be the same on all marine mammals, that is, no effect, the outcome is expected to be the same on the harbour seal for operational noise. Therefore, no adverse effect is envisaged on the Conservation Objectives for the harbour seal population (i.e. in relation to maintaining the population, distribution of species within the site and disturbance to the species) of the Dornoch Firth and Morrich More SAC. Thus, no adverse effects are anticipated on the overall site integrity and this effect is not expected to prevent the SAC from making an appropriate contribution to achieving favourable conservation status.
305. On the basis of the assessment of in-combination operational noise from turbines provided in the Original ES, no adverse effect on the harbour seal population or the habitats that support this population is predicted. Therefore, no adverse effect on the integrity of the Dornoch Firth and Morrich More SAC has been identified as a result of the Wind Farm in combination with the Moray Firth Round 3 Zone development.

In-Combination Noise Disturbance Associated with Other Activities in the Moray Firth

306. Noise disturbance from maintenance vessels was previously discussed (Section 4.4.2.2). As the effects are predicted to be the same on all marine mammals, no adverse effect is envisaged on the relevant harbour seal Conservation Objectives (i.e. population, distribution and disturbance) for the Dornoch Firth and Morrich More SAC. Thus, no adverse effect is anticipated on the overall site integrity and

this effect is not expected to prevent the SAC from making an appropriate contribution to achieving favourable conservation status

307. On the basis of the assessment of in-combination noise disturbance associated with other activities in the Moray Firth provided in the Original ES, no adverse effect on the harbour seal population or the habitats that support this population is predicted. Therefore no adverse effect on the integrity of the Dornoch Firth and Morrich More SAC has been identified as a result of the Wind Farm in combination with the Moray Firth Round 3 Zone development.

In-Combination Collision Risk and Physical Injury/Mortality due to Ship Strike

308. Collision risk during the operational phase is described in detail in the Original ES, Section 12: Wind Farm Marine Mammals (Section 12.5.2.3) and summarised above (Section 4.4.2.2). These assessments predict only a small proportion of marine mammals would be intermittently affected, although this was considered unlikely. Consequently, no adverse effect is predicted on the Conservation Objectives for harbour seal (i.e. maintaining the population, distribution and ensuring no significant disturbance) and on the overall site integrity. Furthermore, this effect would also not prevent the SAC from making an appropriate contribution to achieving favourable conservation status

309. On the basis of the assessment of in-combination collision risk and physical injury/mortality due to ship strike provided in the Original ES, no adverse effect on the harbour seal population or the habitats that support this population and therefore no adverse effect on the integrity of the Dornoch Firth and Morrich More SAC has been identified as a result of the Wind Farm in combination with the Moray Firth Round 3 Zone development.

In-Combination Behavioural Effects Arising from EMF

310. Behavioural effects arising from EMF are described in detail in the Original ES, Section 12: Wind Farm Marine Mammals (Section 12.5.2.4) and summarised above (Section 4.4.2.2). Although, the assessment generally refers to the more sensitive cetacean species, the behavioural effects described could equally occur in seals and therefore an effect, which will be localised and reversible, is predicted. Consequently, no adverse effect is envisaged on the Conservation Objectives (i.e. maintaining the population and distribution, as well as ensuring no significant disturbance) for the harbour seal population of the Dornoch Firth and Morrich More SAC. Thus, the overall site integrity would be maintained and this effect would not prevent the SAC from making an appropriate contribution to achieving favourable conservation status.

311. On the basis of the assessment of in-combination behavioural effects arising from EMF provided in the Original ES, no adverse effect on the harbour seal population or the habitats that support this population is predicted. Therefore, no adverse effect on the integrity of the Dornoch Firth and Morrich More SAC has been identified as a result of the Wind Farm in combination with the Moray Firth Round 3 Zone development.

In-Combination Indirect Effects Arising from Changes in Prey Resources and Tidal Regimes due to Presence of Turbine Structures

312. The indirect effects resulting from changes in prey resources and tidal regimes on marine mammals, due to the presence of turbine structures are described in detail in the Original ES, Section 12: Wind Farm Marine Mammals (Section 12.5.2.5) and previously (Section 4.4.2.2). Consequently, a similar effect is envisaged on seals, whereby a negligible effect is envisaged due to changes in the tidal regime and a small-negligible positive effect on seals which could benefit from a potential increase in fish species around the turbine structures. Thus, no adverse effect is predicted on the Conservation Objectives for the harbour seal population of the Dornoch Firth and Morrich More SAC or on the overall site integrity. Furthermore, this effect would not prevent the SAC from making an appropriate contribution to achieving favourable conservation status.
313. On the basis of the assessment of in-combination indirect effects arising from changes in prey resources and tidal regimes due to presence of turbine structures provided in the Original ES, no adverse effect on the harbour seal population or the habitats that support this population is predicted. Therefore, no adverse effect on the integrity of the Dornoch Firth and Morrich More SAC has been identified as a result of the Wind Farm in combination with the Moray Firth Round 3 Zone development.

4.4.2.6 Summary of All Effects (Total Effects)

314. The potential for all in-combination effects described above in 4.4.2.4 and 4.4.2.5 combine during construction, operation or decommissioning to create an effect of greater magnitude than the effect of each in-combination effect alone is considered to be unlikely. During the construction phase in particular, the displacement of marine mammal species from the area during piling events at the Wind Farm and Moray Firth Round 3 Zone will potentially reduce the exposure to the other in-combination effects, namely increased suspended sediment concentrations and increased vessel strike risk. As there is no change in the overall significance of effects from those presented for each of the in-combination effects alone, the likely significant effects are not predicted to have adverse effects on the Conservation Objectives of harbour seal and the overall site integrity of the Dornoch Firth and Morrich More SAC. The sum of all in-combination effects would not prevent the SAC from making an appropriate contribution to achieving favourable conservation status.

4.4.3 SUMMARY OF EFFECTS ON THE MORAY FIRTH SAC

315. This Report to inform an Appropriate Assessment concludes that, with regard to the effects of piling noise from the Wind Farm alone on bottlenose dolphin, based on the population modelling undertaken and acknowledging the precautionary assumptions adopted in this assessment, long-term direct or indirect adverse effects on the viability of the population are not predicted. Displacement effects are unlikely to occur within the SAC boundary and effects on individuals out with the boundary are likely to be short to medium-term in nature, with piling taking place over a period of two to three years depending on whether single or concurrent

- piling is employed. In particular, the area in which avoidance behaviour is likely to occur falls outside of areas considered to be important for the population. The potential effects arising from piling noise during construction of the Wind Farm alone were assessed against the Conservation Objectives of the SAC and based on the evidence presented here there is considered to be no long-term adverse effect on the integrity of the European site (Table 4.11).
316. Furthermore, this Report to inform an Appropriate Assessment also concludes that long-term effects on the viability and distribution of the bottlenose dolphin population as a result of non-piling related construction and operational effects are also not predicted to adversely affect bottlenose dolphin within, or out with, the Moray Firth SAC. Therefore, based on the evidence presented here relating to these effects, no long-term adverse effects are predicted on the integrity of the European site.
317. Although the in-combination piling activity is not predicted to adversely affect bottlenose dolphins within the SAC boundaries, the disturbance to individuals out with the SAC is likely to be greater than for the Wind Farm site alone. This is because the noise disturbance could occur over a greater proportion of the SAC bottlenose dolphins' range and arise in areas of higher bottlenose dolphin densities. In addition, temporally the disturbance from in-combination piling occurs over a longer period (up to seven years compared with up to three years for the Wind Farm alone). In-combination piling could therefore result in disturbance of individuals out with the SAC boundary at least in the medium-term (two to seven years). Based on the population modelling undertaken and acknowledging the precautionary approach taken, the bottlenose dolphin population is predicted to recover in the long-term following cessation of the piling. The potential effects arising from piling noise during construction of the Wind Farm in-combination with construction at Moray Firth Round 3 Zone were assessed against the Conservation Objectives of the SAC and based on the evidence presented here there is considered to be no long-term adverse effect on the integrity of the European site (Table 4.12).
318. The in-combination effects arising from non-piling related effects are also not predicted to result in any long-term adverse effect on the integrity of the Moray Firth SAC.
319. This Report on the effects of the Wind Farm (both alone and in combination with other plans and projects) is provided to inform the Scottish Ministers' (acting through Marine Scotland) Appropriate Assessment of the implications of the Wind Farm on the identified SACs in view of the sites' Conservation Objectives.
320. This Report is based on current best scientific understanding of the issues. Uncertainties have been addressed by adopting a precautionary approach to each stage of the assessment and by carrying out population modelling to investigate possible long-term effects associated with piling noise. It should be noted that the assessment is based on a worst case 'Rochdale envelope' scenario.

4.4.3.1 Mitigation

321. The mitigation proposed for reducing the effects of piling noise on marine mammals remains the same as that described in the Original ES. In summary this involves the following measures, following the JNCC guidelines on reducing the risk of injury to marine mammals during piling:

- During all piling operations trained Marine Mammal Observers (MMOs) will use visual and where required, acoustic detection, to ensure that marine mammals are not within the direct injury zone (termed the 'mitigation zone' - as agreed with relevant Statutory Advisors). The use of MMOs will subsequently reduce the potential for injurious effects for any marine mammal species present in the mitigation zone;
- Passive Acoustic Monitoring (PAM) will be particularly important for periods of poor visibility or night time conditions. PAM buoys will surround the piling location and detections will be sent back to the PAM operator on a dedicated vessel. The use of PAMs will subsequently reduce the potential for injurious effects for any marine mammal species present in the mitigation zone;
- Acoustic Deterrent Devices (ADDs) are a particularly useful for mitigating effects upon seals as a result of the difficulties associated with identifying and observing these species, particularly at night and during periods of poor visibility; and
- When piling commences a 'soft-start' procedure will be employed and the force of piling will gradually be increased to alert marine mammals in the vicinity to the commencement of the operations and thus reduce the potential for injury on all marine mammal species.

