MORAY WEST
OFFSHORE WINDFARM

Moray West Offshore Habitats Regulations Appraisal

Report to Inform Appropriate Assessment

June 2018

Moray Offshore Windfarm (West) Limited

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Acronyms	
Acronym	**Definition of Term**
AC	Aberdeenshire Council
AEoI	Adverse effect on integrity
BOWL	Beatrice Offshore Wind Farm Limited
CA	Competent Authority
CES	Central East Scotland
CI	Confidence intervals
CIA	Cumulative impact assessment
cSAC	Candidate Special Area of Conservation
DDV	Drop down video
DECC	Department of Energy and Climate Change
dSAC	Draft Special Area of Conservation
DSS	Decision Support System
DTI	Department of Trade and Industry
ECC	East Caithness Cliffs
EDPR	EDP Renovaveis
EDPR UK	EDP Renewables UK Ltd
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
EMP	Environmental Management Plan
ES	Environmental Statement (referred to as the Environmental Report and the EIA Report in different pieces of EIA legislation)
ESAS	European Seabirds at Sea
FAME	Future of the Atlantic Marine Environment
GAM	Generalised Additive Model
GBS	Gravity Base Structure
GNS	Greater North Sea
GPS	Global Positioning System
GW	Gigawatt
GWDTE	Groundwater dependent terrestrial ecosystem
ha	Hectares
HAT	Highest astronomical tide
HDD	Horizontal directional drilling
HRA	Habitats Regulations Appraisal

Acronyms	
Acronym	**Definition of Term**
HVAC	High voltage alternating current
IAMMWG	Interagency Marine Mammal Working Group
IROPI	Imperative Reasons of Overriding Public Interest
JCP	Joint Cetacean Protocol
JNCC	Joint Nature Conservation Committee
km	Kilometre
kV	Kilovolt
LAT	Lowest astronomical tide
LSE	Likely Significant Effect
MARPOL	International Convention for the Prevention of Pollution from Ships
MC	Moray Council
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MMMP	Marine Mammal Monitoring Programme
MORL	Moray Offshore Renewables Limited (now known as Moray East)
MPA	Marine Protected Area
MPCP	Marine Pollution Contingency Plan
MS-LOT	Marine Scotland Licensing Operations Team
MSS	Marine Scotland Science
MSW	Multi Sea Winter
MU	Management Unit
MW	Megawatt
NCC	North Caithness Cliffs
NETS	National Electricity Transmission System
nm	Nautical mile
NMPi	National Marine Planning Interactive
NNR	National Nature Reserve
NRMSD	National Research and Monitoring Strategy for Diadromous Fish
OfTI	Offshore Transmission Infrastructure
O&M	Operation and maintenance
OnTI	Onshore Transmission Infrastructure
OSP	Offshore Substation Platform

Acronyms	
Acronym	**Definition of Term**
PAM	Passive Acoustic Monitoring
PCOD	Population consequences of disturbance
pSAC	Possible Special Area of Conservation
pSPA	Potential Special Protection Area
PTS	Permanent Threshold Shift
QA	Quality Assurance
REZ	Renewable Energy Zone
RIAA	Report to Inform an Appropriate Assessment
RSBP	Royal Society for the Protection of Birds
SAC	Special Area of Conservation
SCANS	Small Cetaceans in the European Atlantic and North Sea
SCI	Site of Community Interest
SCOS	Special Committee on Seals
SMRU	Sea Mammal Research Unit
SNCBs	Statutory Nature Conservation Bodies
SNH	Scottish Natural Heritage
SPA	Special Protection Area
SPP	Scottish Planning Policy
STAR	Seabird Tracking and Research
TCE	The Crown Estate
TI	Transmission Infrastructure
WTG	Wind Turbine Generator
WWT	Wildfowl and Wetlands Trust
ZDA	Zone Development Agreement

Glossary of Terms	
Term	**Description**
Birds Directive	Directive 2009/147/EC of 30 November 2009 on the conservation of wild birds
EIA Regulations	The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017
Habitats Directive	Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora
Habitats Regulations	Conservation (Natural Habitats, &c.) Regulations 1994 (as amended)

Glossary of Terms	
Term	**Description**
Moray East	Moray Offshore Windfarm (East) Limited
Moray East Offshore Wind Farm	The wind farm to be developed in the Moray East Site
Moray East Site	The area of the Zone in which the Moray East Offshore Wind Farm will be located, previously known as the Eastern Development Area
Moray Firth Zone	UK offshore wind Round 3 Zone 1 area held under a Zone Development Agreement (ZDA) by Moray Offshore Renewable Power Limited which is comprised of the Moray East Site and the Moray West Site
Moray West	Moray Offshore Windfarm (West) Limited
Moray West Offshore Wind Farm	The wind farm being proposed by Moray West
Moray West Site	The area of the Zone in which the Moray West Offshore Wind Farm and elements of the Moray West OfTI will be located, previously known as the Western Development Area
Natura site	A Natura 2000 site which forms a network of nature protection areas in the territory of the European Union. It is made up of SACs and SPAs designated respectively under the Habitats Directive and Birds Directive. The network includes both terrestrial and marine sites (MPAs).
Offshore Habitats Regulations	The Offshore Marine Conservation (Natural Habitats &c) Regulations 2007 (as amended)
Ramsar	A wetland site designated of international importance under the Ramsar Convention. The Convention on Wetlands, known as the Ramsar Convention, is an intergovernmental environmental treaty established in 1971 by UNESCO, and coming into force in 1975.
Scoping Study Area	The area of search for the OnTI that is located landward of MLWS, as illustrated in Figure 1.1.1
The Project	The Moray West OfTI, OnTI and Offshore Wind Farm combined together

Acknowledgements

GoBe Consultants Ltd (GoBe) has produced this report on behalf of Moray West.

GoBe would like to thank the following organisations for their technical assistance and contributions to the preparation of this Report to Inform an Appropriate Assessment:

- Moray Offshore Windfarm (West) Limited;
- Niras Consulting Limited; and

Executive Summary

Introduction

This document has been produced to inform the Habitats Regulations Appraisal (HRA) process for the Moray West Offshore Wind Farm and Moray West Offshore Transmission Infrastructure (OfTI) (the Development). The purpose of this document is to provide supporting information to the Competent Authority in order to allow them to undertake a decision on whether there will be an adverse effect upon the integrity of European sites (also known as 'Natura 2000' sites or 'European offshore marine sites') as a result of the Development, taking into consideration the sites' Conservation Objectives.

European sites are defined within this document as Special Areas of Conservation (SACs), Sites of Community Importance (SCIs) and Candidate SACs (cSACs) designated under the Habitats Directive (92/43/EEC) and Special Protection Areas (SPAs) and proposed SPAs (pSPAs) designated under Council Directive (2009/147/EC) on the conservation of wild birds (the 'Birds Directive'). In addition to sites designated under European nature conservation legislation, UK Government policy (ODPM Circular 06/2005) and Scottish Planning Policy (Scottish Government, 2014) states that internationally important wetlands designated under the Ramsar Convention 1971 (Ramsar sites and potential Ramsar sites) are afforded the same protection as SPAs and SACs and so are considered in this report as European sites.

This Report to Inform Appropriate Assessment (RIAA) has been prepared in accordance with 'Habitats Regulations Appraisal of Plans. Guidance for Plan-making Bodies in Scotland.' (Tyldesley *et al*., 2015) and will be submitted as part of the application for consent for the Development. It also takes into consideration the recent EU Court Ruling that proposed mitigation measures cannot be taken into account at the HRA screening stage (People Over Wind and Sweetman v Coillte Teoranta (C-323/17)).

HRA Screening

The need for an HRA was identified and requested by Marine Scotland Licensing Operations Team (MS-LOT) in their Scoping Opinion following the EIA Scoping process for Moray West Offshore Windfarm (Moray West, 2016).

The first stage in the HRA process is to determine whether it is possible to conclude that there is no likely significant effect (LSE) on the site. Only where it is not possible to conclude this, does an Appropriate Assessment need to be carried out by the Competent Authority. Determination of whether there was LSE for the Moray West Offshore Wind Farm and / or Moray West OnTI was undertaken through an HRA Screening exercise, which included the production of an HRA Screening Report (Appendix 4.1).

This HRA Screening Report (Moray West, 2017) was then issued to MS-LOT and Scottish Natural Heritage (SNH) for consultation in September 2017, in order to initially determine whether the Moray West Offshore Wind Farm and Moray West OfTI have the potential to affect the site integrity and / or the qualifying features of any nearby European site. The HRA Screening Report initially identified that the Moray West Site does not overlap with any European site or Ramsar, whilst the OfTI overlaps with the Moray Firth pSPA in the near shore extent. Therefore, with the exception of the pSPA, it was considered that connectivity to European sites was associated with either the potential for mobile species to be present within the zone of influence from the Project, or for the zone of influence to extend out to European or Ramsar sites that are close by.

The Screening Report initially identified 29 European sites that had the potential for connectivity and therefore the potential for LSE on one or more features could not be discounted. These included:

- A total of 13 European sites designated for ornithological features: one pSPA (Moray Firth); nine SPA (East Caithness Cliffs, North Caithness Cliffs, Troup, Pennan and Lion's Heads,

Buchan Ness to Collieston Coast, Loch of Strathbeg, Moray and Nairn Coast, Dornoch Firth and Loch Fleet, Cromarty Firth and Inner Moray Firth); and three Ramsar (Dornoch Firth and Loch Fleet, Cromarty Firth and Inner Moray Firth);

- A total of five SACs designated for marine mammal features: Moray Firth, Dornoch Firth and Morrich More, Faray and Holm of Faray, Isle of May and Monach Islands;
- A total of eight SACs designated for migratory fish features: Berriedale and Langwell Waters, River Borgie, River Dee, River Naver, River Thurso, River Oykel, River Moriston and River Spey; and
- A total of three SACs designated for habitat features: Moray Firth, Dornoch Firth and Morrich More and Culbin Bar.

A HRA Screening Opinion was received from MS-LOT in October 2017 (Marine Scotland, 2017; Appendix 4.2), which identified that there was potential for LSEs upon ornithology, marine mammal and habitat features and an Appropriate Assessment was required.

The outcome of the screening exercise was that there was potential for LSEs upon five European sites with ornithological qualifying features of interest (Moray Firth pSPA, East Caithness Cliffs SPA, North Caithness Cliffs SPA, Buchan Ness to Collieston Coast SPA and Troup, Pennan and Lion's Head SPA), two European sites with marine mammal qualifying features of interest (Moray Firth SAC and Dornoch Firth and Morrich More SAC) and one site with habitat qualifying features of interest (Moray Firth SAC). The remaining 21 European sites identified as having potential connectivity were screened out of any further assessment. With the exception of soft start pile driving, mitigation was not used as a basis to screen out any European sites from assessment but mitigation has been taken into account within the RIAA to inform the Appropriate Assessment stage.

Although screened out in the HRA Screening Report, SNH and MS-LOT advised that there was no requirement to consider diadromous fish as part of the HRA for differing reasons. SNH advised that impacts to diadromous fish should be considered within the Offshore EIA Report. In their view, SNH did not feel that it was possible to undertake site-specific HRA for migratory Atlantic salmon or other migratory fish because impacts could not be apportioned correctly to individual SACs. This was due to the current lack of information on SAC diadromous fish populations upon which to inform decisions on site integrity. Migratory fish were therefore screened out of the HRA.

Recent EU Court Ruling and Review of HRA Screening Mitigation

Following the recent Court Ruling (C-323/17), a review of any mitigation incorporated into the HRA Screening Report has been undertaken as part of this RIAA. The only mitigation identified at HRA Screening was in relation to soft start piling. Soft start piling was identified as a mitigation measure to be applied in order to reduce the effects of underwater noise upon marine mammal and migratory fish qualifying interests. However, most recent scientific opinion is that this mitigation is not currently suitable for migratory fish due to the potential for behavioural effects (e.g. displacement from foraging or spawning areas) and with removal of this mitigation, the other reasons provided for screening out of LSE (e.g. hearing thresholds for the specific fish species) are sufficient to validate screening out, without soft start mitigation. The Screening Opinion went on to confirm that migratory fish did not require further consideration in the RIAA but this was screened out by the Competent Authority for other reasons and did not rely on mitigation.

For marine mammals, soft start piling is an embedded mitigation within the design of the scheme and is included within the Piling Strategy for the development, which will be required as part of the consenting conditions which will form part of any future Marine Licence. It is not mitigation that has been specifically identified as being required for HRA purposes during the HRA Screening, but is included within the design

mitigation set out within Section 5 of this RIAA. Soft start piling is therefore accounted for within this RIAA and recognised as an embedded mitigation measure that will assist in reducing LSE upon marine mammals.

Report to Inform Appropriate Assessment

The design scenarios selected for assessment of impacts on European sites were those which would result in the worst design scenario and the greatest potential effect on relevant qualifying features. These were defined taking account of the information provided in the project description and relevant project designed-in mitigation measures, and are consistent with those used for assessment in the EIA Report Chapters relevant to the Appropriate Assessment.

The in-combination assessment was undertaken, taking account of the Cumulative Impact Assessment (CIA) Screening Exercise used for the EIA Report (Appendix 4.3) for relevant topics and followed the list of projects subsequently identified for inclusion.

Ornithology

The screening stage of the HRA process identified potential for LSEs on the kittiwake, herring gull, guillemot, razorbill and puffin populations of a number of European sites in relation to collision risk and displacement during operation. These seabird features originate from Buchan Ness to Collieston Coast SPA, East Caithness Cliffs SPA, North Caithness Cliffs SPA and Troup, Pennan and Lion's Heads SPAs. In addition, LSEs on various features of the Moray Firth pSPA were identified in relation to disturbance during construction.

The assessment of adverse effects on site integrity carried out for the Development alone and in-combination with other plans and projects, did not predict significant impacts in terms of disturbance, collision risk and displacement. It was therefore concluded that there would be no adverse effects on the integrity of on the sites included in the assessment.

Marine Mammals

The HRA screening process indicated that LSE on the qualifying features of the Dornoch Firth and Morrich More SAC and the Moray Firth SAC could not be discounted and so a systematic assessment of the potential for an adverse effect on the integrity of these European sites has been undertaken.

The assessment has considered the potential impacts of Development during construction, operation and maintenance and decommissioning, alone and in-combination with other relevant plans and projects with respect to the site's Conservation Objectives.

With respect to these SACs, there is no indication that the construction, operation and maintenance or decommissioning will lead to a significant change in the extent and distribution of the habitats of any of the qualifying features for those sites. There is no indication that the structure and function of the habitats of the qualifying features will be significantly altered, nor the supporting processes on which those habitats rely. In each case the distribution of qualifying features within each site will also be maintained.

With respect to the population of each of the qualifying features, the likely effects arising from the construction and operation of Development alone and in-combination with other plans and projects (other offshore wind farms in this case) has been predicted. Based on the in-combination scenarios assessed, there was no significant long term effect on the population trajectory of either harbour seals or bottlenose dolphin populations.

Having considered the information provided in the EIA Report and the precautionary quantitative assessments described above, the potential risks from the different impact pathways, in the presence of the embedded mitigation (the development of a piling strategy to reduce the risk of injury and mortality including a piling hammer energy soft start and other mitigation measures as agreed, the development of a vessel management plan) the Development, alone or in-combination with other plans or projects, will not adversely affect the integrity of the Moray Firth SAC with respect to bottlenose dolphins or the Dornoch and Morrich More SAC with respect to harbour seals.

Habitats

Due to the physical processes modelling not being available at the time of HR Screening, it was not possible to rule out the potential for LSE on the subtidal sandbank qualifying feature.

Following completion of the physical processes modelling, an assessment of the potential physical processes and hydrodynamic changes that may occur as a result of the construction and operation of the Moray West Offshore Wind Farm and the Moray West OfTI has shown, through the application of numerical modelling, that increased suspended sediment concentrations (SSCs) would occur within the construction phase, but that these would be localised and within one tidal excursion of the Project. In addition, there would be no measurable change to current speeds, wave direction or wave period and that any wave height reduction would be small (0.1 m within coastal waters) and within existing wave height ranges that naturally occur. The assessment shows that there would therefore be no adverse effect upon the Moray Firth SAC and its designated feature of subtidal sandbanks.

The assessment also shows, through the numerical modelling, that when the Moray West Site is considered cumulatively with other relevant operational projects in the area and the decommissioning of the Beatrice Oil Field and Demonstrator turbines there would be no adverse effect upon the Moray Firth SAC and its designated feature of subtidal sandbanks.

Conclusions

To meet with the requirements of the HRA Screening Report (Appendix 4.1) and the HRA Screening Opinion (Appendix 4.2), information is presented within this RIAA to support and assist the Competent Authority with completion of an Appropriate Assessment of European sites with ornithological, marine mammal and habitat qualifying features that could be adversely affected by the Development.

Detailed assessment of each European site and qualifying feature has concluded that the Moray West Offshore Wind Farm and Moray West OfTI, alone or in-combination with other plans or projects, will not adversely affect the integrity of any of the European sites and their qualifying features.

1 Introduction

1.1 Project Background

1.1.1.1 Moray Offshore Windfarm (West) Limited (known as Moray West) is promoting the development of the Moray West Offshore Wind Farm. The offshore wind farm will be located in the Outer Moray Firth (Figure 1.1.1), approximately 22.5 km south of the Caithness coastline at its nearest point. It will comprise up to 85 Wind Turbines Generators (WTGs) which will be connected to the Offshore Transmission Infrastructure (OfTI) by a series of subsea inter-array cables.

1.1.1.2 The OfTI will comprise one or two Offshore Substation Platform(s) (OSP(s)) (joined by an OSP interconnector cable if two are required) and up to two offshore export cable circuits that carry electricity generated by the offshore wind farm to an onshore landfall location to join the Onshore Transmission Infrastructure (OnTI). The OnTI will transmit the power inland to a new onshore substation where it will be transformed before being fed (via buried cables) into the National Electricity Transmission System (NETS) at the existing Blackhillock substation, approximately 1.5 km south of Keith in Moray.

1.1.1.3 The Moray West Offshore Wind Farm and OfTI are herein referred to as the Development.

1.2 The Moray Firth Zone

1.2.1.1 In January 2010, Moray Offshore Renewables Limited was awarded a Zone Development Agreement (ZDA) by The Crown Estate (TCE) to develop Zone one of the nine UK offshore wind Round 3 zones. Zone one (the Moray Firth Zone) is located within the Outer Moray Firth within the UK Renewable Energy Zone (REZ) (Figure 1.1.1). The ZDA is now held by Moray Offshore Renewable Power Limited which owns 100% of Moray West.

1.2.1.2 Using a zonal constraints analysis, Moray East identified two distinct development areas, the Moray East Site and the Moray West Site.

1.2.1.3 The Moray East Site was the first of the two development areas to be progressed and was consented under Section 36 of the Electricity Act 1989, with consent awarded in March 2014. Consents are now being sought for development of the Moray West Site, which are being supported by Environmental Impact Assessment. The Moray West Offshore Wind Farm and the associated OfTI will require Marine Licences under the Marine (Scotland) Act 2010 and Marine and Coastal Access Act 2009. A consent under Section 36 of the Electricity Act 1989 will also be required for the offshore wind farm.

1.2.1.4 An integral part of the consenting process is to demonstrate due regard to the European Council Directives 92/43/EEC on the Conservation of Natural Habitats and of Wild Flora and Fauna Habitats Directive (European Commission, 1992; 'Habitats Directive') and 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (codified version) (European Commission, 2009; 'Birds Directive') with the promoter required to provide sufficient information to enable the competent authority[1] (CA) (which is the Scottish Ministers in the case of the Moray West Offshore Wind Farm) to undertake an Appropriate Assessment in accordance with Habitats Regulations[2] and Offshore Habitats Regulations[3].

[1] A 'competent authority' is the authority with the power or duty to determine whether or not a proposal can proceed. The competent authority carries out the appropriate assessment and can require the developer to provide the necessary information to inform the assessment. The competent authority must consult SNH in accordance with the Habitats Regulations (SNH, 2010).

[2] The Conservation (Natural Habitats, & c.) Regulations 1994 as amended, and The Conservation of Habitats and Species Regulations 2017 (both referred to as the 'Habitats Regulations').

[3] Offshore Marine Conservation (Natural Habitats &c) Regulations 2007, as amended (referred to as the 'Offshore Habitats Regulations')

1.2.1.5 This Report to Inform an Appropriate Assessment (RIAA) considers the Moray West Offshore Wind Farm and the OfTI together. It does not cover the OnTI. The HRA requirements for the OnTI have been consulted upon separately by Wood Environment & Infrastructure Solutions UK Limited, and these separate discussions concluded that no onshore HRA was required.

1.3 Definitions

1.3.1.1 The definitions listed below have been applied throughout this RIAA. They reflect the recent establishment of Moray West, which is distinct from Moray East.

- **Moray Firth Zone** - UK offshore wind Round 3 Zone 1 area held under a ZDA by Moray Offshore Renewable Power Limited which is comprised of the Moray East Site and the Moray West Site.
- **Moray West** - Moray Offshore Windfarm (West) Limited.
- **Moray West Site** - The area of the Moray Firth Zone in which the Moray West Offshore Wind Farm will be located, previously known as the Western Development Area.
- **Moray West Offshore Wind Farm** - The wind farm to be developed in the Moray West Site.
- **Moray West OfTI** - The Offshore Transmission Infrastructure associated with the Moray West Offshore Wind Farm.
- **Moray West OfTI Site** - The area within which the OfTI will be located. It includes the Moray West Site, within which the OSP(s) and a portion of the export cable circuits will be located, and the Offshore Export Cable Corridor within which the remainder of the export cable circuits will be located.
- **Moray West OnTI** - The Onshore Transmission Infrastructure associated with the Moray West Offshore Wind Farm.
- **Moray West OnTI Site** - The area within which the OnTI will be located. It includes onshore transition bays at landfall, up to two onshore cable circuits that transmit power to a new onshore substation along with buried interconnecting cables that connect into the NETS.
- **Landfall Area** - The section of Aberdeenshire Coast located between Findlater Castle and Redhythe Point within which the export cable(s) will be brought ashore and connected to the Moray West Onshore Transmission Infrastructure (OnTI).
- **The Development** – Moray West Offshore Wind Farm and OfTI.
- **The Project** - Moray West Offshore Wind Farm, OfTI and the Moray West OnTI.
- **Moray East** - Moray Offshore Windfarm (East) Limited, formerly known as Moray Offshore Renewables Limited (MORL).
- **Moray East Site** - The area of the Moray Firth Zone in which the Moray East Offshore Wind Farm will be located, previously known as the Eastern Development Area.
- **Moray East Offshore Wind Farm** - The wind farm to be developed in the Moray East Site.
- **Moray East Modified Transmission Infrastructure (TI)** - Offshore and onshore electricity transmission infrastructure associated with the Moray East Offshore Wind Farm.
- **Telford, Stevenson and MacColl offshore wind farms** - The three consented offshore wind farms proposed to be located within the Moray East Site and collectively comprising Moray East Offshore Wind Farm.

1.4 Purpose of this Document

1.4.1.1 The need for an HRA was identified and requested by Marine Scotland Licensing Operations Team (MS-LOT) in their Scoping Opinion following the EIA Scoping process for the Moray West Offshore Wind Farm (Moray West, 2016). An HRA Screening Report (Moray West, 2017) was therefore issued to MS-LOT and Scottish Natural Heritage (SNH[4]) for consultation in September 2017, in order to initially determine whether the Development has the potential to affect the site integrity and / or the qualifying features of any nearby European sites (also known as a 'Natura 2000' site or 'European offshore marine site'). A HRA Screening Opinion was received from MS-LOT in October 2017 (Marine Scotland, 2017), which identified that there was potential for likely significant effects (LSEs) on a number of sites and therefore an Appropriate Assessment was required. The steps in the HRA process and associated reporting requirements are described in Section 3 and Figure 3.2.1.

1.4.1.2 This RIAA specifically provides information to assist with informing of the Appropriate Assessment part of the process. It draws on both the HRA Screening Report and the HRA Screening Opinion and a summary of these stages in the process is provided in Section 4.

1.4.1.3 The conclusions reached within the HRA Screening Report and Screening Opinion on the potential for LSEs form the basis of this RIAA. Each potential LSE is assessed further, with respect to the conservation objectives of the particular European site being considered, to determine whether there is the potential for an adverse effect on integrity (AEoI). It is the information on the potential for an AEoI that is required by the Competent Authority (in this case MS-LOT) which allows them to undertake an Appropriate Assessment. The developer for a particular project is responsible for the provision of information to the Competent Authority to assist them with their Appropriate Assessment and this is the main function of this RIAA.

1.4.1.4 This report should be read in conjunction with HRA Screening Report (Moray West, 2017; Appendix 4.1), the Screening Opinion (Marine Scotland, 2017; Appendix 4.2) and the relevant chapters and Technical Appendices of the Moray West Offshore EIA Report (Volume 2 - Chapter 6: Physical Processes and Water Quality; Chapter 9: Marine Mammals and Chapter 10: Ornithology).

1.5 Structure of this Document

1.5.1.1 This document is structured as outlined within Table 1.5.1.

Table 1.5.1 Structure of the RIAA

Section	Heading	Overview
Section 1	Introduction	Introduces the project and sets out the background to the proposals and the need for an Offshore HRA Screening Report, along with stating the purpose of the Offshore HRA Screening Report.
Section 2	Proposed Development	This section provides an overview of the key offshore components of the Project.
Section 3	The HRA Process	Provides background on the overall process along with a description of the relevant legislative and policy drivers and key guidance.
Section 4	HRA Screening	A summary of the screening process that has been completed to identify and agree potential LSE (Steps 1 and 2 of the HRA process)
Section 5	Development Design Parameters and Mitigation	This section identifies the maximum adverse scenario being applied to the assessment, the mitigation already incorporated into the design of the Project components (Design Mitigation)

[4] SNH also coordinate on behalf of the Joint Nature Conservation Committee (JNCC)).

Table 1.5.1	Structure of the RIAA	
Section	**Heading**	**Overview**
Sections 6, 7 & 8	Assessment of Adverse Effects upon Site Integrity	Detailed information (for Ornithology, Marine Mammals and Habitats) is provided on the following: The conservation objectives associated with each qualifying feature under consideration for each relevant European site; The potential impacts of the Project on the relevant qualifying feature(s) and European site(s); A review of the baseline information on the distribution and ecology of the relevant qualifying features and European sites requiring assessment; Approach to the assessment of effects (Development alone and in-combination); and Assessment of adverse effect on the integrity of European sites (both for the project alone and in-combination with other projects).
Section 9	Summary and Conclusions	A summary of the main conclusions of the assessment.
Section 10	References	Sources of information that have been used to inform the baseline characterisation, the HRA Screening appraisal and the conclusions.
Appendix 4.1	HRA Screening Report	HRA Screening Report submitted to MSLOT September 2017 setting out approach to the HRA and identifying a list of sites where LSE could not be discounted therefore require inclusion in the RIAA.
Appendix 4.2	HRA Screening Opinion	Opinion on sites requiring further assessment as part of the RIAA.
Appendix 4.3	CIA List of Projects	List of projects identified as requiring assessment as part of the in-combination assessment.
Appendix 4.4	Phenology and Apportioning	Describes the approach to the apportioning of birds within the Moray West Site to SPAs within foraging range of the Moray West Site for those species.
Appendix 4.5	PVA Report	Report prepared by DMP Stats presenting the approach to, and results from the Population Viability Assessment (PVA) Modelling.
Appendix 4.6	HRA Displacement Matrices	Displacement matrices used to inform the assessment of effects from displacement.
Appendix 4.7	Influence of Flight Speed Parameters in Collision Risk Modelling (CRM)	Report on the Influence of Flight Speed Parameters in Collision Risk Modelling (CRM) and comparative results using different flight speeds for kittiwake and herring gull.