322. In addition to the measures outlined above, BOWL is committed to reducing effects on marine mammals as a result of piling noise through the implementation of a range of measures during piling. These include:

- If concurrent piling operations are undertaken, vessels will operate at no more than 5 km from each other. The purpose of this will be to reduce the potential area of ensonification from that presented in the worst case, and the use of two vessels should also decrease the installation programme; and
- Upon receiving detailed geotechnical information, BOWL will develop a piling strategy with the aim of reducing effects on agreed species throughout the construction period. The current Rochdale Envelope currently allows for the use of hammer energy up to 2,300 kJ, although the most likely scenario is that the largest hammer energy will not be required across the entire Wind Farm. Where possible the piling programme will determine what hammer energies are most likely to be used at specific locations in advance of any piling commencing, which will allow the development of a piling programme that has measures embedded within it to reduce the effects on marine mammals when compared to the worst case scenario presented in the Original ES and ES Addendum. This may include measures such as the spatial phasing of piling across the Wind Farm to reduce effects on the more sensitive parts of the Moray Firth during certain times of the year. As the detailed geotechnical information is not yet

available, the specific measures which will be used cannot be defined. However, BOWL will continue discussions with Marine Scotland and relevant consultees in order to devise a piling strategy with the aim of mitigating certain effects where possible.

Table 4.11: Summary of Potential Effects of the Wind Farm Alone on the Integrity of the Moray Firth SAC Relating to the Conservation Objectives

Issues Relating to the Moray Firth Conservation Objectives	Effect on Integrity of the SAC	Evidence Base	Confidence in Predictions ³
Will the proposal cause any deterioration to habitats within the Moray Firth SAC which support bottlenose dolphin?	No deterioration of habitats predicted and therefore no effect on site integrity.	Sections 9.5, 21.5, 10.4 and 22.5 of the Original ES and Sections 9.6 and 10.6 of the ES Addendum.	Certain
Will it affect the extent or distribution of any of these habitats in the SAC?	No effect on the extent or distribution of habitats predicted and therefore no effect on site integrity.	Sections 9.5, 21.5, 10.4 and 22.5 of the Original ES and Sections 9.6 and 10.6 of the ES Addendum.	Certain
Will it affect the structure and function of these habitats or any of their supporting processes?	No effect on the structure and function of habitats predicted and therefore no effect on site integrity.	Sections 9.5, 21.5, 10.4 and 22.5 of the Original ES and Sections 9.6 and 10.6 of the ES Addendum.	Certain
Will the proposal cause significant disturbance to bottlenose dolphin while they are in the SAC, and will it cause any change to their distribution within the site?	No disturbance to bottlenose dolphin within the SAC boundary and therefore no effect on site integrity.	Annex 7A: Wind Farm Underwater Noise Technical Report of the Original ES.	Probable
Will the proposal cause significant disturbance to bottlenose dolphin while they are out with the SAC such that the viability of this SAC population is affected?	Potential for short to medium-term disturbance to a small proportion of the bottlenose dolphin population during the two to three year piling phase but no key foraging areas affected by Wind Farm alone and not predicted to lead to an effect on site integrity.	Annex 7A: Wind Farm Underwater Noise Technical Report of the Original ES and Section 6.6 of the ES Addendum.	Probable
Will the proposal in any way affect the population viability of the bottlenose dolphins of the Moray Firth SAC?	Based on the precautionary assumptions adopted in this assessment and the results of the population model, long-term direct or indirect adverse effects on the viability of the population are not predicted and consequently no long-term adverse effect on the integrity of the European site is predicted.	Annex 7A: Wind Farm Underwater Noise Technical Report and Section 12: Wind Farm Marine Mammals of the Original ES and Section 6.6 of the ES Addendum.	Probable
The potential effects arising from piling noise during construction of the Project alone were assessed against the Conservation Objectives of the SAC, and, based on the evidence presented here, there is considered to be no adverse effect on the integrity of the SAC.			

³ Following the IEEM (2010) guidelines this is the confidence that the effect will occur as predicted based on a four-point scale: 1) Certain/near-probable (probability estimated as 95% or higher); 2) Probable (probability 50% or higher); 3) unlikely (probability above 5% but less than 50%); 4) Extremely unlikely (probability less than 5%).

Table 4.12: Summary of Potential In-Combination Effects of the Wind Farm and the Moray Firth Round 3 Zone on the Integrity of the Moray Firth SAC Relating to the Conservation Objectives

Issues Relating to the Moray Firth Conservation Objectives	Potential Effect on Integrity of the SAC	Evidence Base	Confidence in Predictions ³
Will the proposal cause any deterioration to habitats within the Moray Firth SAC which support bottlenose dolphin?	No deterioration of habitats predicted and therefore no effect on site integrity.	Sections 9.7 and 10.9 of the Original ES and Sections 9.8 and 10.8 of the ES Addendum.	Certain
Will it affect the extent or distribution of any of these habitats in the SAC?	No effect on the extent or distribution of habitats predicted and therefore no effect on site integrity.	Sections 9.7 and 10.9 of the Original ES and Sections 9.8 and 10.8 of the ES Addendum.	Certain
Will it affect the structure and function of these habitats or any of their supporting processes?	No effect on the structure and function of habitats predicted and therefore no effect on site integrity.	Sections 9.7 and 10.9 of the Original ES and Sections 9.8 and 10.8 of the ES Addendum.	Certain
Will the proposal cause significant disturbance to bottlenose dolphin while they are in the SAC, and will it cause any change to their distribution within the site?	No disturbance to bottlenose dolphin within the SAC boundary and therefore no effect on site integrity.	Annex 7A: Wind Farm Underwater Noise Technical Report of the Original ES.	Probable
Will the proposal cause significant disturbance to bottlenose dolphin while they are out with the SAC such that the viability of this SAC population is affected?	Potential for medium-term disturbance to a small proportion of the bottlenose dolphin population over two to seven years, depending on the piling scenario. Key foraging areas in Spey Bay may be affected, however, assuming that feeding behaviour (and consequently fitness) returns to normal following cessation of the piling activities, it is likely that females within the population will continue to reproduce, therefore long-term effects are not predicted. Therefore, the effect of in-combination noise from the Wind Farm and Moray Firth Round 3 Zone is not predicted to lead to an effect on site integrity.	Annex 7A: Wind Farm Underwater Noise Technical Report of the Original ES and Section 6.9 of the ES Addendum.	Probable
Will the proposal in any way affect the population viability of the bottlenose dolphins of the Moray Firth SAC?	Based on the precautionary assumptions adopted in this assessment and the results of the population model, long-term direct or indirect adverse effects on the viability of the population are not predicted and consequently no long-term adverse effect on the integrity of the European site is predicted.	Annex 7A: Wind Farm Underwater Noise Technical Report and Section 12: Wind Farm Marine Mammals of the Original ES and Section 6.9 of the ES Addendum.	Probable
The potential effects arising from piling noise during construction of the Project in-combination with the Moray Firth Round 3 Zone development were assessed against the Conservation Objectives of the SAC and, based on the evidence presented here, there is considered to be no adverse effect on the integrity of the SAC.			

4.4.4 SUMMARY OF EFFECTS ON THE DORNOCH FIRTH AND MORRICH MORE SAC

323. The assessment concluded that there are likely to be short to medium-term (up to three years) adverse effects from the Wind Farm piling activities on harbour seals due to the potential for injury or disturbance to individuals from the SAC out with the SAC boundary over a large area of their preferred habitat within the Moray Firth (Table 4.13). However, the harbour seal framework model showed that even with this short to medium-term adverse effect on the harbour seals, the population is predict to recover. The potential effects arising from piling noise during construction of the Wind Farm alone were assessed against the Conservation Objectives of the SAC and based on the evidence presented here there is considered to be no long-term adverse effect on the integrity of the European site (Table 4.13).
324. Similarly, this Report to inform an Appropriate Assessment also concludes that long-term effects on the viability and distribution of the harbour seal population as a result of non-piling related construction and operational effects are also not predicted to adversely affect the Conservation Objectives of harbour seal within, or out with, the Dornoch Firth and Morrich More SAC. Therefore, based on the evidence presented here relating to these effects, no long-term adverse effects are predicted on the integrity of the European site (Table 4.13).
325. In terms of in-combination effects with the Moray Firth Round 3 Zone EDA, the information presented here shows that there is likely to be a short to medium-term (two to seven years) effect of piling noise on harbour seals which could lead to injury or disturbance over large area of preferred habitat within the Moray Firth. There is potential for larger numbers of harbour seals to be affected by injury than for the Wind Farm site alone due to the greater area affected at any one time. Although there is potential for effects on the population in the medium-term, the harbour seal population model showed that the population will recover within two years. The potential effects arising from piling noise during construction of the Wind Farm in-combination with construction at Moray Firth Round 3 Zone were assessed against the Conservation Objectives of the SAC and based on the evidence presented here there is considered to be no long-term adverse effect on the integrity of the SAC (Table 4.14).
326. The in-combination effects arising from non-piling related effects are also not predicted to result in any long-term adverse effect on the integrity of the Dornoch Firth and Morrich More SAC (Table 4.14)
327. This Report on the effects of the Wind Farm (both alone and in combination with other plans and projects) is provided to inform the Scottish Ministers' (acting through Marine Scotland) Appropriate Assessment of the implications of the Wind Farm on the identified SACs in view of the sites' Conservation Objectives. This Report is based on current best scientific understanding of the issues. Uncertainties have been addressed by adopting a precautionary approach to each stage of the assessment and by carrying out population modelling to investigate possible long-term effects. It should be noted that the assessment is based on a worst case 'Rochdale envelope' scenario.

4.4.4.1 *Mitigation*

328. Mitigation proposed previously (4.4.3.1) to reduce the noise effect on bottlenose dolphin will also be useful in mitigating any short-term effects on harbour seals.