2 Proposed Development

2.1 Introduction

2.1.1.1 This section provides a description of the infrastructure associated with the Development. It is based on the design information available at the time of Section 36 consent / Marine Licence application and reflects the information presented in the Moray West Offshore EIA Report Volume 2 - Chapter 4: Description of Development.

2.1.1.2 It should be noted that the design of the Development infrastructure will be subject to further refinement throughout the consenting and post-consent phase. However, the level of detail presented below is deemed sufficient to inform this RIAA. As with EIA, a Design Envelope approach has been taken in preparing this document, whereby a series of design options for the Development are set out and the assessments presented in this RIAA have considered the scenario which would give rise to the greatest potential effect.

2.2 Development Location and Boundaries

2.2.1.1 As described in Section 1.1 and shown on Figure 1.1.1, the Development is located within the Outer Moray Firth and encompasses:

- The Moray West Site. This is where the offshore wind farm and part of the OfTI will be located, which will include the Wind Turbine Generators (WTGs), WTG foundations and substructures, inter-array cables, up to two Offshore Substation Platform(s) (OSP(s)), OSP interconnector cables and, to the extent located within the Moray West Site, the offshore export cables.
- The Moray West Offshore Export Cable Corridor. This is where the offshore export cables will be located.

2.2.1.2 The Moray West Site covers an area of approximately 225 km^2 and the Offshore Export Cable Corridor covers an area of approximately 185 km^2.

2.3 Offshore Wind Farm Infrastructure

2.3.1 Offshore Wind Turbine Generators (WTGs)

2.3.1.1 Table 2.3.1 provides a summary of the indicative WTG parameters currently proposed.

2.3.1.2 Four WTG model types are currently under consideration. These are referred to as Model 1, Model 2, Model 3 and Model 4. Subject to final design it is possible that alternative WTG model types may be selected. However, the physical parameters of the WTGs, such as maximum blade tip height, rotor diameter, and height of nacelle will remain within the maximum envelope set out in Table 2.3.1 below. All WTG models are based on the conventional offshore WTG design architecture with three blades and a horizontal rotor axis. Each WTG will have a minimum clearance between the Highest Astronomical Tide (HAT) sea level and the lowest point of the blade of 22 m.

2.3.1.3 The wind farm will be designed and constructed to satisfy the requirements of the Civil Aviation Authority (CAA), Maritime and Coastguard Agency (MCA), and the Northern Lighthouse Board (NLB) in respect of marking, lighting and fog-horn specifications.

2.3.1.4 Typically, WTG components will undergo some pre-assembly before being transported to site by either a transport barge or installation vessel. They will then be lifted onto an installed substructure using a crane attached to an installation vessel.

Table 2.3.1: WTG Parameters				
Parameter	**Maximum Design Envelope**			
	Model 1 WTGs	**Model 2 WTGs**	**Model 3 WTGs**	**Model 4 WTGs**
Maximum number of WTGs	85	85	72	62
Minimum height of lowest blade tip above HAT (m)	22	22	22	22
Maximum blade tip height above HAT (m)	199	230	265	285
Maximum rotor blade diameter (m)	164	195	230	250
Minimum spacing between turbines (m)	1,200 downwind and 1,050 crosswind			

2.3.2 Foundations and Substructures

2.3.2.1 The WTG substructures provide the seabed foundation and supporting structure to an elevation above water level for the WTGs. There are a number of foundation and substructure types that can be used and the types will not be confirmed until the final design of the wind farm post-consent. Consequently, the following range of types are within the design envelope:

- Piled monopile substructures ('monopiles');
- Pin-piled jacket substructures;
- Suction caisson foundation (for jacket or monopile substructures); and
- Gravity base structure foundations.

2.3.2.2 If available to the market at the time of construction, hybrid substructure types may also be used. However, design parameters for any hybrid substructure would not exceed those included in the Design Envelope that forms the basis of the Section 36 and Marine Licence Applications for the Development.

Monopile Substructures

2.3.2.3 A monopile typically consists of a single tubular steel column (pile) embedded into the seabed and extending to approximately water surface level. A tubular steel transition piece (TP) of similar diameter is fitted on to the pile and secured mechanically (e.g. bolts) or by a grouted interface. The TP may include integrated ancillary components, such as boat landing, working platform, sacrificial anodes etc., as well as providing the connection to the wind turbine tower. The maximum dimensions of the monopile substructures can be seen in Table 2.3.2 below.

Table 2.3.2: Monopile Parameters		
Parameter	**Maximum Design Envelope**	
	Model 1 WTGs	**Model 4 WTGs**
Number of monopiles	85	62
Diameter of monopile (m)	12	15
Embedment depth (below seabed)	50	50

2.3.2.4 In the case of all substructure types, the substructures will be fabricated offsite, stored at a suitable port facility and transported to site as needed. Again, in the case of all substructure types, prior to installation, pre-construction preparatory works may be required, such as seabed levelling or boulder clearance.

2.3.2.5 Monopiles will be transported to site either on the installation vessel or on transport barges. Alternatively, monopiles can be sealed and floated horizontally so that they can be towed to site using tugs. Once on site, the monopiles will be installed using the following process:

- Upend and lower pile to seabed using vessel gripper system to maintain verticality;
- Drive pile through seabed to the required embedment depth using either vibro hammer, impact hammer or a combination of techniques;
- Lift transition piece onto monopile (note this may be undertaken at a later date from pile installation); and
- Secure transition piece onto monopile either with grout, bolts or other connection mechanism.

2.3.2.6 If percussive piling installation is not possible due to the presence of rock or hard soils, the material inside the monopile may be drilled out before the monopile is driven to the required depth. This can be done in advance of the driving or if the pilling rate slows significantly during piling, known as refusal. If drilling is required, spoil arising from the drilling will be disposed of adjacent to the foundation location.

2.3.2.7 The piling would include a 20 minute 'soft start' where the hammer energy will be kept at a minimum of approximately 10% maximum energy before being gradually increased in order to maintain a steady embedment rate. Depending on the soil condition encountered, maximum hammer energy will only be required at the later stages of the piling operation. The maximum anticipated hammer energy for monopile installation is 5,000 kJ, with the maximum duration of piling (based on pin piles with 3,000 kJ hammer energy) being nine months (Table 5.2.1).

2.3.2.8 Where grout is used to attach the TP to monopile, this will comprise an inert cement mix that is pumped into the anulus between the TP and the monopile. The grout will be pumped either from the installation vessel or a support vessel. The process will be carefully controlled and monitored to ensure minimal grout is lost to the surrounding environment. The bolted solution will use bolts to connect the TP to the monopile in a similar manner to that used to connect the turbine and the TP.

2.3.2.9 Monopile installation may take up to nine months in total. Up to two installation vessels may be used, with up to two piling events occurring simultaneously.

Pin-piled Jacket Substructures

2.3.2.10 Piled jacket substructures are formed of a steel lattice construction (comprising tubular steel members and welded joints) secured to the seabed by hollow steel pin-piles connected to the jacket feet. The piles rely on frictional and end bearing properties of the seabed for support. Unlike monopiles, there is no separate TP; the TP and ancillary structure is fabricated as an integral part of the jacket. Pin-piles will typically be of a smaller diameter than monopiles.

2.3.2.11 Jacket substructures would be three- or four-legged. The Design Envelope for jacket substructures with pin-piles is shown in Table 2.3.3 below.

Table 2.3.3: Pin-pile Jacket Parameters		
Parameter	**Maximum Design Envelope**	
	Model 1 WTGs	**Model 4 WTGs**
Number of jackets	85	62
Number of legs per jacket	3 or 4	3 or4
Separation of adjacent legs at seabed level (m)	35	40
Leg diameter (m)	3	3.5
Piles per foundation	4	4
Pin pile diameter (m)	3.5	4
Embedment depth (below seabed)	60	60

2.3.2.12 As with the installation of the monopiles, piled jacket structures will be transported to site by installation vessels or barges and lowered onto the seabed by the installation vessel.

2.3.2.13 The pin-piles can be installed either before or after the jacket is lowered to the seabed. If before; a piling template will be placed on the seabed to guide the pile locations. This is usually a welded steel structure. The piles will then be installed through the template, and the jacket affixed to the piles after it has been lowered into position, either mechanically (swage / gripper) or by grouted connection. If after; the piles will be installed through the jacket feet at the seabed, or through the legs of the jacket from the top of the structure.

2.3.2.14 As with monopiles, pile driving would include a 'soft start' procedure for approximately 20 minutes before hammer energies are increased gradually during the piling operation to maintain a sufficient rate of penetration. Depending on the soil condition encountered, maximum hammer energy will only be required at the later stages of the piling operation.

2.3.2.15 The pin-piles can be impact driven, drilled or vibrated into the seabed, in a similar way to monopiles. However, as pin-piles are smaller, the maximum hammer energy (for impact driving) to be used would be lower. The seabed preparation would be as for the monopile substructures. Pin-pile installation may take up to nine months in total. Up to two installation vessels may be used, with up to two piling events occurring simultaneously.

Suction Caisson Foundations (for both Jacket or Monopile Substructures)

2.3.2.16 Suction caissons consist of a steel cylindrical skirt or skirts (the bucket) sealed at the top, which penetrate into the seabed under the weight of the jacket and hydrostatic forces created as a result of hydraulically excavating the internal cavity of the bucket. Once sealed into position these hydrostatic forces provide the structure with sufficient connection with the seabed for the environmental (wind, wave and tide) and turbine loads.

2.3.2.17 Suction caissons can be used with either jacket or monopile substructures. For both the jacket and monopile substructures the TP and ancillary structures may be fabricated as an integrated part of the substructure.

2.3.2.18 Suction caisson jacket substructures will be three or four-legged, whereas monopile caissons will comprise larger, singular structures. Consequently, the dimensions of the suction caissons required for jacket substructures compared to monopile substructures will be different. The Design Envelopes for suction caisson jacket substructures and suction caisson monopile substructures are presented in Tables 2.3.4 and 2.3.5 respectively.

Table 2.3.4: Suction Caisson Jacket Parameters		
Parameter	**Maximum Design Envelope**	
	Model 1 WTGs	**Model 4 WTGs**
Number of jackets	85	62
Number of legs per jacket	3 or 4	3 or4
Separation of adjacent legs at seabed level (m)	35	40
Leg diameter (m)	3	3.5
Suction caissons per foundation	4	4
Suction caisson diameter (m)	20	25
Caisson penetration depth (below seabed) (m)	15	20
Height of caisson remaining above seabed once installed (m)	10	10

Table 2.3.5: Monopile Suction Caisson Parameters		
Parameter	**Maximum Design Envelope**	
	Model 1 WTGs	**Model 4 WTGs**
Number of suction caissons	85	62
Suction caissons per foundation	1	1
Suction caisson diameter (m)	45	55
Caisson penetration depth (below seabed) (m)	30	35
Height of caisson remaining above seabed once installed (m)	10	10

2.3.2.19 The suction caissons (already attached to jacket or monopile substructures) will be transported to site on a jack-up barge or suitable heavy lift vessel. The suction caisson structures (jacket or monopile) will be lowered to the seabed using a crane. The suction caisson will then either be pushed into the seabed or a negative pressure will be created within the skirt by a pipe that is used to "suck the water out" of the caisson. This will secure the suction caisson and associated substructure to the seabed. Concrete or an appropriate filler may then be injected into the caisson between the seabed and the caisson lid.

2.3.2.20 As well as the boulder and obstruction removal that is described in the monopiles section above, some seabed levelling may be required before the suction caissons are installed.

2.3.2.21 Where required, grout will be used to provide a strong connection between the suction caisson and the jacket / monopile. This will be installed using a Remote Operated Vehicle (ROV). After grouting, scour protection may also need to be installed around each suction caisson depending on local conditions.

2.3.2.22 Should the TP not form part of an integrated structure, it will be lifted into position and secured onto the monopile or jacket substructure either with grout, bolts or another connection mechanism.

Gravity Base Substructures

2.3.2.23 Gravity base substructures are concrete or concrete-steel hybrid structures, sometimes including additional ballast (typically sand, gravel, rock or dredged material) that sit on the seabed to support the turbine tower. Gravity bases vary in shape, but are significantly wider at the base (at seabed level) to provide support and stability to the structure. Conical or upside down T-shaped bases are being considered for the Development. The Design Envelope for gravity base substructures is shown in Table 2.3.6.

Table 2.3.6: Gravity Base Foundation Parameters

Parameter	Maximum Design Envelope	
	Model 1 WTGs	Model 4 WTGs
Number of gravity base substructures	85	62
External diameter at sea surface (m)	12	15
External diameter at seabed (m)	45	55
Height of installed base above seabed (m)	20	30

2.3.2.24 A gravity base does not require piling or drilling to remain in place. They can either be brought to site on barges or installation vessels as for the other foundation types, or alternatively they can be floated to site. This would be done by designing the structures to be buoyant, and towing them to site using tugs and support vessels. The foundations would then be lowered to the seabed in a controlled manner either by pumping in water, or installation of ballast (or both).