Table 4.13: Summary of Potential Effects of the Wind Farm Alone on the Integrity of the Dornoch Firth and Morrich More SAC Relating to the Conservation Objectives

Issues Relating to the Dornoch Firth and Morrich More Conservation Objectives	Potential Effect on Integrity of the SAC	Evidence Base	Confidence in Predictions ²
Will the proposal cause any deterioration to habitats within the Dornoch Firth and Morrich More SAC which support harbour seals?	No deterioration of habitats predicted and therefore no effect on site integrity	Sections 9.5, 21.5, 10.4 and 22.5 of the Original ES and Sections 9.6 and 10.6 of the ES Addendum.	Certain
Will it affect the extent or distribution of any of these habitats in the SAC?	No effect on the extent or distribution of habitats predicted and therefore no effect on site integrity	Sections 9.5, 21.5, 10.4 and 22.5 of the Original ES and Sections 9.6 and 10.6 of the ES Addendum.	Certain
Will it affect the structure and function of these habitats or any of their supporting processes?	No effect on the structure and function of habitats predicted and therefore no effect on site integrity	Sections 9.5, 21.5, 10.4 and 22.5 of the Original ES and Sections 9.6 and 10.6 of the ES Addendum.	Certain
Will the proposal cause significant disturbance to harbour seals while they are in the SAC, and will it cause any change to their distribution within the site?	No disturbance to harbour seal within the SAC boundary and therefore no effect on site integrity	Annex 7A: Wind Farm Underwater Noise Technical Report of the Original ES.	Probable
Will the proposal cause significant disturbance to harbour seals while they are out with the SAC such that the viability of this SAC population is affected?	Adverse effect from injury/disturbance of harbour seals due to piling noise in the short to medium-term (two to three years). The population is predicted to fully recover within 2 following cessation of the piling years and no long-term effects are predicted therefore no effect on site integrity.	Annex 7A: Wind Farm Underwater Noise Technical Report of the Original ES and Section 6.6 of the ES Addendum.	Probable
Will the proposal in any way affect the population viability of the harbour seals of the Dornoch Firth and Morrich More SAC?	The harbour seal population model did not predict a long-term effect on the viability of the harbour seal population arising from piling noise. Population recovery is predicted to occur within 2 years following cessation of the piling. Therefore no long-term adverse effects on site integrity are predicted.	Annex 7A: Wind Farm Underwater Noise Technical Report and Section 12: Wind Farm Marine Mammals of the Original ES and Section 6.9 of the ES Addendum.	Probable
The potential effects arising from piling noise during construction of the Project alone were assessed against the Conservation Objectives of the SAC and, based on the evidence presented here, there is considered to be no effect on the integrity of the SAC			

Table 4.14: Summary of Potential Effects of the Wind Farm In-Combination with the Moray Firth Round 3 Zone on the Integrity of the Dornoch Firth and Morrich More SAC Relating to the Conservation Objectives

Issues Relating to the Dornoch Firth and Morrich More Conservation Objectives	Potential Effect on Integrity of the SAC	Evidence Base	Confidence in Predictions ²
Will the proposal cause any deterioration to habitats within the Dornoch Firth and Morrich More SAC which support harbour seals?	No deterioration of habitats predicted and therefore no effect on site integrity	Sections 9.7 and 10.9 of the Original ES and Sections 9.8 and 10.8 of the ES Addendum.	Certain
Will it affect the extent or distribution of any of these habitats in the SAC?	No effect on the extent or distribution of habitats predicted and therefore no effect on site integrity	Sections 9.7 and 10.9 of the Original ES and Sections 9.8 and 10.8 of the ES Addendum.	Certain
Will it affect the structure and function of these habitats or any of their supporting processes?	No effect on the structure and function of habitats predicted and therefore no effect on site integrity	Sections 9.7 and 10.9 of the Original ES and Sections 9.8 and 10.8 of the ES Addendum.	Certain
Will the proposal cause significant disturbance to harbour seals while they are in the SAC, and will it cause any change to their distribution within the site?	No disturbance to harbour seal within the SAC boundary and therefore no effect on site integrity	Annex 7A: Wind Farm Underwater Noise Technical Report of the Original ES.	Probable
Will the proposal cause significant disturbance to harbour seals while they are out with the SAC such that the viability of this SAC population is affected?	Temporary and reversible adverse effect from injury/disturbance of harbour seals due to piling noise in the medium-term (two to seven years) to a large proportion of the harbour seal population out with the SAC boundary. Based on the evidence from the harbour seal population model, the population will recover with no long-term effect predicted. Consequently no long-term adverse effect on the integrity of the European site is predicted	Annex 7A: Wind Farm Underwater Noise Technical Report of the Original ES and Section 6.9 of the ES Addendum.	Probable
Will the proposal in any way affect the population viability of the harbour seals of the Dornoch Firth and Morrich More SAC?	The harbour seal population model did not predict a long-term effect on the viability of the harbour seal population arising from piling noise. Therefore, no long-term adverse effects on site integrity are predicted.	Annex 7A: Wind Farm Underwater Noise Technical Report and Section 12: Wind Farm Marine Mammals of the Original ES and Section 6.9 of the ES Addendum.	Probable
The potential effects arising from piling noise during construction of the Project in-combination with the Moray Firth Round 3 Zone development were assessed against the Conservation Objectives of the SAC and, based on the evidence presented here, there is considered to be no adverse effect on the integrity of the SAC.			

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5 FISH AND SHELLFISH ECOLOGY

5.1 NATURA 2000 SITES AND QUALIFYING INTEREST FEATURES

360. SNH and JNCC have provided advice on SACs considered to have the potential for connectivity with the Wind Farm and OfTW and so for which they considered HRA was required (SNH/JNCC Scoping Advice, 14 May 2010). Within the Original ES and the ES Addendum, effects on fish and shellfish have been assessed by considering the worst case scenarios associated with the construction, operation and decommissioning activities of the Wind Farm and OfTW and these are presented in Sections 11: Wind Farm Fish and Shellfish Ecology and 23: OfTW Fish and Shellfish Ecology of the Original ES respectively, and Section 5: Fish and Shellfish Ecology of the ES Addendum.
361. There were six designated sites identified by SNH for the Wind Farm and OfTW assessments which need to be considered in this Report, these are:
- Berriedale and Langwell Waters SAC;
 - River Evelix SAC;
 - River Moriston SAC;
 - River Oykel SAC;
 - River Spey SAC; and,
 - River Thurso SAC.

5.2 CONSERVATION OBJECTIVES

362. The Conservation Objectives for each of the SACs described above (in relation to fish and shellfish species) are as follows:
- *“To avoid deterioration of the habitats of the qualifying species (listed below) 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 (FCS) for the qualifying interest.”*
 - *“To ensure for the qualifying species that the following are established then maintained in the long-term:*
 - *Population of the species as a viable component of the site;*
 - *Distribution of the species within the site;*
 - *Distribution and extent of habitats supporting the species;*
 - *Structure, function and supporting processes of habitats supporting the species;*
 - *No significant disturbance of the species;*
 - *Distribution and viability of freshwater pearl mussel host species;*
 - *Structure, function and supporting processes of habitats supporting freshwater pearl mussel host species.”*
363. The ‘favourable conservation status’ to which the site must appropriately contribute refers to the population of the qualifying species as a whole within the UK and is defined in Article 1 (i) as: *“population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and the natural range of the species is neither being reduced nor is likely to be*

reduced for the foreseeable future, and there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis”.

364. It is clear from the Conservation Objectives and definition of favourable conservation status that the aim of the HRA must be to assess long-term effects on SAC integrity (although noting that short- and medium-term effects can also be important in contributing to the long-term viability of the SAC).

5.3 SCREENING - IDENTIFICATION OF LIKELY SIGNIFICANT EFFECTS

365. This section of the Report considers the potential for LSE to occur on SACs and their qualifying features in relation to fish and shellfish. To determine whether the Wind Farm would result in LSE it was necessary to identify potential effects and subsequent effects on the qualifying features and designated sites in light of the site's Conservation Objectives. LSE screening was carried out on the basis of effects identified at an early stage in the assessment process, taking account of SNH, Marine Scotland and other consultees' views (some of which were expressed during EIA Scoping).

366. Screening for LSE has been carried out on the basis of effects identified at an early stage in the assessment process, taking account of SNH, Marine Scotland and other consultees' views (some of which were expressed during EIA Scoping). Based on the information available at this early Project stage, the following effects were considered to have the potential to result in a LSE as a result of the Amended Project, alone or in-combination:

- Disturbance associated with construction noise;
- Disturbance associated with Electromagnetic Fields (EMFs);
- Disturbance associated with Suspended Sediment Concentration (SSC);
- Disturbance associated with operational noise; and
- Disturbance associated with changes to fishing activity.

367. As a result, the following Conservation Objectives are of relevance for appraisal of the effects on the integrity of SACs:

- *“To avoid 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 (FCS) for the qualifying interest.” and*
- *“To ensure for the qualifying species that the following are established then maintained in the long-term:*
 - *Population of the species as a viable component of the site;*
 - *Distribution and extent of habitats supporting the species;*
 - *Structure, function and supporting processes of habitats supporting the species;*
 - *No significant disturbance of the species;*
 - *Distribution and viability of freshwater pearl mussel host species.*

368. A summary of these SACs is given in Table 5.1 followed by a full description of the citation features. The locations of the SACs are displayed on Figures 1.1b and 1.1c, labelled with the following reference numbers:

- Berriedale and Langwell: 63;
- River Evelix: 35;
- River Morriston (no number as outwith 100 km radius search area);
- River Oykel: 32;
- River Spey: 52; and
- River Thurso: 20.

Table 5.1: Summary of Likely Significant Effects

SAC	Qualifying Features	Potential Effects	Wind Farm LSE	LSE In-combination	Proposed Generic Mitigation Measures
Berriedale and Langwell Waters	Atlantic salmon	Disturbance associated with construction noise	Potential for Likely Significant Effects	Potential for Likely Significant Effects	Use of soft-start and monitored zone If concurrent piling operations are undertaken, vessels will operate at no more than 5 km from each other. The purpose of this will be to reduce the potential area of ensonification from that presented in the worst case, and the use of two vessels should also decrease the installation programme (see Section 4.4.3.1)
River Evelix	Freshwater pearl mussel	Disturbance associated with EMFs			
River Moriston	Freshwater pearl mussel Atlantic Salmon	Disturbance associated with increased SSC			
River Oykel	Freshwater pearl mussel	Disturbance associated with operational noise			
River Spey	Freshwater Pearl Mussel Atlantic salmon Sea Lamprey	Disturbance associated with changes to fishing activity			
River Thurso	Atlantic Salmon				

369. Taking account of the information available at the Scoping stage, and the information outlined above together with the Conservation Objectives relevant to the SACs under assessment, the potential for LSE on Atlantic salmon, freshwater pearl mussel and sea lamprey was acknowledged, and information to inform an Appropriate Assessment is provided for each of these in Section 5.4, where the effects are discussed in relation to the Conservation Objectives of the qualifying features. Section 5.4 considers both the effects of the Amended Project alone, and the in-combination effects with other projects where there is potential for LSE.

5.4 APPRAISAL OF EFFECTS ON CONSERVATION OBJECTIVES AND INTEGRITY OF SACs

370. As outlined in Table 5.1 and in Sections 11: Wind Farm Fish and Shellfish Ecology and 23: OfTW Fish and Shellfish Ecology of the Original ES, and in Section 5: Fish and Shellfish Ecology of the ES Addendum, there will be some level of noise disturbance associated with construction noise on salmon and sea lamprey. Similarly some level of disturbance associated with EMFs may occur on these species. In the particular case of freshwater pearl mussel indirect effects may occur whether the established distribution and viability of its host species (salmon) is maintained in the long-term.
371. As described in Section 11: Wind Farm Fish and Shellfish Ecology, of the Original ES and further recognised thorough Section 5: Fish and Shellfish Ecology of the ES Addendum, there is limited information available to date in relation to the migratory routes taken, and the use that Atlantic salmon from different rivers, including those designated as SACs may make of the Moray Firth area, including the area of the Wind Farm, and the OfTW. This is also the case for the sea lamprey for which little is known in relation to the use that they make of the marine environment (Annex 11A: Fish and Shellfish of the Original ES). As a result, and taking a precautionary approach, a conservative assumption has had to be made that salmon from all the SAC populations requiring assessment may transit the area of the Wind Farm and OfTW during migration and feeding. Similarly, the assumption has been made that the River Spey SAC sea lamprey population transit the area of the Wind Farm and the OfTW (both after leaving the river during the early stages of their marine migration and prior to river entry for spawning). As no apportioning of the SAC populations has been undertaken as part of this assessment, the findings of the assessment presented in the Original ES and ES Addendum are directly relevant here.
372. In the case of freshwater pearl mussel, as they only inhabit the rivers, they will not be directly affected by the construction/decommissioning and operational phases of the Wind Farm and OfTW. During their first year, however, this species lives in the gills of Atlantic salmon and sea trout and therefore may be indirectly affected if the Wind Farm and OfTW result in significant effects on their host species. For assessment of LSE on freshwater pearl mussel, the conservative assumption has been made that the LSE identified for salmon will also apply to freshwater pearl mussel. The identified recommended Appropriate Assessment relates to the

potential disturbance to qualifying features, whether as a result of disturbance associated with construction noise and/or EMFs. There will be no effect on the habitat of the qualifying features, whether within the SACs or the wider marine environment.

5.4.1 ATLANTIC SALMON

373. There are no Atlantic salmon SACs located immediately adjacent to the Wind Farm or the OfTW. As a result, the habitat of the SACs where salmon is a qualifying feature (Berriedale & Langwell Waters, River Moriston, River Spey and River Thurso) will not be subject to direct deterioration derived from the construction/decommissioning and operational phases of the Wind Farm and the OfTW.

374. Effects on Atlantic salmon habitat could however occur in the marine environment. As described in Section 10: Wind Farm Benthic Ecology and Section 22; OfTW Benthic Ecology of the Original ES, however, no significant effects on benthic habitats are identified in the Original ES, with the exception of the MoeVen habitat as a result of its elevated importance (although the high ability of this community to recover rapidly is noted), as a result of the construction/decommissioning and operational phases of the Wind Farm, nor the OfTW. Similarly, as detailed in Section 5.6.1.1 of the ES Addendum the effect of loss of habitat on salmon has been assessed to be negligible and probable. Introduction of new habitat (and associated changes to the relative distribution of individual fish species and the fish assemblage in general) has been assessed to result in a positive/negative minor and probable effect in the ES Addendum.

375. The information provided above indicates that the habitat of salmon (whether at sea or in the relevant SACs) will not be deteriorated. Atlantic salmon may however be disturbed during the construction/decommissioning and operational phases of the Wind Farm and OfTW as a result of the following potential effects :

- Increased SSCs and sediment re-deposition;
- Construction noise;
- EMFs;
- Operational noise; and
- Changes to fishing activity.

376. As such, the following Conservation Objectives are considered to have the potential to receive effects:

- To avoid 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 (FCS) for the qualifying interest; and
- To ensure for the qualifying species that the following are established then maintained in the long-term:
 - Population of the species as a viable component of the site;
 - Structure, function and supporting processes of habitats supporting the species;
 - No significant disturbance of the species; and

- Distribution and viability of freshwater pearl mussel host species.

377. A summary of the assessment in relation to salmon associated with the effects listed above is given in Table 5.2.

Table 5.2: Summary of Wind Farm and OfTW Assessment on Salmon

Potential Effect	Wind Farm	OfTW	In-Combination Effects
Increased SSCs and sediment re-deposition	Negligible and Probable	Negative, Minor and Probable for the River Spey; Negligible and Probable for the rest of rivers	Negative and Minor
Construction noise	Negative, Minor and Probable	Negligible and Probable	Negative and Minor to Moderate
EMFs	Negative, Minor and Probable	Negative, Minor and Probable	Negative and Minor
Operational Noise	Negative, Minor and Unlikely	n/a	Negative and Minor
Changes to Fishing Activity	Negligible	n/a	Below Moderate

378. These potential effects are discussed in further detail below.

5.4.1.1 Increased SSC and Sediment Re-Deposition

379. The effects of SSC and sediment re-deposition as a result of the Project have been assessed within the Original ES Sections 11.4 and 23.4, and further information in relation to SSC is provided in Section 5.6 of the ES Addendum. These are assessed as being not significant in all instances, and are of a magnitude that they are considered to not affect the integrity of any of the SACs under consideration.

380. The HDD at landfall will be undertaken from land to sea, reducing the number of vessels required for a sea to land HDD operation. This will also minimise any increases in SSC associated with the operation. The potential effects of the OfTW at the landfall point on the River Spey SAC, namely SSC and habitat disturbance from HDD will be negligible and drilling noise and vibration will be at low levels above ambient noise and of short duration so will not adversely affect the Conservation Objectives or integrity of this SAC.

5.4.1.2 Construction Noise

381. For the assessment of construction noise, the short-term and intermittent nature of piling activity should be noted when considering the potential disturbance to salmon. The worst case scenario presented assumes a maximum piling duration of 5 hours per pile. Taking that no simultaneous piling takes place and construction occurs over 3 years, active piling will constitute approximately 21% of the total construction period. Under the assumption that piling takes place simultaneously at two locations within the Wind Farm and the construction period is reduced to two years the total active piling duration will represent between 16% and 32% of the total construction period (subject to the degree of simultaneous piling that takes place). It is recognised that piling noise in the adjacent Moray Firth Round 3 Zone

will potentially increase the duration and the area being disturbed by construction noise. Taking the short-term and intermittent nature of piling activity, however, the degree of interaction with salmon and the potential disturbance resulting from construction noise will be small. As such, salmon will only be potentially disturbed on an individual level rather than population level and on a temporary rather than long-term basis.

5.4.1.3 EMFs

382. In the particular case of EMFs, whilst the potential effect will last during the life of the Amended Project, potential disturbance to salmon associated with EMFs will only occur on a localised short-term basis (i.e. only when in the vicinity the cables). The linear nature of cables is noted in this context. The information provided in Sections 11.4 and 23.4 of the Original ES indicates that whilst there is a gap in the current knowledge in relation to the level of EMFs to which salmon may respond, the magnetic fields produced by the cables will be well below the earth's magnetic field. Cable burial and protection where feasible would ensure that these species are not in close proximity to the highest EMFs. The degree of interaction between salmon and the potential disturbance resulting from the EMFs generated by the cables will be necessarily small. As such salmon will only be potentially disturbed on an individual level rather than population level and on a temporary rather than long-term basis.

5.4.1.4 Operational Noise

383. The effects of operational noise as a result of the Amended Project have been assessed within the Original ES (Sections 11.4 and 23.4), and further information in relation to SSC is provided in Section 5.6 of the ES Addendum. These are assessed as being not significant in all instances, and are of a magnitude that they are considered to not affect the integrity of any of the SACs under consideration.

5.4.1.5 Changes to Fishing Activity

384. The effects of changes to fishing activity as a result of the Amended Project have been assessed within the Original ES (Sections 11.4 and 23.4), and further information in relation to SSC is provided in Section 5.6 of the ES Addendum. These are assessed as being not significant in all instances, and are of a magnitude that they are considered to not affect the integrity of any of the SACs under consideration.

5.4.1.6 Conclusion

385. On the basis of the assessment, it is considered that the Conservation Objectives for the SACs under consideration will not be undermined as a result of the Amended Project (both alone and in-combination). Consequently, this assessment concludes that the Amended Project (alone or in-combination) will not adversely affect the integrity of the SACs under consideration, which are:

- Berriedale and Langwell Waters SAC;
- River Evelix SAC;
- River Moriston SAC;

- River Oykel SAC;
- River Spey SAC; and,
- River Thurso SAC.

5.4.2 FRESHWATER PEARL MUSSEL

386. As identified in Section 5.3 and Table 5.1, for assessment of LSE on freshwater pearl mussel as a qualifying feature of relevant SACs (River Evelix, River Moriston, River Oykel and River Spey), the conservative assumption has been made that the LSE identified for salmon also apply to freshwater pearl mussel i.e. noise and EMF. These are discussed below.

5.4.2.1 Construction Noise

387. In respect of freshwater pearl mussel, given that the established distribution and viability of its host species will be maintained in the long-term, indirect effects associated with construction noise are not expected.

5.4.2.2 EMFs

388. In respect of freshwater pearl mussel, given that the established distribution and viability of its host species will be maintained in the long-term, indirect effects associated with EMFs are not expected.

5.4.2.3 Conclusion

389. On the basis of the assessment, it is considered that the Conservation Objectives for the SACs under consideration will not be undermined as a result of the Amended Project (both alone and in-combination). Consequently, this assessment concludes that the Amended Project (alone or in-combination) will not adversely affect the integrity of the SACs under consideration, which are:

- Berriedale and Langwell Waters SAC;
- River Evelix SAC;
- River Moriston SAC;
- River Oykel SAC;
- River Spey SAC; and
- River Thurso SAC.

5.4.3 SEA LAMPREY

390. Sea lamprey is a qualifying feature in the River Spey SAC, this SAC is not located immediately adjacent to the Wind Farm nor the OfTW and therefore the habitat of the SAC will not be subject to direct deterioration as a result of the construction/decommissioning or operational phases of the Wind Farm and the OfTW.

391. Effects on sea lamprey habitat could however occur in the marine environment. As described in Section 10: Wind Farm Benthic Ecology and Section 22; OfTW Benthic Ecology of the Original ES, however, no significant effects on benthic habitats are identified in the Original ES, with the exception of the MoeVen habitat as a result of its elevated importance (although the high ability of this community to recover rapidly is noted), as a result of the construction/decommissioning and operational

phases of the Wind Farm, nor the OfTW. Similarly, as described in Section 11.4.2.1 of the Original ES, the effect of loss of habitat on sea lamprey was assessed to be negligible and probable. As identified in Section 11.4.2.2 of the Original ES, introduction of new habitat (and associated changes to the relative distribution of individual fish species and the fish assemblage) was assessed to result in a positive/negative, minor and probable effect. The information provided above indicates that the habitat of sea lamprey (whether at sea or in the SAC) will not be deteriorated. As identified in Section 11: Wind Farm Fish and Shellfish Ecology and Section 23: OfTW Fish and Shellfish Ecology of the Original ES, sea lamprey may however be disturbed as a result of the construction/operational and decommissioning phases of the Wind Farm and OfTW. Disturbance to sea lamprey may arise from in association with the following potential effects:

- Increased SSCs and sediment re-deposition;
- Construction noise;
- EMFs;
- Operational noise; and
- Changes to fishing activity.