2.3.2.25 Gravity base substructures need to be placed in pre-prepared areas of seabed. Seabed preparation would involve levelling and dredging of the soft mobile sediments as required, as well as any boulder and obstruction removal, and the installation of a gravel bedding and levelling layer. Dredging would be carried out by dredging vessels using suction hoppers or similar, and the spoil would either be deposited on site or at a licensed marine disposal site. It is possible that a portion of it could be used as under-base infill and ballast. The bedding and levelling layer installation would be undertaken by a rock installation vessel such as a 'fall pipe' type vessel.

2.3.2.26 Some gravity base structure solutions may require the injection of a cement grout mix under the foundation to strengthen the sea bed and / or fill voids to ensure structural integrity.

2.3.3 Scour Protection for Substructures

2.3.3.1 Scour protection is designed to prevent substructures for WTGs, OSPs and other offshore infrastructure being undermined by hydrodynamic and sedimentary processes, resulting in seabed erosion and subsequent scour hole formation. The shape of the substructure is an important parameter influencing the potential depth of scour hole formation. Scour around substructures is typically mitigated by the use of scour protection measures. Several types of scour protection exist, and the Development is considering use of the following:

- Graded rock placement – layers of graded stones placed around / on structures to inhibit erosion;
- Rock bags – rock-filled fibre mesh bags, which adopt the shape of the seabed/structure as they are lowered onto it;
- Concrete mattresses - typically several metres wide and long, of cast articulated concrete blocks which are linked by a polypropylene rope lattice, which are placed on / around structures to stabilise the seabed and inhibit erosion; and

- Frond mats – mats typically several metres wide and long, comprised of continuous lines of overlapping buoyant polypropylene fronds that create a drag barrier which prevents the sediment in their vicinity from being transported away. The frond lines are secured to a polyester webbing mesh base that is itself secured to the seabed by a weighted perimeter or anchors pre-attached to the mesh base by polyester webbing lines.

2.3.3.2 The amount and type of scour protection required will vary for the different substructure types being considered and the final design of the substructures, which will in turn be influenced by the results of pre-construction seabed investigation. As with the WTG types and substructures, flexibility in scour protection choice is required to ensure that anticipated changes in available technology can be accommodated within the final Development design.

2.3.3.3 Scour protection options for WTG substructures and maximum area of scour protection (m^2) are shown in Table 2.3.7 below.

Table 2.3.7: Scour Protection Parameters

Parameter	Maximum Design Envelope				
	Monopile	**Pin-Pile Jacket (per pin pile)**	**Suction Caisson Jacket (per caisson)**	**Mono Suction Caisson**	**Gravity Base**
Scour protection options	Rock placement; rock bags; concrete mattressing; frond mats				
Area of scour protection (including foundation) per foundation (m^2)	1,080	167	1100	4,712	4,712

2.3.4 Inter-Array Cables

2.3.4.1 Inter-array cable circuits carry the electrical current produced by the WTGs. They link the WTGs to one another and the WTGs to the OSP(s), from where the electricity generated can be transformed in voltage and transferred to shore.

2.3.4.2 The inter-array cable circuits will consist of a number of power conductor cores, usually made from copper or aluminium, and fibre optic communication cables surrounded by layers of insulating material as well as material to armour the cable for protection from external damage and material to keep the cable watertight. The Design Envelope for inter-array cables is shown in Table 2.3.8 below.

Table 2.3.8: Inter-array Cable Circuit Parameters

Parameter	Maximum Design Envelope
Cable specification	3-core cable, most likely with integrated fibre optics
Length of cable (km)	275
Voltage range (kV)	33 - 72.5

2.3.4.3 Seabed obstructions, will be removed where necessary prior to cable installation. Pre-lay grapnel runs (PLGR) will be conducted to remove linear seabed surface debris along cable routes; debris will be brought ashore for recycling or disposal. Where boulders are present they may need to be removed by grab or plough methods, and they will be moved onto seabed adjacent to the cable route.

2.3.4.4 The cables will be buried below the seabed wherever possible, to a minimum trench depth of 1 m, noting that trench depths may vary across the site down to 3 m depending on seabed conditions.

2.3.4.5 Possible installation methods include jetting, cutting and ploughing whereby the seabed is opened and the cable laid within the trench simultaneously using a tool towed behind the installation vessel. Alternatively, it may also be necessary to install the cable by pre-trenching whereby a trench is opened in one operation and then the cable laid subsequently from another vessel. These operations may occur post-cable lay whereby the cable is surface laid onto the seabed, a trench is opened up, and the cable is then laid into the trench.

2.3.4.6 If the inter-array cables must cross infrastructure such as existing cables, both the third-party asset and the installed cable must be protected. This protection would usually consist of rock placement or concrete mattressing.

2.3.4.7 There may be a requirement for cable protection around the inter-array cables as they transition from the seabed to enter the WTGs via J-tubes or I-tubes (hollow tubes that hang from the substructure that are in the shape of an "I" or "J"). The exact amount of cable protection required at each cable end will depend on the burial depths achieved by the inter-array cable installation.

2.3.4.8 In some cases it may be necessary to use alternative methods (other than burial) to provide an adequate degree of protection for the cables. The method of cable protection may include rock placement or use of concrete mattresses or grout bags and/or installation of a cable protection system (CPS) around the cable.

2.4 Offshore Transmission Infrastructure

2.4.1 Offshore Substation Platforms

2.4.1.1 Up to two offshore substation platforms (OSPs) will be located within the Moray West Site. OSPs provide a centralised connection point for the inter-array cable circuits and contain the primary electrical equipment and ancillary components that are required to transform the voltage of the electricity generated at the WTGs to a higher voltage that is suitable for transporting power to the onshore electricity transmission network.

2.4.1.2 In terms of appearance, the most common designs use a platform consisting of a single or multi-level 'topside' within or upon which sits the primary electrical equipment and ancillary components. The topside is supported above sea level on a foundation structure. The primary electrical equipment on the topside typically includes step-up transformers and switchgear. The ancillary components typically include communication and control equipment as well as emergency refuge facilities. The OSP(s) will be high voltage alternating current (HVAC).

2.4.1.3 As with the WTGs, the OSPs will be marked in accordance with the requirements of the NLB, MCA and CAA.

2.4.1.4 The OSPs will be pre-fabricated onshore. Installation of the substructures and application of scour protection (where required) will occur using the methods described in Section 2.3.3 above in relation to WTG substructures.

2.4.1.5 Table 2.4.1 presents the Design Envelope parameters for the OSPs.

Table 2.4.1: OSP Design Parameters		
Parameter	**Maximum Design Envelope**	
	1 OSP	**2 OSPs**
Topside length (m)	100	75
Topside width (m)	100	75
Topside height above HAT (m)	70	60

Substructures

2.4.1.6 The OSPs will be supported by pin-pile or suction caisson jackets, jack-up, monopile, mono suction caisson or gravity base substructures. The characteristics of the substructures will be similar to those already described under those appropriate headings above (see Section 2.3.2 above). The jack-up concept, which is not considered for WTGs, is described below.

Jack-Up

2.4.1.7 The fabricated jack-up (with or without the WTG pre-installed) consists of a self-elevating platform with a buoyant hull and movable legs, made of tubular steel sections, capable of raising its hull over the surface of the sea. The buoyant hull enables transportation of the unit and all attached machinery (substation) to site. Once on location, the legs of the jack-up will be lowered onto the seabed enabling the hull to then be raised to the required elevation above the sea surface. Once installed, the jack-up supporting the OSP(s) will remain fixed at the site for the duration of the operation of the offshore wind farm.

2.4.1.8 The jack-up is towed to site, unless self-propelled, and then has its legs lowered to the seabed and pre-loaded (ballast water is added to the legs) before being jacked-up to appropriate clearance above the sea surface before being fixed in situ, most likely using pin-piles as for the jacket substructure.

2.4.1.9 Table 2.4.2 below presents the Design Envelope parameters for the OSP substructure options.

Table 2.4.2: OSP Substructure Parameters		
Element	**2 OSPs**	**1 OSP**
Monopiles		
Number of monopiles	2	1
Diameter of monopile (m)	15	15
Embedment depth (below seabed)	50	50
Jack-Ups		
Number of jack ups	2	1
Number of legs per jack up	4	8
Separation of adjacent legs at seabed level (m)	50	100
Leg diameter (m)	3.5	3.5
Pin-Pile Jackets		
Number of jackets	2	1
Number of legs per jacket	4	8

Table 2.4.2: OSP Substructure Parameters		
Element	**2 OSPs**	**1 OSP**
Separation of adjacent legs at seabed level (m)	50	100
Leg diameter (m)	3.5	3.5
Piles per jacket	4	8
Pin-pile diameter (m)	3.5	4
Embedment depth (below seabed)	60	60
Suction Caisson Jackets		
Number of jackets	2	1
Number of legs per jacket	4	4
Separation of adjacent legs at seabed level (m)	35	40
Leg diameter (m)	3.5	3.5
Suction caissons per foundation	4	4
Suction caisson diameter (m)	20	30
Caisson penetration depth (below seabed) (m)	15	25
Height of caisson remaining above seabed once installed (m)	10	10
Suction Caisson Monopiles		
Number of suction caissons	2	1
Suction caissons per substructure	1	1
Suction caisson diameter (m)	45	55
Caisson penetration depth (below seabed) (m)	30	35
Height of caisson remaining above seabed once installed (m)	10	10
Gravity Base Structures		
Number of gravity base substructures	2	1
External diameter at sea surface (m)	15	15
External diameter at seabed (m)	55	80
Seabed preparation diameter (m)	95	120
Seabed excavated depth (m)	5	8
Height of installed base above seabed (m)	20	30

2.4.2 OSP Interconnector Cables

Design

2.4.2.1 If two OSPs are installed, an interconnector cable circuit may be used to link the two OSPs. The extent of the possible cabling between OSP(s) will depend upon the distance between OSP(s), which will be located within the Moray West Site. The voltage for the OSP interconnector cables will be between 33 and 400 kV as presented in Table 2.4.3 below.

2.4.2.2 The OSP Interconnector cables will be installed using the methods described above for the inter-array cabling (Section 2.3.4). Cables will be buried and / or protected as described in Section 2.3.4 above.

Table 2.4.3: Most Likely OSP Interconnector Cable Parameters

Parameter	Maximum Design Envelope
Cable specification	3-core cable with integrated fibre optics
Cable diameter (mm)	200 (subject to crossing agreement)
Total length of cable circuit (km)	15
Voltage range (kV)	33 - 400

2.4.3 Offshore Export Cables

2.4.3.1 Offshore export cable circuits will transfer power from the OSPs to the landfall location in the Landfall Area. Two export cable circuits will be installed in total, and they will be located within the Offshore Export Cable Corridor shown in Figure 1.1.1.

2.4.3.2 Like the inter-array cables, the offshore export cables will consist of a number of conductor cores, usually made from copper or aluminium. These will be surrounded by layers of insulating material as well as material to armour the cable for protection from external damage, and material to keep the cable watertight. Export cables however, are typically larger in diameter than inter-array cables, due to the larger conductor cores required to transport greater volumes of power. Fibre optic cabling, which allows for communication with the Development, is typically wrapped around the export cables, though may be installed separately.

2.4.3.3 The installation method for the export cable circuits will be as described for inter-array cables (see Section 2.3.4).

2.4.3.4 Management of cable crossings (a maximum design scenario of six has been allowed for) will be as described for inter-array cables (see Section 2.3.4 above).

2.4.3.5 Export cable protection measures will be as described for inter-array cables (see Section 2.3.4 above).

2.4.3.6 The Design Envelope for export cables is shown in Table 2.4.4 below.

Table 2.4.4: Export Cable Parameters

Parameter	Maximum Design Envelope
Number of export cable circuits	Up to 2
Cable circuit specification	3-core cable, most likely with integrated fibre optics
Total length of cable (km)	65 per circuit
Voltage range (kV)	132 - 400

2.4.4 Landfall

2.4.4.1 The offshore export cable 'landfall' is the location where the offshore export cable circuits are brought ashore and connected to the onshore export cable circuits within transition joint bays (TJBs). The TJBs comprise buried underground chambers that are installed at a location above Mean High Water Springs (MHWS) (to minimise the potential for seawater to enter the TJB).

2.4.4.2 At the landfall, the offshore export cable circuits will be installed using one, or a combination of, the following:

- Jetting / open-cut trenching – This involves excavating a trench from a point below MLWS to the TJBs using one of the methods described in Section 2.3.4 above. From the cable laying vessel, the offshore export cable circuits are brought to the landfall by a combination of floating and pulling ashore. Once in position the cables are sunk to the seabed and then laid in the trench before the trench is backfilled.
- Horizontal directional drilling (HDD) – HDD involves drilling holes from the landward side of the landfall to a point where marine installation equipment can operate. Ducts or pipes are installed in the drilled holes and the cables are then pulled into the ducts.