392. A summary of the effect assessment carried out in Section 11: Wind Farm Fish and Shellfish Ecology and Section 23: OfTW Fish and Shellfish Ecology, of the Original ES in relation to sea lamprey is given in Table 5.3.

Table 5.3: Summary of Wind Farm and OfTW Assessment on Sea Lamprey

Potential Effect	Wind Farm	OfTW	In-Combination Effects
Increased SSCs	Negligible and Probable	Negative, Minor and Probable for the Spey Negligible and Probable in the rest of rivers	Negative and Minor
Construction noise	Negative and Minor *	Negligible and Probable	
EMFs	Negative, Minor and Unlikely	Negative, minor and unlikely	Negative and Minor
Operational Noise	Negative, Minor and Unlikely	n/a	Negative and Minor
Changes to Fishing Activity	Negligible and Probable	n/a	Negligible

* Based on a qualitative assessment where no probabilities were assigned as species specific noise modelling was not undertaken nor an appropriate surrogate defined

393. As shown above, no effects above minor were identified on sea lamprey in the Original ES or ES Addendum. As for salmon, however, there is also uncertainty and a lack of species specific information in relation to the exact use that they may make of the area of the Wind Farm and the OfTW. Similarly, uncertainty exists in terms of the implications of behavioural effects triggered by construction noise and EMFs (Section 11: Wind Farm Fish and Shellfish Ecology and Section 23: OfTW Fish and Shellfish Ecology).

5.4.3.1 Increased SSC and Sediment Re-Deposition

394. The effects of SSC as a result of the Project have been assessed within the Original ES (Sections 11: Wind Farm Fish and Shellfish Ecology and 23: OfTW Fish and Shellfish Ecology), and further information in relation to SSC is provided in Section

5: Fish and Shellfish Ecology of the ES Addendum. These are assessed as being not significant in all instances, and are of a magnitude that they are considered to not affect the integrity of any of the SACs under consideration.

395. The HDD at landfall will be undertaken from land to sea, reducing the number of vessels required for a sea to land HDD operation. This will also minimise any increases in SSC associated with the operation. The potential effects of the OfTW at the landfall point on the River Spey SAC, namely SSC and habitat disturbance from HDD will be negligible and drilling noise and vibration will be at low levels above ambient noise and of short duration so will not adversely affect the Conservation Objectives or integrity of this SAC.

5.4.3.2 Construction Noise

396. For the assessment of construction noise, the short-term and intermittent nature of piling activity should be noted when considering the potential disturbance to sea lamprey. The worst case scenario presented assumes a maximum piling duration of 5 hours per pile. Taking that no simultaneous piling takes place and construction occurs over 3 years, active piling will constitute approximately 21% of the total construction period. Under the assumption that piling takes place simultaneously at two locations within the Wind Farm and the construction period is reduced to two years the total active piling duration will represent between 16% and 32% of the total construction period (subject to the degree of simultaneous piling that takes place). It is recognised that piling noise in the adjacent Moray Firth Round 3 Zone will potentially increase the duration and the area being disturbed by construction noise. Taking the short-term and intermittent nature of piling activity, however, the degree of interaction between sea lamprey and the potential disturbance resulting from construction noise will be necessarily small. As such, sea lamprey will only be potentially disturbed on an individual level rather than population level and on a temporary rather than long-term basis.

5.4.3.3 EMFs

397. In the particular case of EMFs, whilst the potential effect will last during the life of the project, potential disturbance to sea lamprey species associated with EMFs will only occur on a localised short-term basis (i.e. only when in the vicinity the cables). The linear nature of cables is noted in this context. The information provided in Section 11: Wind Farm Fish and Shellfish and Section 23: OfTW and Shellfish of the Original ES indicates that whilst there is a gap in the current knowledge in relation to the level of EMFs to which sea lamprey may respond, the magnetic fields produced by the cables will be well below the earth's magnetic field. Cable burial and protection would ensure that these species are not in close proximity to the highest EMFs. The degree of interaction between sea lamprey and the potential disturbance resulting from the EMFs generated by the cables will be necessarily small. As such sea lamprey will only be potentially disturbed on an individual level rather than population level and on a temporary rather than long-term basis.

5.4.3.4 Operational Noise

398. The effects of operational noise as a result of the Project have been assessed within the Original ES (Sections 11: Wind Farm Fish and Shellfish Ecology and 23: OfTW: Fish and Shellfish Ecology), and further information in relation to SSC is provided in Section 5: Fish and Shellfish Ecology of the ES Addendum. These are assessed as being not significant in all instances, and are of a magnitude that they are considered to not affect the integrity of any of the SACs under consideration.

5.4.3.5 Changes to Fishing Activity

399. The effects of changes to fishing activity as a result of the Project have been assessed within the Original ES (Sections 11: Wind Farm Fish and Shellfish Ecology and 23: OfTW Fish and Shellfish Ecology), and further information in relation to SSC is provided in Section 5: Fish and Shellfish Ecology of the ES Addendum. These are assessed as being not significant in all instances, and are of a magnitude that they are considered to not affect the integrity of any of the SACs under consideration.

5.4.3.6 Conclusion

400. On the basis of the assessment, it is considered that the Conservation Objectives for the SACs under consideration will not be undermined as a result of the Amended Project (both alone and in-combination). Consequently, this assessment concludes that the Amended Project (alone or in-combination) will not adversely affect the integrity of the SACs under consideration.

6 PHYSICAL PROCESSES AND GEOMORPHOLOGY

6.1 NATURA 2000 SITES AND QUALIFYING INTEREST FEATURES

401. SNH and JNCC have provided advice on SACs considered to have the potential for connectivity with the Wind Farm and OfTW and so for which they considered HRA was required (SNH/JNCC Scoping Advice, 14 May 2010). Within the Original ES and the ES Addendum, effects on physical processes and geomorphology have been assessed by considering the worst case scenarios associated with the construction, operation and decommissioning activities of the Wind Farm and OfTW and these are presented in Sections 9: Wind Farm Physical Processes and Geomorphology and 21: OfTW Physical Processes and Geomorphology of the Original ES respectively, and Section 9: Physical Processes and Geomorphology of the ES Addendum.
402. Four designated sites with the potential for connectivity have been identified:
- The East Caithness Cliffs SAC (Figure 1.1a-c, reference no. 22);
 - Moray Firth SAC (Figure 1.1a-c, reference no. 34);
 - Dornoch Firth and Morrich More SAC (Figure 1.1a-c, reference no. 31); and
 - Culbin Bar SAC (Figure 1.1a-c, reference no. 46).
403. This section of the Report focuses on the potential effects on the qualifying interest habitats of the designated sites that have been considered in the EIA. The sites which qualify as Natura 2000 sites by virtue of faunal species are considered in Section 3: Ornithology, Section 4: Marine Mammals and Section 5: Fish and Shellfish Ecology of this Report, and are not considered further in this section. The relevant qualifying features of these designations are given in Table 6 1.

Table 6.1: Qualifying Habitat Features of the Designated Sites Considered in Relation to Physical Processes and Geomorphology

Site Name	Qualifying Features
East Caithness Cliffs SAC	Vegetated Sea Cliffs of the Atlantic and Baltic Coasts
Moray Firth SAC	Subtidal sandbanks
Dornoch Firth and Morrich More SAC	Reefs Subtidal Sandbanks Glasswort and other annuals colonising mud and sand Atlantic salt meadows Estuaries Intertidal mudflats and sandflats Coastal dune heathland Dunes with juniper thickets Lime-deficient dune heathland with crowberry Shifting dunes Dune grassland Humid dune slacks Shifting dunes with marram
Culbin Bar SAC	Atlantic salt meadows (<i>Glauco-Puccinellietalia maritimae</i>) Embryonic shifting dunes Perennial vegetation of stony banks

404. A summary of the baseline conditions for these SACs is provided below.

6.1.1 EAST CAITHNESS CLIFFS SAC

405. Although lacking the extreme exposure of the some of the island sites and Cape Wrath, this stretch of northern Scottish coast provides a diverse range of habitats. Roseroot *Sedum rosea* and Scots lovage *Ligusticum scoticum* grow without any associates in the north of the site, and there are tall herb gullies in more sheltered positions often dominated by meadowsweet *Filipendula ulmaria*. There are two very small patches of perched saltmarsh with saltmarsh rush *Juncus gerardii*, and locally there is also bird-influenced vegetation. Grasslands with many tall herbs are plentiful in ungrazed areas and short herb-rich grasslands and heath occur on the cliff tops. Around Berriedale, the vegetation lacks some of the more maritime components such as thrift *Armeria maritima* and sea plantain *Plantago maritima*, and becomes progressively less maritime southwards, with no maritime heath on the cliff top. Owing to a reduction in maritime influence, the gullies have developed scrub including willow *Salix spp.*, juniper *J. communis*, hazel *Corylus avellana*, hawthorn *Crataegus monogyna* and aspen *Populus tremula*⁴.

6.1.2 MORAY FIRTH SAC

406. The Moray Firth marine SAC encompasses the Beaully / Inverness Firth and the outer reaches of the Dornoch and Cromarty Firths. The boundary of the site extends to the Mean Low Water Mark of Spring Tides. Much of the coastline immediately adjacent to the SAC is characterised by sweeping sandy beaches and dunes that lie within predominantly agricultural land. Cliffs and rocky shores occur where high ground meets the coast. The site extends eastwards to a seaward boundary between the River Helmsdale on the north coast of the Moray Firth and Lossiemouth on the south coast.

407. The first qualifying marine feature are the sandbanks which are slightly covered by sea water all the time and made up of soft sediment types (including sand predominantly in the size range 0.0625 mm to 2 mm). They are typically (but not exclusively) found at depths of less than 20 m below chart datum. Subtidal sandbanks have an important role in maintaining sediment balance, and coastline protection. The distribution of sediments in shallow water is linked to bathymetry and a close correlation exists between increased depth and decreasing grain size, with the exception of fine sand accumulating in the shallow sheltered waters of the inner Firths. Muddy sands and sandy sediments are dominant in the area seaward of the inner Firths.

408. Tide-swept mixed sediments within the site are colonised by distinctive communities of algae and invertebrates, including polychaete worms, bivalves and amphipods. Coarse sublittoral sediments, for example in the Dornoch Firth, have been found to support high numbers of the sand mason, *Lanice conchilega*, the banded wedge-shell, *Donax vittatus*, and clam species. Fine unstable sands off Whiteness, which are more exposed to wave action, contain sparse animal communities that are dominated by bivalves. Within the Cromarty Firth the firm

⁴ Web reference:

<http://jncc.defra.gov.uk/protectedsites/sacselection/sac.asp?EUCode=UK0030143> (accessed 18/05/2012)

and sandy bottom sediments support polychaete worms, with a small sub-community of these worms found within the coarser deposits. Gravel sediments here are also colonised by the horse mussel, *Modiolus modiolus*, dead men's fingers, *Alcyonium digitatum*, hydroids, bryozoans and barnacles. The sediment is finer in the open Moray Firth, 6 km east of the Sutors. At a depth of 20 m, the diversity is less than within the Cromarty Firth, but includes some additional species of molluscs, sea potato, *Echinocardium cordatum*, polychaete worms and amphipods. Pockets of coarse sediment occur in fast currents in the narrows between Chanonry Point and Fort George and these areas contain communities characterised by polychaete worms. Just outside the Inverness Firth at Fort George, the sediment is sandy and dominated by clams. In stable areas of the open coast within the site, the shallow sandy sediments support populations of bivalves, with sea potatoes, *Echinocardium cordatum*, razor shells, *Ensis arcuatus*, and the sabellid polychaete found at depth.

409. Subtidal sandbanks support spawning grounds and nursery areas for juvenile fish species. This productivity in turn becomes an important food source for marine mammals and seabirds such as guillemots, *Uria aalge*, and razorbills, *Alca torda*. The conservation importance of these habitats centres on their intrinsic value based on the biological communities present, together with the predators which are dependent on those communities.
410. The SAC hosts the only resident population of bottlenose dolphins, *Tursiops truncatus*, in the North Sea. Bottlenose dolphins are particularly known to frequent near-shore waters around the Sutors at the entrance to the Cromarty Firth, Chanonry Point and Fort George at the entrance to the Inverness Firth and North and South Kessock at the entrance to the Beaully Firth. Dolphins are also frequently recorded at other localities along the coast, including Findhorn Bay, Speybay, Burghead and Lossiemouth. The shallow sandy sediments within the SAC provide important nursery, feeding or migration areas for fish and these in turn provide important prey species for the dolphins such as salmon, *Salmo salar*, sea trout, *Salmo trutta*, cod, *Gadus morhua*, herring, *Clupea harengus*, mullet, *Mugil cephalus*, eels, *Anguilla anguilla* and squid, *Loligo vulgaris*. The Moray Firth dolphin population is at the extreme northern end of its natural range and therefore subject to stress factors such as low temperatures. Current research estimates that there are around 130 bottlenose dolphins living in the Moray Firth and, due to its small size and relative isolation, the population is vulnerable to both natural and human influences⁵.

6.1.3 DORNOCH FIRTH AND MORRICH MORE SAC

411. Dornoch Firth is the most northerly large, complex estuary in the UK. The estuary is fed by the Kyle of Sutherland and is virtually unaffected by industrial development. There is a complete transition from riverine to fully marine conditions and associated communities. Inland, and in sheltered bays, sediments are generally muddy. Gravelly patches occur in the central section of the Firth.

⁵ Web reference: <http://jncc.defra.gov.uk/protectedsites/sacselection/SAC.asp?EUCode=UK0019808> (accessed 05/05/2013)

Wide sandy beaches dominate the large bays at the mouth of the Firth, and areas of saltmarsh occur around the shores. Sublittoral sediments are predominantly medium sands with a low organic content. The estuary contains extensive areas of mudflats and sandflats that extend in a wide belt along the northern and southern shores and provide a range of environmental conditions. There is a continuous gradient in the physical structure of the flats, from medium-sand beaches on the open coast to stable, fine-sediment mudflats and muddy sands further inland. This results in a high diversity of animal and plant communities supporting polychaetes, oligochaetes, amphipods, gastropods and bivalves. The sheltered bays provide a habitat for communities of algae, eelgrass, *Zostera* spp. and the pioneer saltmarsh plant glasswort *Salicornia* spp.

412. Dornoch Firth and Morrich More have the most extensive area of pioneer glasswort *Salicornia* spp. saltmarsh in the northern part of its UK range in Scotland. They form part of a complete transition from pioneer to upper saltmeadow and include important sand dune habitats. These sites also host Atlantic salt meadows (*Glaucopuccinellietalia maritima*) in the northern part of their UK range. The site supports a wide variety of community types, with the characteristic zonation from pioneer to upper marsh vegetation. At Morrich More the saltmarshes lie adjacent to sand dunes and there are important transitions between these habitats.
413. Dornoch Firth and Morrich More is one of three sites representing embryonic shifting dunes on the east coast of Scotland and is the most northerly example of the habitat type in the SAC series. The lyme-grass, *Leymus arenarius*, dominated dunes front the prograding sections of this site. The process of continued progradation is central to the conservation of this habitat type at this site, which has the largest, most complete area of sand dune in the UK, in part owing to the exceptionally high rate of progradation. This large dune system is physically diverse, with areas of active accretion, areas of marine erosion and areas of internal instability. Dune vegetation has developed on a coastline that has been generally rising relative to sea level in the 7,000 years since the last glaciation. A combination of leaching, stabilisation and the decreased influence of salt water has produced a sequence of dry, stable dune ridges, interspersed with wet dune hollows. There are also well-formed parabolic dunes in one area. All of these formations provide shifting dunes along the shoreline with opportunities for *Ammophila arenaria* to develop. As a result this habitat type is relatively extensive within the site. The vegetation is representative of northern mobile dune vegetation, with *Leymus arenarius* prominent in some stands. The site is largely undisturbed, resulting in a natural habitat structure. An extensive complex fixed dune with herbaceous vegetation system lies in the inner Moray. It consists of a low dune plain which is still developing in its outer part. The dune system consists of a series of ridges with heath and juniper scrub on the older ridges which grade into the fixed dune vegetation of maritime grassland in the mid and outer parts.
414. There is a large area of decalcified fixed dunes with *Empetrum nigrum* vegetation on this site, occurring in a complicated mosaic of acidic fixed dune vegetation types, principally 2150 Atlantic decalcified fixed dunes (*Calluno-Ullicetea*). A combination of leaching, stabilisation and the decreased influence of saltwater has produced a

sequence of dry, stable dune ridges, interspersed with wet dune hollows. Within this complex of habitats there are examples of dune, saltmarsh and transitional communities that include large populations of several northern dune species, such as Baltic rush, *Juncus balticus* with dune heath containing heather, *Calluna vulgaris*, and sand sedge, *Carex arenaria*. This is the most important acidic dune site in Scotland because of its size and the exceptional diversity of habitats within it. Despite some localised industrial development, structure and function are well-conserved at this site and accretion is continuing.

415. Morrich More is one of the largest acidic dune sites in the UK. The sequence of development has resulted in the formation of extensive humid slack communities of an acidic character which lie as parallel hollows between the dune ridges and form part of a complex mosaic of dune habitats. This is the most important acidic dune system in Scotland, owing to its size and the exceptional diversity of the habitats within it. Morrich More is also the most important site in the UK for juniper, *Juniperus spp.* stands on dune. Stands of juniper cover approximately 10 ha, with scattered individuals over a larger area. The juniper is extremely well-developed on the dry ridges and transitions to dune slacks. The best stands occur in grasslands in the southern sector, but prostrate individuals also extend into wet heath and slack habitats within the site.
416. Dornoch Firth and Morrich More consists of an estuarine system with extensive areas of bordering natural habitat including sand dune, woodland and small lochans. The Rivers Evelix and Oykel both feed into the site, providing habitat for the otter, *Lutra lutra*. Dornoch Firth and Morrich More are the only east coast estuarine sites selected for the species in Scotland and a good population of otters is supported. The Dornoch Firth supports a significant proportion of the inner Moray Firth population of the common seal, *Phoca vitulina*. The seals, which utilise sandbars and shores at the mouth of the estuary as haul-out and breeding sites, are the most northerly population to utilise sandbanks. Their numbers represent almost 2% of the UK population⁶.

6.1.4 CULBIN BAR SAC

417. Historically, Culbin Bar in north-east Scotland formed part of the same shingle aggregation as Lower River Spey – Spey Bay to the east. Although sea-level rise has separated the sites, they are still linked, being maintained by the same coastal processes. Culbin Bar and the Lower River Spey – Spey Bay are, individually, the two largest shingle sites in Scotland and together form a shingle complex unique in Scotland. They represent perennial vegetation of stony banks in the northern part of its range in UK. Culbin Bar is 7 km long. It has a series of shingle ridges running parallel to the coast that support the best and richest examples of northern heath on shingle. Dominant species are heather, *Calluna vulgaris*, crowberry, *Empetrum nigrum* and juniper, *Juniperus communis*. The natural westward movement of the bar deposits new ridges for colonisation. Being virtually unaffected by damaging

⁶ Web reference: <http://jncc.defra.gov.uk/protectedsites/sacselection/SAC.asp?EUCODE=UK0019806> (accessed 05/05/2013)

human activities, Culbin Bar is an example of a system with natural structure and function⁷.

6.2 CONSERVATION OBJECTIVES

418. The Conservation Objectives for the East Caithness Cliffs SAC are to avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and 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;*
- *Structure, function and supporting processes of habitats supporting the species; and*
- *No significant disturbance of the species.”*

419. The Conservation Objectives⁸ for the qualifying features of the Moray Firth SAC, the Dornoch Firth and Morrich More SAC and the Culbin Bar SAC are to avoid deterioration of the qualifying habitats thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and to ensure for the qualifying habitats that the following are maintained in the long-term:

- *“Extent of the habitat on site;*
- *Distribution of the habitat within site;*
- *Structure and function of the habitat;*
- *Processes supporting the habitat;*
- *Distribution of typical species of the habitat;*
- *Viability of typical species as components of the habitat; and*
- *No significant disturbance of typical species of the habitat.”*

6.3 SCREENING - IDENTIFICATION OF LIKELY SIGNIFICANT EFFECTS

420. To determine whether the Wind Farm would result in LSE it was necessary to identify potential effects and subsequent effects on the qualifying features and designated sites in light of the site's Conservation Objectives. LSE screening was carried out on the basis of effects identified at an early stage in the assessment process, taking account of SNH, Marine Scotland and other consultees' views (some of which were expressed during EIA Scoping). The effects were assessed in detail in Sections 9: Wind Farm Physical Processes and Geomorphology and 21: OfTW Physical Processes and Geomorphology of the Original ES and Section 9: Physical Processes and Geomorphology of the ES Addendum, but are briefly summarised in the following sections.