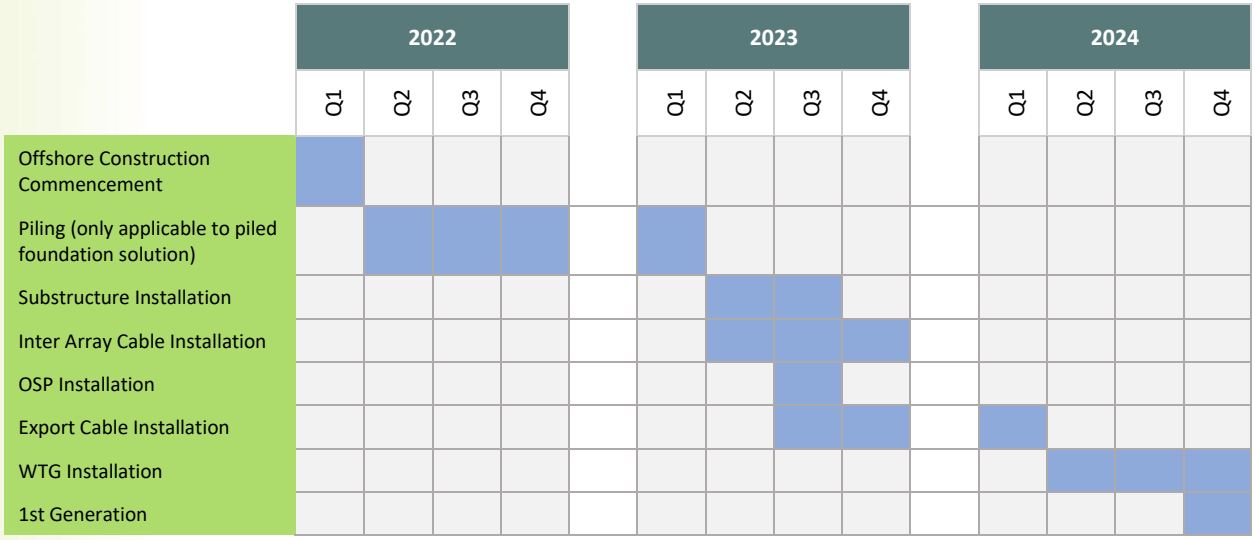
2.5 Construction Programme

2.5.1.1 A high-level indicative construction programme is presented in Image 2.5.1 below. The programme illustrates the likely duration of the major offshore installation elements, and how they may relate to one another if built out in a single construction campaign. It covers installation of the major components and does not include elements such as preliminary site preparation and commissioning of the wind farm post-construction. Offshore construction is currently planned to commence in 2022 and complete in 2024. First generation is currently predicted to occur in 2024 and the Wind Farm is currently predicted to be fully commissioned in 2025.

2.5.1.2 Timing of construction works will be subject to CfD and actual works durations will be dependent on a number of factors including, component and vessel availability, weather and final construction strategy. Construction is intended to take place 24 hours per day, 365 days per year, subject to weather conditions, until construction is complete.

2.5.1.3 It is likely that construction of the onshore substation and installation of the onshore cable circuits will occur in parallel, from Quarter 2 of 2022.

Image 2.5.1: Offshore Construction Programme



2.5.2 Construction Vessels and Helicopters

2.5.2.1 Construction will require a variety of different vessel and helicopter options dependent on the final WTG and substructure design, selected construction port, and overall construction strategy.

2.5.2.2 It is expected that up to 25 construction vessels may be present at or in the vicinity of the Development location at any one time, potentially working in the Moray West Site and along the Offshore Export Cable Corridor simultaneously.

2.6 Operation and Maintenance

2.6.1 Operation and Maintenance Strategy

2.6.1.1 The indicative programme (see Section 2.5) suggests that Operation and Maintenance (O&M) activity will commence in 2024 based on a construction start date of 2022.

2.6.1.2 The overall O&M strategy will be finalised once the technical specification of the Development is known. O&M activities will most likely be coordinated from an onshore O&M harbour base located in close proximity to the Development.

2.6.1.3 The O&M strategy for the Development will allow for the use of either a Special Operations Vessel (SOV) that will accommodate O&M personnel offshore, or a combination of Crew Transfer Vessels (CTVs), supply vessels, and helicopters. Larger heavy lift vessels or jack up barges may be used for occasional major maintenance works.

2.6.1.4 Maintenance activities can be categorised into two levels: preventative and corrective maintenance. Preventative maintenance is according to scheduled services whereas corrective maintenance covers unexpected repairs, component replacements, retrofit campaigns and breakdowns.

2.6.1.5 Typical maintenance activities would include: general wind turbine service; oil sampling / change; UPS (uninterruptible power supply)-battery change; service and inspections of wind turbine safety equipment, nacelle crane, service lift, high voltage (HV) system and blades; major overhauls (typically every few years); wind turbine repairs and restarts.

2.6.1.6 During the life of the Development, there should be no need for scheduled repair or replacement of the sub-sea cables, however, reactive repairs may be required and periodic inspection may be required. Periodic surveys would also be required to ensure the cables remain buried and if they do become exposed, re-burial works would be undertaken.

2.6.2 O&M Vessels

2.6.2.1 A number of vessel visits to each turbine and OSP would be required each year to allow for scheduled and unscheduled maintenance.

2.6.2.2 If O&M activity is coordinated entirely from an onshore base, this would mean small crew vessels sailing to and from the Moray West Site on a daily basis from shore. If the SOV option is preferred, the majority of small crew vessels would be operated on a daily basis from a single SOV, although further support vessels are also still likely to transit to and from shore each day and helicopter operations may still be utilised. OSPs would require one visit a week maximum.

2.6.2.3 Although it is not anticipated that large components (e.g. wind turbine blades or substation transformers) would frequently require replacement during the operational phase, the failure of one of these components is possible. Should this be required, large jack-up or heavy lift vessels may need to operate continuously for significant periods to carry out these major maintenance activities.

2.7 Decommissioning

2.7.1.1 At the end of the operational lifetime of the offshore wind farm, it is anticipated that all structures above the seabed level will be completely removed. The decommissioning sequence will generally be the reverse of the construction sequence (reverse lay) and involve similar types and numbers of vessels and equipment. Closer to the time of decommissioning, it may be decided that removal would lead to greater environmental impacts than leaving components in-situ, in which case certain components may be cut at or below the seabed (e.g. piles), or left buried (e.g. cables).

2.7.1.2 A decommissioning plan and programme would be required to be submitted prior to the construction of the Development. The decommissioning plan and programme would be updated during the lifespan of the wind farm to take account of changing best practice and new technology.

2.7.1.3 For the purpose of this RIAA the following has been assumed; that WTGs and OSPs, and foundations and substructures, would be removed, where practicable, with piled foundations removed to just below seabed. There is no statutory requirement for decommissioned subsea cables to be removed, though it has been assumed that they will be removed.

3 The HRA Process

3.1 Legislative Context

3.1.1.1 Under Article 6(3) of the Habitats Directive, a HRA is required where a plan or project is likely to have a significant effect upon a European site (also known as a 'Natura 2000' site) either individually or in combination with other plans or projects.

3.1.1.2 Within Scotland, the Habitats Regulations (HMSO, 1994) and the Offshore Habitats Regulations (HMSO, 2017) implement the Habitats Directive and the Birds Directive[5]. The Habitats Regulations specify, amongst other issues, how development control decisions which could directly or indirectly affect Natura sites are to be reached.

3.1.1.3 European sites include:

- Special Areas of Conservation (SACs) designated under the Habitats Directive to promote the protection of flora, fauna and habitats, along with sites which have been approved by Scottish Ministers for formal consultation but which have not yet been formally accepted and designated at a European level (candidate SACs (cSACs) and Sites of Community Importance (SCIs)); and
- Special Protection Areas (SPAs) designated under the Birds Directive in order to protect rare, vulnerable and migratory birds, along with sites which have been approved by Scottish Ministers for formal consultation but which have not yet been formally accepted and designated at a European level (potential SPAs (pSPAs)).

3.1.1.4 Scottish Planning Policy (Scottish Government, 2014) states that proposed SPAs and SACs should be afforded the same level of protection as fully designated SPAs and SACs. In addition, SPP also states that Ramsar sites (wetlands of international importance designated under the Ramsar Convention 1971) are considered as European sites. Therefore, effects on these sites should also be appraised.

3.1.1.5 Article 6(3) of the Habitats Directive states that:

> *'Any plan or project not directly connected with or necessary to the management of the [European] site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives. In the light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4 [Article 6(4)], the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public.'*

3.1.1.6 It is therefore necessary, in the first instance, to determine whether it is possible to conclude that there is no LSE on the site. Only where it is not possible to conclude this, does an Appropriate Assessment need to be carried out by the CA. The European Court of Justice ruling in the case of Waddenzee (Case C-127/02), stated that an Appropriate Assessment of a project is necessary, "if it cannot be excluded, on the basis of objective information, that it will have a significant effect on the site." It is therefore clear that if LSE cannot be objectively ruled out, then an Appropriate Assessment must be carried out. The test is therefore negative, and embeds precaution within it.

[5] The Conservation (Natural Habitats &c.) Regulations 1994 apply to territorial waters out to 12 nautical miles (nm), while Conservation of Offshore Marine Habitats and Species Regulations 2017 apply to waters beyond 12 nm, to the extent of the British Fishery Limits and UK Continental Shelf Designated Area.

3.1.1.7 The Habitats Regulations and the Offshore Habitats Regulations provide that an Appropriate Assessment must be undertaken by the Competent Authority before any decision to give consent for any plan or project that is likely to have a significant effect on a European site (either alone or in combination with other plans or projects) and which is not directly connected with or necessary to the [conservation] management of the site. The Appropriate Assessment must be carried out in view of that site's conservation objectives.

3.2 The Habitats Regulations Appraisal (HRA) Process

3.2.1.1 Both the European Commission's Guidance 'Managing Natura 2000 Sites. The provisions of Article 6 of the Habitats Directive 92/43/EEC' (European Commission, 2000) and the SNH Guidance 'Natura sites and the Habitats Regulations. How to consider proposals affecting SACs and SPAs in Scotland. The essential quick guide' (SNH, 2010) identify a staged process that is applied. These can be summarised as:

- Step One: Is the proposal directly connected with or necessary for site management for nature conservation?;
- Step Two: Is the proposal likely to have a significant effect on the site? (otherwise referred to as 'screening');
- Step Three: Can it be ascertained that the proposal will not adversely affect the integrity of the site? (otherwise referred to as 'Appropriate Assessment'); and
- Step Four: If it cannot be ascertained that a proposal will not adversely affect the integrity of a Natura site are there any alternative solutions? If not, are there imperative reasons of overriding public interest (IROPI) for proceeding; and can compensatory measures be taken?

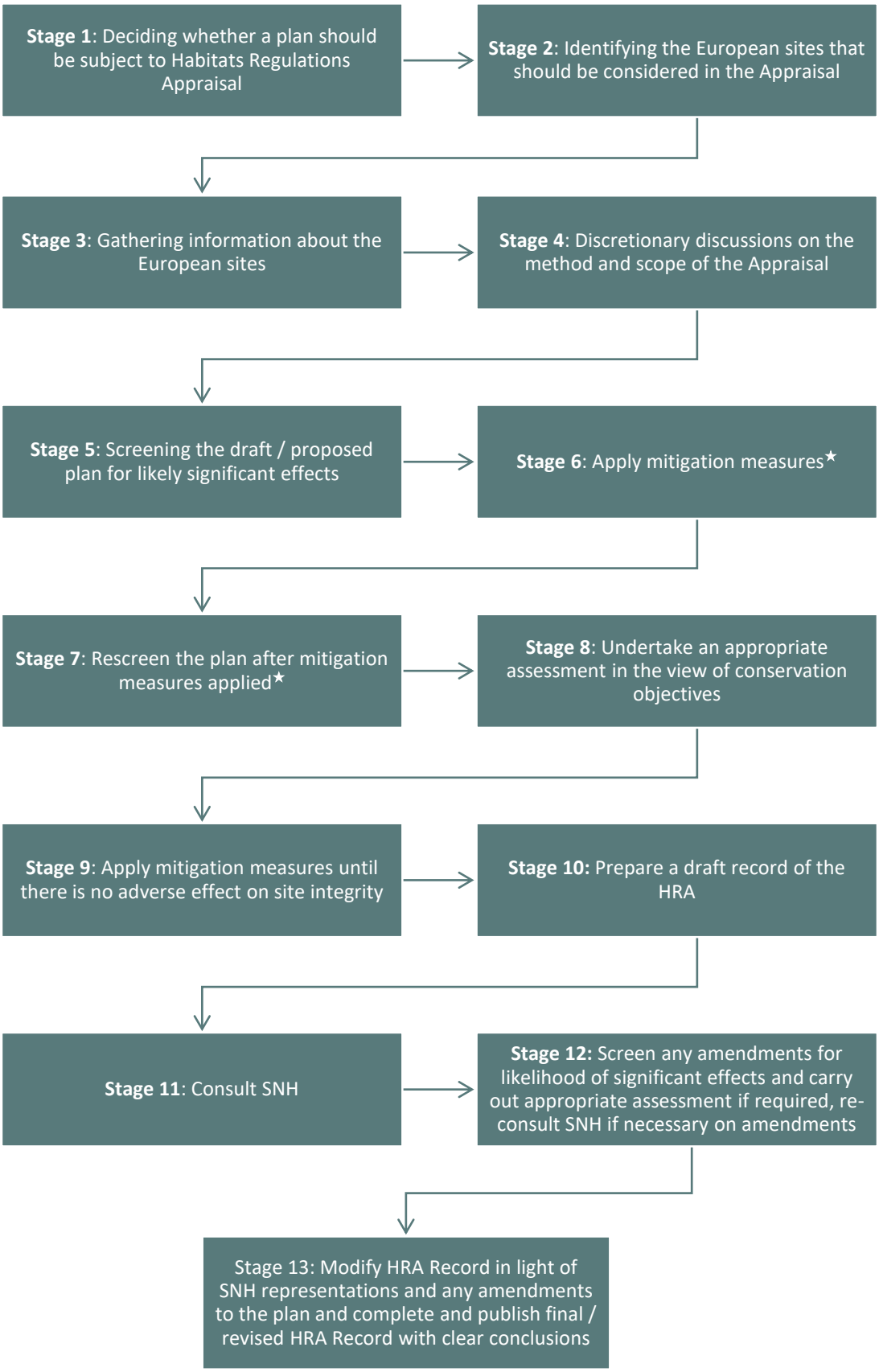
3.2.1.2 Cumulatively, these stages are referred to as a HRA, in order to clearly distinguish the whole process from the third stage within it, which is referred to as Appropriate Assessment.