⁷ Web reference: <http://jncc.defra.gov.uk/protectedsites/sacselection/sac.asp?EUCode=UK0019807> (accessed 18/05/2012)

⁸ Web reference: <http://gateway.snh.gov.uk/sitelink/index.jsp> (accessed 27/05/13)

6.3.1.1 In-Combination Likely Significant Effects

421. In relation to physical processes, in-combination effects were also specifically identified as a requirement from the Scoping process informing the EIA. Cumulative effects were assessed in detail in Sections 9: Wind Farm Physical Processes and Geomorphology and 21: OfTW Physical Processes and Geomorphology of the Original ES. It is important to note the cumulative assessment provided in the Original ES and ES Addendum is referred to as an in-combination assessment within this Report to ensure compliance with the terminology required.

422. The nature of the in-combination effects that may arise are the same as those identified for the Wind Farm alone. The extent and magnitude of certain cumulative effects (e.g. far field dispersion of sediments in suspension and the effect on waves) are however typically greater when considering multiple developments.

6.3.1.2 Summary of Likely Significant Effects

423. A summary of the identified potential LSE in relation to the Conservation Objectives of the qualifying features in each designated site is provided in Table 6.2.

Table 6.2: Screening Matrix for the Identification of Likely Significant Effects

SAC and Qualifying Feature	Conservation Objectives	Potential Effects	Wind Farm LSE	LSE In-Combination
East Caithness Cliffs (SAC) (Vegetated Sea Cliffs of the Atlantic and Baltic Coasts)	<p>To avoid deterioration of the habitats of the qualifying species 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 interest.</p> <p>To ensure for the qualifying species that the following are established then maintained in the long-term:</p> <ul style="list-style-type: none"> • 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. 	<p>Potential direct effects of the Wind Farm and OfTW on the physical environment (water levels, currents, waves, sedimentary processes) are confined to subtidal and intertidal areas. The qualifying features (vegetated sea cliffs) are located above the high water mark (supralittoral) and, therefore, no direct effects can occur.</p> <p>The cliffs are exposed to the naturally present wave climate, which might indirectly control the long-term morphological state of cliff habitats through erosion and alongshore sediment transport processes. The Wind Farm presents a small obstruction to waves and so has a potential to cause an indirect effect by modifying (reducing the overall energy of) the wave climate and/or wave approach angle at the coastline in this SAC. However, the coastal cliff are rocky and resistant to erosion and so are not considered sensitive to this potential effect.</p>	No Potential for Likely Significant Effects	No Potential for Likely Significant Effects
Moray Firth (SAC) (Subtidal sandbanks)	<p>To avoid deterioration of the habitats of the qualifying species 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</p>	<p>The structure and function of subtidal and intertidal habitats, including its extent and distribution, may be affected by effects associated with the construction or decommissioning phases of the Wind Farm, namely:</p> <ul style="list-style-type: none"> • Increases in suspended sediment concentration (SSC) and • Associated sediment deposition (smothering or change of seabed character). <p>During the operational phase of the Wind Farm, potential effects on the</p>	Potential for Likely Significant Effects	Potential for Likely Significant Effects

SAC and Qualifying Feature	Conservation Objectives	Potential Effects	Wind Farm LSE	LSE In-Combination
	<p>status for the qualifying interest.</p> <p>To ensure for the qualifying species that the following are established then maintained in the long-term:</p> <ul style="list-style-type: none"> • <i>Extent of the habitat on site;</i> • <i>Distribution of the habitat within site;</i> • <i>Structure and function of the habitat;</i> • <i>Processes supporting the habitat;</i> • <i>Distribution of typical species of the habitat;</i> • <i>Viability of typical species as components of the habitat; and</i> • <i>No significant disturbance of typical species of the habitat.</i> 	<p>processes supporting these habitats may arise, namely:</p> <ul style="list-style-type: none"> • Effects on tidal water levels; • Effects on tidal currents; • Effects on wave climate; and • Effects on sediment supply. 		
<p>Dornoch Firth and Morrich More (SAC) (Coastal dune heathland; Dunes with juniper thickets; Lime-deficient dune heathland with crowberry; Shifting dunes; Dune grassland; Humid dune</p>	<p>To avoid deterioration of the habitats of the qualifying species 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 interest.</p> <p>To ensure for the qualifying species that the following are established then maintained in the long-term:</p> <ul style="list-style-type: none"> • <i>Extent of the habitat on site;</i> • <i>Distribution of the habitat within</i> 	<p>Potential direct effects of the Wind Farm and OfTW on the physical environment (water levels, currents, waves, sedimentary processes) are confined to subtidal and intertidal areas. Many qualifying features are located above the high water mark (supralittoral) and, therefore, no direct effects can occur in the short-term. However, the process of continued progradation is central to the conservation of this habitat type at this site, which has the largest, most complete area of sand dune in the UK, in part owing to the exceptionally high rate of progradation.</p> <p>The structure and function of subtidal and intertidal habitats, including their extent and distribution, may be affected by effects associated with the construction or decommissioning phases of the Wind Farm, namely:</p> <ul style="list-style-type: none"> • Increases in SSC and • Associated sediment deposition (smothering or change of seabed character). 	<p>Potential for Likely Significant Effects</p>	<p>Potential for Likely Significant Effects</p>

SAC and Qualifying Feature	Conservation Objectives	Potential Effects	Wind Farm LSE	LSE In-Combination
slacks; Shifting dunes with marram; Reefs; Subtidal sandbanks; Glasswort and other annuals colonising mud and sand; Atlantic salt meadows; Estuaries; Intertidal mudflats; and sandflats)	<p><i>site;</i></p> <ul style="list-style-type: none"> • <i>Structure and function of the habitat;</i> • <i>Processes supporting the habitat;</i> • <i>Distribution of typical species of the habitat;</i> • <i>Viability of typical species as components of the habitat; and</i> • <i>No significant disturbance of typical species of the habitat.</i> 	<p>During the operational phase of the Wind Farm, potential effects on the processes supporting these habitats may also arise, namely:</p> <ul style="list-style-type: none"> • Effects on tidal water levels; • Effects on tidal currents; • Effects on wave climate; and • Effects on sediment supply. 		
Culbin Bar (SAC) (Atlantic salt meadows; Embryonic shifting dunes; Perennial vegetation of stony banks)	<p>To avoid deterioration of the habitats of the qualifying species 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 interest.</p> <p>To ensure for the qualifying species that the following are established then maintained in the long-term:</p> <ul style="list-style-type: none"> • <i>Extent of the habitat on site;</i> • <i>Distribution of the habitat within site;</i> • <i>Structure and function of the habitat;</i> 	<p>The structure and function of subtidal and intertidal habitats, including their extent and distribution, may be affected by effects associated with the construction or decommissioning phases of the Wind Farm, namely:</p> <ul style="list-style-type: none"> • Increases in SSC and • Associated sediment deposition (smothering or change of seabed character). <p>During the operational phase of the Wind Farm, potential effects on the processes supporting these habitats may also arise, namely:</p> <ul style="list-style-type: none"> • Effects on tidal water levels; • Effects on tidal currents; • Effects on wave climate; and • Effects on sediment supply. 	Potential for Likely Significant Effects	Potential for Likely Significant Effects

SAC and Qualifying Feature	Conservation Objectives	Potential Effects	Wind Farm LSE	LSE In-Combination
	<ul style="list-style-type: none">• <i>Processes supporting the habitat;</i>• <i>Distribution of typical species of the habitat;</i>• <i>Viability of typical species as components of the habitat; and</i>• <i>No significant disturbance of typical species of the habitat.</i>			

6.4 APPRAISAL OF EFFECTS ON CONSERVATION OBJECTIVES AND INTEGRITY OF SACs

6.4.1 INTRODUCTION

424. The identified recommended Appropriate Assessment relates to the potential disturbance to qualifying features, whether as a result of disturbance associated with sediment re-suspension during construction or modification of physical processes during the operational phase of the development. It is considered that of the Conservation Objectives applicable to the SACs under assessment detailed in Section 6.3, the following are of relevance for appraisal of the effects on Conservation Objectives and integrity of SACs:

- *“To avoid deterioration of the habitats of the qualifying species 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 interest;” and*
- *“To ensure for the qualifying species that the following are established then maintained in the long-term:*
 - *Extent of the habitat on site;*
 - *Distribution of the habitat within site;*
 - *Structure and function of the habitat; and*
 - *Processes supporting the habitat.”*

425. As described above, potential effects on the physical environment may arise within the Wind Farm Site and Amended OfTW Corridor, which have the potential to extend also to other areas of the Moray Firth, including the SACs. More details are provided in the following section regarding assessments of the extent, duration and magnitude of the identified potential LSE.

426. This is followed by an appraisal of the assessed effects in relation to the Conservation Objectives of the qualifying features for each SAC.

427. In summary, effects relating to the construction (i.e. measurable increases in SSC and accumulation of sediment on the seabed) and operational (i.e. effects on patterns of tidal water levels, currents, waves and sediment transport) phases of the Amended Project (alone or in combination) are shown to be of negligible magnitude at the locations of the SACs, both in absolute terms and relative to the natural range of variability.

6.4.2 ASSESSMENTS INFORMING THE APPRAISAL

428. Sediment may be disturbed (e.g. by drilling, dredging or trenching) in the course of installing and decommissioning the Wind Farm and OfTW. Where disturbed sediment is released into the water column, it will contribute to an increase in the level of SSC locally. Local modification to SSC at a level and duration that is not normally experienced due to natural processes (within the natural range of variability) might be considered an effect on the function of the habitat. Local effects on SSC may also be transported away from the source by ambient currents, for as long as the sediment remains in suspension. Coarser sediment (i.e. sands and

gravels) will settle relatively rapidly to the seabed (in the order of seconds to minutes) and so these sediment types have limited potential to affect suspended sediment concentrations at locations other than those local to the source. All sediment placed in suspension will be eventually re-deposited onto the seabed and, depending on the nature of the sediment and the hydrodynamic environment, may accumulate in certain locations. If the deposited sediment thickness is relatively large, and occurs on a short time-scale, smothering of sensitive benthic species might occur. If the grain size and sorting of the re-deposited sediment is very different from that already present at the local seabed location, and the thickness of sediment is sufficiently large, then a change in seabed character might be considered to occur. In either case, the re-deposited sediment will subsequently be subject to natural rates and directions of sediment transport and reworked into the marine environment, gradually returning the seabed towards the original baseline condition.