3.2.1.3 Within Scotland, the HRA process draws upon and follows the advice provided within the SNH HRA guidance document 'Habitats Regulations Appraisal of Plans. Guidance for Plan-making Bodies in Scotland' (Tyldesley *et al.*, 2015). This guidance sets out a 13-stage process of statutory procedures which are designed to assess the potential effects of plans and projects on European sites. The guidance is referred to within 'Planning Circular 6 2013. Development Planning' (Scottish Government, 2013). The 13 steps and the order in which they are applied are illustrated in Figure 3.2.1. This document is set out to assist with the provision of information to the CA, to inform Step Three identified above and Stages 8 - 11 of Figure 3.2.1 (Appropriate Assessment and consultation stages).

3.2.1.4 Other guidance documents that have been used to inform this RIAA include:

- Department of Energy and Climate Change (DECC) (2016). Guidance on when new marine Natura 2000 sites should be taken into account in offshore renewable energy consents and licences. May 2016;
- SNH (2000). Natura Casework Guidance: Consideration of Proposals affecting SPA and SAC. Guidance Note Series; and
- Oxford Brookes (2001). Assessment of Plans and Projects Significantly Affecting Natura 2000 Sites: Methodological Guidance on the provisions of Article 6(3) and 6(4) of the 'Habitats' Directive 92/43/EEC. November 2001.

Figure 3.2.1 Summary illustration of HRA Process as set out within SNH Guidance (Tyldesley, D and Associates, 2015). See Footnote.



* Note: Stages 6 and 7 have not been applied during the HRA Screening Exercise. This reflects the recent European Court of Justice ruling made on the 12th April 2018 by Peter Sweetman. Further information can be found at:
http://curia.europa.eu/juris/document/document.jsf?text=&docid=200970&pageIndex=0&doclang=EN&mode=req&dir=&occ=first&part=1&cid=632898

4 HRA Screening

4.1 Introduction

4.1.1.1 This section describes the approach to, and outcome from, HRA Screening for the Development.

4.1.1.2 A detailed Offshore HRA Screening Report was produced in September 2017 (Moray West, 2017) and submitted to the Scottish Ministers for consultation (Appendix 4.1). An Offshore HRA Screening Opinion was received from MS-LOT in October 2017 (Marine Scotland, 2017) and is presented in full in Appendix 4.2.

4.1.1.3 Due to ongoing discussions in October 2017, regarding ornithological baseline characterisation and modelling requirements for EIA (and therefore also relevant to HRA), additional EIA and HRA advice on the ornithological requirements for SPAs was provided from MS-LOT and SNH through further detailed stakeholder consultations held on various occasions between October 2017 and April 2018. These consultations are discussed in more detail within the Offshore EIA Report (Moray West, 2018).

4.2 Screening Criteria

4.2.1.1 Screening is a relatively coarse filter to identify those European sites and qualifying features with connectivity to the Moray West Site for which a LSE cannot be discounted. In order to screen for LSE, three hierarchical aspects were applied:

- Connectivity;
- Route to impact; and
- Non-trivial abundance.

4.2.1.2 Connectivity was defined as the presence of the qualifying feature of an SPA, SAC or Ramsar site in the zone of influence of a project. So, if a qualifying feature had no connectivity to the Moray West Site, it led to the conclusion of no LSE. Where connectivity could not be objectively ruled out on this ground for any one qualifying feature, it was necessary to conclude that LSE cannot be excluded on the grounds of connectivity.

4.2.1.3 The next stage of the LSE consideration process was to consider potential for a route to impact (be it direct or indirect). Where connectivity had been identified, but it was determined that there was no route to impact on the qualifying feature, then it was still possible to objectively conclude no LSE. If, however, a route to impact existed then a conclusion of LSE could not be ruled out. Site-specific screening criteria were identified that assisted with this part of the appraisal (Moray West, 2017).

4.2.1.4 Finally, if following confirmation of potential for connectivity and route to impact the abundance of a qualifying feature within the zone of influence was deemed trivial, it was argued that no LSE could be concluded, as the conservation objectives of the site would not be compromised. The classification of trivial abundance was considered on a case by case basis and varied between features, based on their habitat extent or population size.

4.2.1.5 The European sites for which there was potential connectivity with the Moray West Site and Offshore Export Cable Corridor were identified using the criteria set out in Table 4.2.1.

Table 4.2.1: Screening Criteria for the Initial Identification of European Sites

Criteria for the initial identification of European Sites	Specific Criteria
European site or Ramsar that overlaps with the Moray West Site and / or Offshore Export Cable Corridor.	All - physical overlap between project boundary and designated site.

Table 4.2.1: Screening Criteria for the Initial Identification of European Sites	
Criteria for the initial identification of European Sites	**Specific Criteria**
SACs supporting mobile populations of qualifying features (e.g. Annex II marine mammals or migratory fish) that may interact with potential effects associated with the Moray West Site and / or Offshore Export Cable Corridor.	Extent of the mobile species study area – e.g. management units for marine mammals.
European site or Ramsar with qualifying features whose mean maximum foraging or migratory range overlaps with the Moray West Site and / or Offshore Export Cable Corridor.	Birds – based on standard ranges; Seal – based on standard foraging range from haul out sites; and Marine mammals & migratory fish – based upon known key migrations routes.
European sites with marine mammal and migratory fish qualifying features who may be exposed to auditory injury (Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS)).	Based on hearing thresholds identified through research and published data and project specific underwater noise modelling outputs
European sites with marine mammal and migratory fish qualifying features who may suffer behavioural changes or effects.	Assessment of behavioural responses to underwater noise taking into consideration published research findings.
European site or Ramsar and / or a qualifying feature located within the potential extent of impacts associated with the Moray West Site and / or Offshore Export Cable Corridor.	Indirect pathways to features e.g. pollution or suspended sediment reaching designated sites / features.
European site or Ramsar qualifying species recorded during site specific surveys.	Presence of a qualifying species that can be associated with a designated site.

4.2.1.6 Following the above process, for each European site (and their qualifying features) considered within the HRA screening it was concluded that either:

- There was no LSEs on the European site(s) and their qualifying features, so therefore no further assessment was required; or
- LSEs on the European site(s) and their qualifying features could not be discounted and therefore an Appropriate Assessment required completion by the Competent Authority.

4.2.1.7 Given the comparatively high level nature of screening, the precautionary principle was applied and so where any doubt as to the potential for LSE existed, the feature was screened into the Appropriate Assessment stage of the HRA process.

4.2.1.8 With respect to in-combination effects, the HRA Screening Report identified the categories of plans and projects that would need to be considered, but recognised that further discussion with the Competent Authority was required to identify specific projects for inclusion in the in-combination assessment. In January 2018, a list of plans, projects and activities identified as requiring consideration in the cumulative impact assessment (CIA) of the EIA was drawn up and consulted upon with MS-LOT and SNH. This specific list (as far as relevant to the qualifying features) is subsequently used within this in-combination assessment (Appendix 4.1). For those European sites and qualifying features screened into the Appropriate Assessment, a detailed in-combination assessment drawing on the findings of the EIA (including the CIA) that will be undertaken specifically for the Moray West Site to understand the magnitude of those effects and whether they may lead to an adverse effect on site integrity.

4.3 Initial Identification of Key Receptors that could be Impacted by the Development

4.3.1.1 Consideration was given to the existing Moray East Appropriate Assessment (Marine Scotland, 2014) and also the feedback from key stakeholders on the Moray West Site EIA Scoping Report. From these sources key receptors that were identified as being potentially impacted upon and required inclusion and consideration within the HRA Screening Report were identified as:

- Ornithological receptors (particularly breeding colonies) associated with a suite of SPAs identified as having connectivity;
- Marine mammal receptors and the assessment of key species associated with SACs with connectivity (harbour seal, bottlenose dolphin, harbour porpoise and grey seal – note minke whale is not an SAC qualifying feature and therefore is not included in the HRA);
- Migratory fish associated with SACs with connectivity (Atlantic salmon and sea lamprey); and
- Marine / estuarine habitat receptors associated with SACs with connectivity.

4.3.1.2 For ornithology, the potential impacts were focused on the breeding season as the period of key concern where there could be significant effects on SPA breeding colonies. While the consequences of impacts outwith the breeding season on SPA breeding colonies are less clearly understood, these are also becoming increasingly important and required consideration.

4.3.1.3 For marine mammals, the key concern was the potential disturbance of marine mammals due to construction noise (particularly from pile-driving the turbine foundations) and collision risk and disturbance from vessels.

4.3.1.4 For migratory fish, the key concern was associated with the impact of underwater noise upon migratory behaviour and movements of adult salmon and smolts.

4.3.1.5 For marine / estuarine habitat receptors, the key concern was the potential for changes to habitat features due to hydrodynamic changes caused by the presence of WTG and OSP foundations. These habitat features included Annex I sandbanks which are slightly covered by sea water all the time, Atlantic salt meadows, intertidal mudflats and sandflats, and subtidal sandflats.

4.4 European Sites Considered in the HRA Screening Report

4.4.1.1 The Scoping Opinion received from Marine Scotland for the Moray West Offshore Wind Farm (Marine Scotland, 2016) provided detailed advice on the European sites and Ramsar that the Competent Authority and its statutory advisors considered to require assessment as part of the HRA. The HRA Screening Report (Moray West, 2017) however, undertook a full independent review of all European sites that had potential to have connectivity with the Moray West Site and OfTI to ensure that all screening out was justified and validated. Full details of the European sites considered during screening are set out within the HRA Screening Report (Moray West, 2017).

4.4.1.2 The Screening Report initially identified 29 European sites for which an LSE on one or more features could not be discounted. These included:

- **A total of 13 European sites designated for ornithological features**: one pSPA (Moray Firth); nine SPA (East Caithness Cliffs, North Caithness Cliffs, Troup, Pennan and Lion's Heads, Buchan Ness to Collieston Coast, Loch of Strathbeg, Moray and Nairn Coast, Dornoch Firth and Loch Fleet, Cromarty Firth and Inner Moray Firth); and three Ramsar (Dornoch Firth and Loch Fleet, Cromarty Firth and Inner Moray Firth);
- **A total of five SACs designated for marine mammal features**: Moray Firth, Dornoch Firth and Morrich More, Faray and Holm of Faray, Isle of May and Monach Islands;

- **A total of eight SACs designated for migratory fish features**: Berriedale and Langwell Waters, River Borgie, River Dee, River Naver, River Thurso, River Oykel, River Moriston and River Spey; and
- **A total of three SACs designated for habitat features**: Moray Firth, Dornoch Firth and Morrich More and Culbin Bar.

4.5 Outcomes from HRA Screening

4.5.1 Introduction

4.5.1.1 The following section presents, for ornithological, marine mammal, migratory fish and habitat features the outcome from the HRA Screening exercise in terms of the following:

- Sites identified as requiring inclusion in the RIAA; and
- Impacts requiring further assessment in the RIAA on the basis of conclusions of LSEs.

4.5.2 Ornithology

Baseline Characterisation

4.5.2.1 Moray West has used an evidence based approach to characterising the offshore ornithology associated with the Moray West Site and along the Offshore Export Cable Corridor. This has been based on results from the digital aerial site-specific baseline characterisation surveys that were carried out between April 2016 and March 2017 combined with a number of other baseline data sources that exist for the Moray Firth (and, to varying extents, overlap with the Moray West Site) which include:

- Moray East boat-based surveys – Data collected during 28 boat-based surveys between April 2010 and March 2012 covering Moray East Site plus a 4 km buffer;
- BOWL boat-based surveys – Data collected during boat-based surveys of the Beatrice Offshore Wind Farm plus a 4 km buffer between October 2009 and September 2011; and
- BOWL pre-construction aerial surveys – Data collected during aerial surveys of the area between the East Caithness Cliffs SPA and the Beatrice offshore wind farm plus a 10 km buffer between May and August 2015.
- Moray East aerial surveys – Data collected during six aerial surveys between May and July 2011 covering a wide strip from the East Caithness Cliffs and North Caithness Cliffs SPAs to the southern coast of the outer Moray Firth; and
- Zonal Surveys commissioned by The Crown Estate / COWRIE – comprising aerial surveys of the Moray Firth Zone (Zone 1) including a 4 km buffer.

4.5.2.2 Further information on these data and their use in the Moray West Offshore Wind Farm EIA and this RIAA is provided in the Offshore EIA Report (Volume 4) – Technical Appendix 10.1 and its Annex 10.1A. These data provide information on the densities of key seabird species in addition to data on flight heights, with both the BOWL pre-construction and Moray East boat based surveys overlapping to some extent with the Moray West Site (Offshore EIA Report Volume 4 - Technical Appendix 10.1, Annex 10.1A).

4.5.2.3 Additional data has also been gathered through great black-backed gull and herring gull tagging (project managed and co-funded by Moray East) as well as through regional strategic monitoring undertaken by Marine Scotland Science (MSS). Tracking data from this study are useful to establish connectivity between breeding colonies and the Moray West Site and, in turn, the assumptions that are made about apportioning of impacts calculated to arise from construction and operation of the Moray West Offshore Wind Farm back to those colonies.

4.5.2.4 Tracking of herring and great black-backed gulls has also been carried out at the East Caithness Cliffs SPA (Archibald *et al.,* 2014).

SPAs Identified as Having Connectivity with the Development and Therefore Requiring Inclusion in the RIAA

4.5.2.5 During the breeding season foraging birds may travel some distance from their breeding colonies. The information available on the distances that breeding birds will forage depends on the species. Thaxter *et al*. (2012) provides data on recorded foraging ranges for a wide range of species, including the mean and maximum distances travelled. Typically the mean-maximum range (i.e. the mean average of the maximum foraging trips recorded) has been used as a criterion for establishing whether there is likely to be connectivity (and hence risk of an impact) between a SPA breeding colony and a proposal/project. In some cases more specific information is available from GPS/satellite tracking studies, such as, for example, the FAME/STAR initiatives for kittiwake and gannet colonies associated with SPAs.

4.5.2.6 For the identification of SPAs relevant to the Moray West Offshore Wind Farm, mean-maximum foraging ranges (±1 SD) as reported by Thaxter *et al*. (2012) have been used to determine potential connectivity with the Moray West Site). A full description of the process used to identify connectivity between features of SPAs and the Moray West Site is provided in Appendix 4.2: Phenology and Apportioning.

4.5.2.7 During the non-breeding period, birds from colonies further afield may also be present within the Moray West study area (Moray West Site plus 4 km buffer), although there is some uncertainty regarding how many individuals from each of the colonies will be affected by the Moray West Offshore Wind Farm. Details of how potential impacts are apportioned are given in Appendix 4.2: Phenology and Apportioning for the RIAA, connectivity and apportioning for features of SPAs.

4.5.2.8 Tables 4.5.1 and 4.5.2 below list all the SPAs designated for breeding seabird features and SPAs designated for non-seabird migratory and wintering wildfowl species, respectively, considered in the HRA Screening as having potential to be affected by the Development. Those identified as having connectivity with the Development, and therefore requiring further assessment in the RIAA, are identified and justification provided for screening out certain sites and / or species.

Table 4.5.1: Breeding Seabird SPAs Requiring Inclusion in RIAA

Qualifying Feature	Foraging Range (km)	Distance to Closest Point (km)		Included in RIAA?	Justification
		Moray West Site	Offshore Export Cable Corridor		
Buchan Ness to Collieston Coast SPA					
Shag	14.5 ± 3.5	92.9	59.8	No	Both Moray West Site and Offshore Export Cable Corridor beyond foraging range therefore no connectivity.
Fulmar	400 ± 245.8			Yes	N/A
Guillemot	84.2 ± 50.1			Yes	N/A
Herring gull	61.1 ± 44.0			Yes	N/A

Table 4.5.1: Breeding Seabird SPAs Requiring Inclusion in RIAA					
Qualifying Feature	**Foraging Range (km)**	**Distance to Closest Point (km)**		**Included in RIAA?**	**Justification**
		Moray West Site	**Offshore Export Cable Corridor**		
Kittiwake	60.0 ± 23.3			Yes (Offshore Export Cable Corridor only)	Outside foraging range for the Moray West Site.
East Caithness Cliffs SPA					
Shag	14.5 ± 3.5	19.8	30	No	Both Moray West Site and Offshore Export Cable Corridor beyond foraging range therefore no connectivity.
Cormorant	25.0 ± 10.0			No	Absent from the aerial surveys.
Fulmar	400 ± 245.8			Yes	N/A
Guillemot	84.2 ± 50.1			Yes	N/A
Razorbill	48.5 ± 35.0			Yes	N/A
Great black-backed gull	60			No	Based on results from tracking work from East Caithness Cliffs SPA in 2014 (Archibald *et al.*, 2014) none of the great black-backed gulls fitted with tags foraged in the boundary of the Moray West Site and tended to only forage in nearshore areas, with maximum recorded distance offshore of 20 km but most trips much shorter than this. Therefore confirmed no connectivity.
Herring gull	61.1 ± 44.0			Yes	N/A
Kittiwake	60.0 ± 23.3			Yes	N/A
North Caithness Cliffs SPA					
Fulmar	400 ± 245.8	41.8	57.1	Yes	N/A
Guillemot	84.2 ± 50.1			Yes	N/A
Razorbill	48.5 ± 35.0			Yes	N/A
Puffin	105.4 ± 46.0			Yes	N/A
Kittiwake	60.0 ± 23.3			Yes	N/A
Troup, Pennan and Lion's Head SPA					
Fulmar	400 ± 245.8	52.4	20.8	Yes	N/A

Table 4.5.1: Breeding Seabird SPAs Requiring Inclusion in RIAA					
Qualifying Feature	**Foraging Range (km)**	**Distance to Closest Point (km)**		**Included in RIAA?**	**Justification**
		Moray West Site	**Offshore Export Cable Corridor**		
Guillemot	84.2 ± 50.1			Yes	N/A
Razorbill	48.5 ± 35.0			Yes	N/A
Herring gull	61.1 ± 44.0			Yes	N/A
Kittiwake	60.0 ± 23.3			Yes	N/A
Loch of Strathbeg SPA					
Sandwich tern	49.0 ± 7.1	76.7	47.7	No	Screened out based on advice from SNH (on basis not included in the final short list for the Moray East HRA) and only recorded in low numbers (12 birds in September)

Table 4.5.2: Non-Seabird Migratory and Wintering Wildfowl SPAs Requiring Inclusion in RIAA				
Qualifying Feature	**Distance to Closest Point (km)**		**Included in RIAA?**	**Justification for screening out of the RIAA**
	Moray West Site	**Offshore Export Cable Corridor**		
Loch Strathbeg SPA				
Pink-footed goose	76.7	47.7	No	Screened out based on advice from SNH (on basis not included in the final short list for the Moray East HRA) and only recorded in low numbers (one birds in May)
Moray Firth pSPA				
Shag, breeding and non-breeding; Common scoter, non-breeding; Eider, non-breeding; Goldeneye, non-breeding; Great northern diver, non-breeding; Long-tailed duck, non-breeding; Red-breasted merganser (*Mergus serrator*), non-breeding; Red-throated diver, non-breeding; Scaup, non-breeding; Slavonian grebe, non-breeding; and Velvet scoter, non-breeding.	11	0	Yes	N/A

Table 4.5.2: Non-Seabird Migratory and Wintering Wildfowl SPAs Requiring Inclusion in RIAA				
Qualifying Feature	**Distance to Closest Point (km)**		**Included in RIAA?**	**Justification for screening out of the RIAA**
	Moray West Site	**Offshore Export Cable Corridor**		
Moray and Nairn Coast SPA				
Bar-tailed godwit (*Limosa lapponica*), nonbreeding; Common scoter, non-breeding; Dunlin (*Calidris alpina alpina*), nonbreeding; Greylag goose (*Anser anser*), non-breeding; Long-tailed duck, non-breeding; Osprey (*Pandion haliaetus*), breeding; Oystercatcher (*Haematopus ostralegus*), non-breeding; Pink-footed goose (*Anser brachyrhynchus*), non-breeding; Red-breasted merganser, non-breeding; Redshank (*Tringa totanus*), non-breeding; Velvet scoter, non-breeding; Waterfowl assemblage, non-breeding; and Wigeon (*Anas penelope*), non-breeding.	36.8	10.5	No	No qualifying features of this SPA were recorded in the Moray West Site. Based on information in Marine Scotland's strategic collision risk assessment[6] birds migrating through Scottish Waters are not considered to be a risk of additional mortality due to collision with offshore wind farm turbines. There is no overlap with the Offshore Export Cable Corridor therefore no potential for direct effects relating to disturbance or habitat loss during cable installation.
Dornoch Firth and Loch Fleet Ramsar				
Bar-tailed godwit, non-breeding; Greylag goose, non-breeding; and Wigeon, non-breeding.	36.2	36.2	No	As for Moray and Nairn Coast SPA. No qualifying features recorded in the Moray West Site. No risk of additional mortality to migratory species due to collision with WTGs and no overlap with Offshore Export Cable Corridor.
Dornoch Firth and Loch Fleet SPA				
Bar-tailed godwit, non-breeding; Curlew (*Numenius arquata*), non-breeding; Dunlin, non-breeding; Greylag goose, non-breeding; Osprey, breeding; Oystercatcher, non-breeding; Teal (*Anas crecca*), non-breeding; and Wigeon, non-breeding.	36.2	36.2	No	As for Moray and Nairn Coast SPA. No qualifying features recorded in the Moray West Site. No risk of additional mortality to migratory species due to collision with WTGs and no overlap with Offshore Export Cable Corridor.
Cromarty Firth SPA				
Bar-tailed godwit, non-breeding; Common tern (*Sterna hirundo*), breeding; Curlew, non-breeding;	54.7	54.7	No	As for Moray and Nairn Coast SPA. No qualifying features recorded in the Moray West

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

Table 4.5.2: Non-Seabird Migratory and Wintering Wildfowl SPAs Requiring Inclusion in RIAA				
Qualifying Feature	**Distance to Closest Point (km)**		**Included in RIAA?**	**Justification for screening out of the RIAA**
	Moray West Site	**Offshore Export Cable Corridor**		
Dunlin, non-breeding; Greylag goose, non-breeding; Knot (*Calidris canutus*), non-breeding; Osprey, breeding; Oystercatcher, non-breeding; Pintail (*Anas acuta*), non-breeding; Red-breasted merganser, non-breeding; Redshank, non-breeding; Scaup, non-breeding; Whooper swan (*Cygnus cygnus*), nonbreeding; and Wigeon, non-breeding.				Site. No risk of additional mortality to migratory species due to collision with WTGs and no overlap with Offshore Export Cable Corridor.
Cromarty Firth Ramsar				
Bar-tailed godwit, non-breeding; and Greylag goose, non-breeding.	54.7	54.7	No	As for Moray and Nairn Coast SPA. No qualifying features recorded in the Moray West Site. No risk of additional mortality to migratory species due to collision with WTGs and no overlap with Offshore Export Cable Corridor.
Inner Moray Firth SPA				
Bar-tailed godwit, non-breeding; Common tern, breeding; Cormorant, non-breeding; Curlew, non-breeding; Goldeneye, non-breeding; Goosander (*Mergus merganser*), nonbreeding; Greylag goose, non-breeding; Osprey, breeding; Oystercatcher, non-breeding; Red-breasted merganser, non-breeding; Redshank, non-breeding; Scaup, non-breeding; Teal, non-breeding; and Wigeon, non-breeding.	63.1	61.5	No	As for Moray and Nairn Coast SPA. No qualifying features recorded in the Moray West Site. No risk of additional mortality to migratory species due to collision with WTGs and no overlap with Offshore Export Cable Corridor.
Inner Moray Firth Ramsar				
Bar-tailed godwit, non-breeding; Greylag goose, non-breeding; Red-breasted merganser, non-breeding; and Redshank, non-breeding.	63.1	61.5	No	As for Moray and Nairn Coast SPA. No qualifying features recorded in the Moray West Site. No risk of additional mortality to migratory species due to collision with WTGs and no overlap with Offshore Export Cable Corridor.

Impacts on Ornithological Receptors Requiring Assessment in the RIAA

4.5.2.9 Table 4.5.3 below provides a summary of the impacts identified as requiring assessment in the RIAA and those identified during HRA where it is concluded that there are no LSEs. In line with the recent European Court of Justice ruling made on the 12th April 2018 by Peter Sweetman the assessment of LSE does not consider the application of mitigation.

4.5.2.10 Further information on the screened in impacts is provided in Chapter 6.

Table 4.5.3: Impacts on Ornithological Receptors Requiring Assessment on the RIAA

Potential Impact	Screened In	Screened Out	Justification for Screening Out of the RIAA
Construction (and Decommissioning)			
Disturbance	x		N/A
Changes to prey availability / habitat loss	x		N/A
Effects of pollution	x		This impact was initially scoped out of the HRA on the basis that even though some species such as divers and auks are considered to be sensitive to pollution incidents, it was concluded that with the implementation of standard pollution prevention measures, the low likelihood of a pollution event occurring and the low quantities of pollutants expected to be released during an accidental spill or pollution event, that impacts at a population level would not occur. However, in light of the recent Sweetman court ruling given pollution prevention measures are considered to be a form of mitigation, in absence of these measures it cannot be concluded that there would be no LSE. Therefore further assessment of this impact is required.
Operation and Maintenance			
Displacement	x		N/A
Barrier effects	x		N/A
Collision risk	x		N/A
Changes in prey distribution	x		N/A
Attraction to lit structures and associated disorientation		x	Species most likely to be present in largest numbers within the Moray West Site (kittiwake, guillemot, razorbill and gannet (not an SPA species)) are unlikely to be active at night. Given that gulls are visual foragers that follow lit trawlers and other vessels it is unlikely that these species would become disorientated by the presence of lit structures. Species most at risk are migrant species that could pass through the Moray West Site at night. However, given the low numbers of migrant species identified as potentially passing through the Moray West Site and research (Welcker *et al*. (2017) which found nocturnal migrants do not have a higher risk of collision with

Table 4.5.3: Impacts on Ornithological Receptors Requiring Assessment on the RIAA			
Potential Impact	**Screened In**	**Screened Out**	**Justification for Screening Out of the RIAA**
			wind turbines than diurnally active species but rather appear to circumvent collision more effectively. Based on this it was concluded that there is limited potential for species associated with the Moray West Site to be affected by disorientation due to attraction to lit structures and it can be concluded in absence of any potential for a population level impact that there would be no LSE on any SPAs.
Effects of pollution	x		As above, this was initially screened out, but following the recent Sweetman Court Ruling (2018) it has been scoped back into the RIAA.

4.5.3 Marine Mammals

Baseline Characterisation

4.5.3.1 The approach to screening for marine mammals focused on the SACs with marine mammal qualifying features identified as having connectivity in terms of their established or most appropriate foraging ranges. This was informed by information from the Moray East ES 2012, supplemented with more up to date data for the Moray Firth obtained from a range of sources including detailed literature review, further site specific surveys of the Moray West Site (aerial surveys carried out between April 2016 and March 2017) and on-going monitoring work. Further information on the various sources of data used to characterise the Moray West Site and Offshore Export Cable Corridor is presented in Chapter 7 of this RIAA and detailed in the EIA Report (Volume 2) - Chapter 9: Marine Mammal Ecology.