429. During the operational phase, the presence of the Wind Farm and OfTW (primarily the foundations for wind turbines and offshore substation platforms) will present a small obstruction within the water column to tidal currents and waves, potentially modifying these parameters at the scale of individual foundations and also at the scale of the whole Wind Farm. Effects on currents can also potentially indirectly modify regional patterns of tidal water levels or ranges and (in conjunction with effects on waves) local/regional patterns of sediment transport.

430. More details regarding the assessed extent, duration and magnitude of these potential effects at the SACs, as a result of the Amended Project (alone and in combination) are provided below.

6.4.2.1 *Suspended Sediment Concentration (SSC)*

431. Assessments of the extent, duration and magnitude of effects on SSC are provided in the Original ES in Sections 9.5.1 (installation of wind turbine foundations), 9.5.3 (inter-array cable burial) and 21.5.1 (OfTW cable burial). The in-combination effect of BOWL and Moray Firth Round 3 Zone windfarms is similarly provided in Section 9.7.3.1 of the Original ES. The assessments show that measurable increases in SSC are localised, to within a few tens or hundreds of metres from the source, i.e. within the Wind Farm(s) or OfTW. These are of short duration and temporary (persisting for the duration of the activity locally and up to one hour following the cessation of dredging, or less for cable burial). At greater distances and at other times, the sediment plume is dispersed to levels that are not measurably different from the natural background. The locations where sediment might be disturbed are all located within the Wind Farm Site and Amended OfTW Corridor and so are typically 12 km or more from the nearest SAC. The SACs will therefore not experience any measurable direct or indirect effects caused by sediment in suspension.

6.4.2.2 *Sediment Deposition and Accumulation*

432. Assessments of the extent, duration and magnitude of effects from sediment accumulation are provided in Sections 9.5.2 (installation of wind turbine foundations), 9.5.3 (inter-array cable burial) and 21.5.1 (OfTW cable burial) of the Original ES. The assessments show that the naturally residual tidal transport processes advect fine sediments that persist in suspension from the Wind Farm(s) towards the central parts of the Outer Moray Firth. These fine sediments will eventually be deposited in this general area, which is outside of the SACs. Installation of the maximum number (277) of turbine foundations in the Wind Farm could lead to a (small) local maximum accumulation thickness of 0.5 to 0.9 mm, but more typically 0.01 to 0.15 mm in this area. On a proportional basis, the additional number of turbines in the Moray Firth Round 3 Zone development (up to 420 in the Original ES) would potentially increase the total in combination thicknesses to a local maximum of 1.3 to 2.26 mm, but more typically 0.03 to 0.38 mm. Relatively coarse grained sediments (i.e. sands and gravels) will instead be deposited to the seabed locally to the operation, i.e. within or near to the Wind Farm or OfTW. In practice, the total thickness of all sediment potentially deposited will be built gradually over the duration of the construction period (several years) and will be subject to naturally occurring erosion, dispersion and bioturbation during this time. Owing to the low energy tidal regime, the seabed in the area of deposition (which is outside the SACs) is relatively fine grained, and thus the additional fine grained material will not materially change the seabed composition, character or local patterns of sediment transport. The SACs will therefore not experience any measurable direct or indirect effects caused by sediment deposition and accumulation.

6.4.2.3 *Tidal Water Levels*

433. An assessment of the extent, duration and magnitude of effects on tidal water levels is provided in Section 9.5.5 (effect of wind turbine foundations on the tidal regime) of the Original ES. The in-combination effect of the Wind Farm(s) and OfTW is similarly provided in Section 9.7.3.2 of the Original ES. The assessments show that the maximum magnitude of effect of the Amended Project (alone or in combination) on tidal water levels in any of the SACs, at any time during a typical spring-neap tidal cycle, is less than 0.001 m. Given the similarity in processes, a similar (low) order of effect on non-tidal (surge) water levels is also assessed. The magnitude of the effect of the array is evidently very small when compared to the natural range of variability in tidal levels (2 to 4 m), non-tidal levels (1 m) and the predicted potential effects of sea level rise due to climate change (0.08 to 0.14 m) and would not be measurable in practice. The SACs will therefore not experience any measurable direct or indirect effects from modification of water levels.

6.4.2.4 *Currents*

434. An assessment of the extent, duration and magnitude of effects on tidal currents is provided in Section 9.5.5 (effect of wind turbine foundations on the tidal regime) of the Original ES. The in-combination effect of the Wind Farm(s) and OfTW is similarly provided in Section 9.7.3.2 of the Original ES. The assessment shows that

the maximum magnitude of effect for the Amended Project (alone or in combination) on tidal current speeds in any of the SACs, at any time during a typical spring-neap tidal cycle, is less than 0.01 m/s. Given the similarity in processes, a similar (low) order of effect on non-tidal (surge) currents is also assessed. The magnitude of the effect of the array is evidently very small when compared to the natural range of variability in tidal currents and would not be measurable in practice. The SACs will therefore not experience any measurable direct or indirect effects from modification of currents.

6.4.2.5 *Waves*

435. An assessment of the extent, duration and magnitude of effects on waves is provided in Section 9.5.6 (effect of wind turbine foundations on the wave regime) of the Original ES. The in-combination effect of the Wind Farm(s) and OfTW is similarly provided in Section 9.7.3.5. The assessments show that the magnitude of effect on wave height is small in both absolute and relative terms and that the effect can also be locally intermittent (depending on the position of the location relative to the Wind Farm(s) and the wave direction). The maximum magnitude of effect on wave height at the East Caithness Cliffs SAC is of the order 0.2 to 0.3 m (2 to 3% of the incident wave condition) for waves from the east or south east (occurring 29% of the time) and less than 0.1 m (less than 1% of the incident wave condition) for other directions (70.4% of the time). The maximum magnitude of effect on wave height at the Moray Firth SAC and other designated sites with an open coastal aspect are of the order 0.1 to 0.2 m (2 to 3% of the incident wave condition) for waves from the north, north east or east (54% of the time) and less than 0.1 m (less than 2% of the incident wave condition) for other directions (46% of the time). The maximum magnitude of effect on wave height in the Inner Moray Firth and other sheltered or enclosed water bodies (including the Dornoch Firth and Morrich More SAC and the Culbin Bar SAC) is less than 0.05 m (less than 1% of the incident wave condition, i.e. no measurable effect) for all wave coming directions. Wave period is not modified by more than 0.1 s (1 to 1.5%) which is not a measurable effect in practice. The SACs will therefore not experience any measurable direct or indirect effects from modification of waves.

6.4.2.6 *Sediment Transport*

436. An assessment of the extent, duration and magnitude of effects on sediment transport is provided in Section 9.5.6 (effect of wind turbine foundations on the wave regime) of the Original ES. The in-combination effect of the Wind Farm(s) and OfTW is similarly considered in Section 9.7.3.6 of the Original ES. It has been established that the Amended Project (alone or in-combination) will not cause measurable change (other than very locally) in the processes driving sediment transport (i.e. currents and waves, as above). No measurable change in the quantity, nature or distribution of sediment available for transport is expected. Given no measurable change in the controlling parameters, there can be no corresponding difference in the potential rates and directions of sediment transport either within the Amended Project area, or within the wider Moray Firth. The SACs

will therefore not experience any measurable direct or indirect effects from modification of sediment transport.

6.4.3 MORAY FIRTH SAC

437. There are no predicted direct or indirect effects on the physical parameters (water levels, currents, waves, sediment supply and transport) that either characterise the present state, or control the long-term evolution of the qualifying features of the Moray Firth SAC (subtidal sand banks), as a result of the Amended Project. As such, the extent, distribution, structure and function and processes supporting the habitat within the site will remain established and will be maintained in the long-term (subject to natural variability). The integrity of the site will be maintained and the site will continue to make an appropriate contribution to achieving favourable conservation status for the qualifying interest.

6.4.3.1 In-Combination Effects

438. The nature, magnitude and spatial distribution of potential in-combination effects are the same as for the Amended Project alone.

439. As such, the extent, distribution, structure and function and processes supporting the habitat within the site will remain established and will be maintained in the long-term (subject to natural variability). The integrity of the site will be maintained and the site will continue to make an appropriate contribution to achieving favourable conservation status for the qualifying interest.

6.4.4 DORNOCH FIRTH AND MORRICH MORE SAC

440. There are no predicted direct or indirect effects on the physical parameters (water levels, currents, waves, sediment supply and transport) that either characterise the present state, or control the long-term evolution of the subtidal and intertidal qualifying features of the Dornoch Firth and Morrich More SAC (see Table 6.2), as a result of the Amended Project. As such, the extent, distribution, structure and function and processes supporting the habitat within the site will remain established and will be maintained in the long-term (subject to natural variability). The integrity of the site will be maintained and the site will continue to make an appropriate contribution to achieving favourable conservation status for the qualifying interest.

6.4.4.1 In-Combination Effects

441. The nature, magnitude and spatial distribution of potential in-combination effects are the same as for the Amended Project alone.

442. As such, the extent, distribution, structure and function and processes supporting the habitat within the site will remain established and will be maintained in the long-term (subject to natural variability). The integrity of the site will be maintained and the site will continue to make an appropriate contribution to achieving favourable conservation status for the qualifying interest.

6.4.5 CULBIN BAR SAC

443. There are no predicted direct or indirect effects on the physical parameters (water levels, currents, waves, sediment supply and transport) that either characterise the

present state, or control the long-term evolution of the qualifying features of the Culbin Bar SAC (see Table 6.2), as a result of the Amended Project. As such, the extent, distribution, structure and function and processes supporting the habitat within the site will remain established and will be maintained in the long-term (subject to natural variability). The integrity of the site will be maintained and the site will continue to make an appropriate contribution to achieving favourable conservation status for the qualifying interest

6.4.5.1 *In-Combination Effects*

444. The nature, magnitude and spatial distribution of potential in-combination effects are the same as for the Amended Project alone.

445. As such, the extent, distribution, structure and function and processes supporting the habitat within the site will remain established and will be maintained in the long-term (subject to natural variability). The integrity of the site will be maintained and the site will continue to make an appropriate contribution to achieving favourable conservation status for the qualifying interest.