Marine Mammal SACs Identified as Having Connectivity with the Development and Therefore Requiring Inclusion in the RIAA

4.5.3.2 Table 4.5.4 below list the SACs where marine mammals (bottlenose dolphin, harbour porpoise, and grey and harbour seals) are a qualifying feature identified as requiring further assessment in the RIAA. Justification for screening out sites and / or species is also provided.

Table 4.5.4: Marine Mammal SACs Requiring Inclusion in the RIAA					
Site	**Qualifying Feature**	**Distance to Closest Point (km)**		**Included in RIAA?**	**Justification for Screening Out of the RIAA**
		Moray West Site	**Offshore Export Cable Corridor**		
Moray Firth SAC	Bottlenose dolphin	17.2	17.2	Yes	N/A
Dornoch Firth and Morrich More SAC	Harbour seal	42.5	42.5	Yes	N/A

Table 4.5.4: Marine Mammal SACs Requiring Inclusion in the RIAA					
Site	**Qualifying Feature**	**Distance to Closest Point (km)**		**Included in RIAA?**	**Justification for Screening Out of the RIAA**
		Moray West Site	**Offshore Export Cable Corridor**		
Faray and Holm of Faray SAC	Grey seal	110	126.1	No	Based on advice provided by Scottish Ministers and SNH in the Moray West Offshore Wind Farm HRA Screening Opinion 2017 it was advised that consideration of a grey seal SAC would only be required where there was an impact pathway from the proposal to within 20 km of a breeding colony. Given the distance of these sites from the Moray West Site and Offshore Export Cable Corridor it has been concluded that these sites can be screened out of the HRA.
Isle of May SAC	Grey seal	205.1	166.3	No	
Monarch Islands SAC	Grey seal	264.8	278.9	No	
Southern North Sea cSAC	Harbour porpoise	Approx. 400	Approx. 400	No	Based on advice provided by SNH in the HRA Screening Opinion (Marine Scotland, 2017) there is no requirement to include this cSAC in the HRA/RIAA on the basis that the Development does not lie within the cSAC, the appropriate management unit to consider for harbour porpoise is the North Sea and the Development does not have any direct or indirect impacts overlapping with the cSAC.

Impacts on Marine Mammals Requiring Assessment in the RIAA

4.5.3.3 Table 4.5.5 below provides a summary of the impacts identified as requiring assessment in the RIAA and those identified during HRA where it is concluded that there are no LSEs. In line with the recent European Court of Justice ruling made on the 12th April 2018 by Peter Sweetman the assessment of LSE does not consider the application of mitigation.

4.5.3.4 Further information on the screened in impacts is provided in Chapter 7.

Table 4.5.5: Impacts Requiring Assessment in the RIAA			
Potential Impact	**Screened In?**	**Screened Out?**	**Justification for Screening Out of the RIAA**
Construction (and Decommissioning)			
Underwater noise - piling	x		N/A
Underwater noise from construction / decommissioning activities (excluding piling)	x		N/A
Risk of collision with vessels	x		N/A
Reduction in prey availability		x	Marine mammals are dependent on fish prey and therefore could be indirectly affected by a change or reduction in the availability of prey due to impacts associated with the Development (e.g. underwater noise, increased suspended sediment concentrations or habitat loss). However, it was concluded in the EIA Report (Volume 2 - Chapter 8: Fish and Shellfish) that potential effects on prey species (fish) would be minor and not significant. It was also concluded in Volume 2 - Chapter 7: Benthic and Intertidal Ecology, there would no significant effects on the habitats supporting key prey species. Given that marine mammals are opportunistic feeders that forage on a wide variety of prey species around the UK coast the potential for any impacts on marine mammal populations due to a reduction in prey species is negligible and no LSE can be concluded. This is in line with advice provided in the Moray West Offshore Wind Farm EIA Scoping Opinion (2016) and HRA Screening Opinion (2017).
Reduction in foraging ability		x	It was concluded in the Offshore EIA Report (Volume 2) Chapter 6: Physical Processes and Water Quality that much of the Moray West Site comprises coarse sands and gravel which will not create persistent sediment plumes and any sediment suspended during installation of the WTG foundations, inter-array and OSP interconnector cables, will settle to the seabed quickly within a few meters from the area of seabed disturbance. There is potential for finer material to create more persistent sediment plumes. However, increased suspended sediment concentrations (SSC) levels are expected to quickly disperse (e.g. within 0.5 to 15 minutes) within a few 100 m to 1,000 m of the source. It was concluded in the Offshore EIA Report (Volume 2) Chapter 9: Marine Mammal Ecology that given marine mammals are well known to forage in tidal areas where water conditions are turbid and visibility is poor the potential for any increase in SSC levels to affect foraging ability is low. It can therefore be concluded that there is no LSE on the basis that there is no potential for marine mammals to be affected by a reduction in forging ability at a population level. This is in line with advice provided in the Moray West Offshore Wind Farm EIA Scoping Opinion (2016) and HRA Screening Opinion (2017).

Table 4.5.5: Impacts Requiring Assessment in the RIAA			
Potential Impact	**Screened In?**	**Screened Out?**	**Justification for Screening Out of the RIAA**
Toxic contamination (seals only)		x	Marine mammals are generally considered to have low sensitivity to pollution or contamination on the basis that they have large foraging ranges, spend less time at the surface of the water (where spilt fuel or oil tends to persist) and can quickly move away from an area where pollution incident as occurred, therefore avoiding potential impacts. The exception to this is the potential impact on seals at haul out sites where there is potential for pollution or toxic contamination to be washed ashore (oiling). However, given that the potential for an accidental spill / pollution incident to occur is very low, the distance of the Moray West Site offshore (potential for dispersion of pollutants before reaching the coastline) and that the quantities of substances / fuels likely to ever be accidentally released are low (due to the low number of vessels and small size of most vessels (therefore not carrying large quantities of fuel), the potential for any spill / pollution event (even in the absence of pollution prevention measures) to impact seals to an extent that would have a population level effect is very low. It can therefore be concluded that there would be no LSE. This is in line with advice provided in the Moray West Offshore Wind Farm EIA Scoping Opinion (2016) and HRA Screening Opinion (2017).
Operation and Maintenance			
Collision from vessels	x		N/A
Toxic contamination		x	See explanation above for construction. The potential for any toxic contamination / pollution incidents to occur during operation is further reduced due to a reduction in the number of vessels likely to be present at the Moray West Site at any one time. It is therefore concluded that there are no LSE associated with toxic contamination. This is in line with advice provided in the Moray West Offshore Wind Farm EIA Scoping Opinion (2016) and HRA Screening Opinion (2017).
Disturbance leading to long -term avoidance as a result of operational noise		x	It is considered that the operational noise from the WTG and OSPs will not be sufficiently significant to cause an impact. This is on the basis that the levels of noise produced by the operational WTGs and OSPs would be imperceptible above baseline noise levels. Disturbance leading to long -term avoidance as a result of operational noise was scoped out the Offshore EIA (Volume 2 - Chapter 9) (see advice provided in the Moray West Offshore Wind Farm EIA Scoping Opinion (2016). It is therefore also concluded there is no LSE associated with this impact.
Reduction in prey availability		x	See explanation above for construction. The potential for reduction in prey availability during operation is negligible on the basis there will be no underwater noise or increased SSC levels. There is potential that the introduction of hard structures could have a reef effect leading to a possible increase in prey availability (See EIA Report Volume 2 - Chapters 8 and 9). It is therefore concluded that there is no LSE associated with a reduction in prey availability.
Strandings due to EMF from cables		x	Potential effects of EMF on marine mammals were scoped out of the Offshore EIA (Moray Offshore Wind Farm Scoping Opinion 2016) and screened out of the HRA (HRA Screening Opinion 2017). Current research studies show

Table 4.5.5: Impacts Requiring Assessment in the RIAA			
Potential Impact	**Screened In?**	**Screened Out?**	**Justification for Screening Out of the RIAA**
			that EMF emissions from AC cables (as to be installed for this Development) will only be detectable by electro sensitive species at a few meters from the seabed and, will not be strong enough to influence the behaviour of those species (Armstrong *et al.*, 2015). Given that marine mammals tend to spend time swimming in various parts of the water column (not restricted to the seabed) and are highly mobile, the potential for detection of, and therefore impact from EMFs, is negligible. It is therefore concludes that there is no LSE associated with EMF emissions. It should be noted that this conclusion does not consider specific mitigation. However, cables are designed to include additional protection to ensure the cables are protected from damage. This protection also serves to reduce EMF emissions by increasing the quantity of material emissions have to pass through before reaching the seabed or water. It is also noted that as part of the Development, all inter-array, OSP interconnector and offshore export cables will be buried where possible or protected if burial is not possible. This is not specific mitigation to protect against EMFs (it is to protect the cable assets from damage) but it does assist in reducing the levels of EMF emissions that will be experience at the seabed.

4.5.4 Migratory Fish SACs

4.5.4.1 Based on advice received from SNH in the HRA Screening Opinion (Marine Scotland, 2017) it was concluded that migratory fish should be screened out from any RIAA. Scottish Ministers (MS-LOT) agreed with the SNH advice that diadromous fish do not need to be considered further through the HRA process.

4.5.5 Habitat SACs

Habitat SACs Identified as Having Connectivity with the Development and Therefore Requiring Inclusion in the RIAA

4.5.5.1 From a review of the previous Appropriate Assessment carried out by Marine Scotland for the Moray East Offshore Wind Farm (Marine Scotland, 2014), no reference was made to the qualifying habitats of the Moray Firth SAC, Dornoch Firth and Morrich More SAC and Culbin Bar SAC, with these having previously been screened out from HRA on the basis that there was no connectivity or LSE. It was concluded at that time that potential LSE on habitat features of SACs should be screened out from the RIAA.

4.5.5.2 However for the Moray West Site, within their scoping response (Marine Scotland, 2016), SNH requested that, with respect to impacts associated with changes in physical processes and sediment transport, qualifying habitats within the Moray Firth SAC, Dornoch Firth and Morrich More SAC and Culbin Bar SAC should be appraised within the HRA. This was initially undertaken with reference to a review of physical processes information available at the time of HRA Screening and since updated based on findings from the Physical Processes and Water Quality impact assessment (Offshore EIA Report (Volume 2) – Chapter 6.

4.5.5.3 Conclusions from this review in terms of identifying Habitat SACs requiring inclusion in the RIAA are presented in Table 4.5.6 below.

Table 4.5.6: Habitat SACs Requiring Inclusion in the RIAA

Site	Qualifying Feature	Distance to Closest Point (km)		Included in RIAA?	Justification for Screening Out of the RIAA
		Moray West Site	Offshore Export Cable Corridor		
Moray Firth SAC	Sandbanks slightly covered by seawater at all times	17.2	17.2	Yes	N/A
Dornoch Firth and Morrich More SAC	Atlantic salt meadows, coastal dune heathland, dune grassland, glasswort (Salicornia spp.) and other annuals colonising mud and sand, dunes with juniper thickets, estuaries, humid dune slacks, intertidal mudflats and sandflats, lime deficient dune heathland with crowberry, reefs, shifting dunes, shifting dunes with	42.5	42.5	No	Based on the outcome from the hydrodynamic and sediment modelling undertaken as part of Physical Processes and Water Quality impact assessment (Offshore EIA Report (Volume 2) - Chapter 6 and Volume 4 - Technical Appendices 6.1 to 6.4, it was concluded that, due to the localised nature of changes in

Table 4.5.6: Habitat SACs Requiring Inclusion in the RIAA					
Site	**Qualifying Feature**	**Distance to Closest Point (km)**		**Included in RIAA?**	**Justification for Screening Out of the RIAA**
		Moray West Site	**Offshore Export Cable Corridor**		
	marram and subtidal sandbanks.				physical processes and sediment transport, these sites would be a too greater distance from the Moray West Site and Offshore Export Cable Corridor to be affected by these changes. These sites, therefore do not need to be included in the RIAA on the basis that there is no connectivity to these sites.
Culbin Bar SAC	Atlantic salt meadows, coastal shingle vegetation outside the reach of waves and shifting sand dunes.	49	49	No	

Impacts on SAC Habitats Requiring Assessment in the RIAA

4.5.5.4 The impacts requiring assessment with respect to the Moray Firth SAC focus specifically on the changes in physical processes and sediment transport and the effect of this on the sandbanks that are slightly covered by seawater at all times. Due to the distance of the Moray Firth SAC it was concluded that there is no route to impact for any direct impacts on the qualifying habitats associated with this SAC (e.g. habitat loss or disturbance). As a sandbank feature this habitat is also not sensitive to pollution or introduction of MINNS therefore it is also concluded there are no LSE for these impacts.

4.5.5.5 Further information on the potential effects of the Development on this habitat feature is provided in Chapter 8.

4.6 LSE Conclusions

4.6.1.1 A summary of the European sites and qualifying features for which LSE has been identified is provided in Table 4.6.1. These are the European sites and features that are assessed within this RIAA.

Table 4.6.1: European Sites and Qualifying Features for which LSE has been Identified				
Key Receptor	**European Site**	**Qualifying Feature**	**Phase**	**Potential Impact**
Ornithology	Buchan Ness to Collieston Coast SPA	Guillemot Kittiwake Herring Gull	Construction / Decommissioning	Disturbance Change in prey availability / habitat loss
			Operation and Maintenance	Barrier effects Displacement Collision risk

Table 4.6.1: European Sites and Qualifying Features for which LSE has been Identified				
Key Receptor	**European Site**	**Qualifying Feature**	**Phase**	**Potential Impact**
	East Caithness Cliffs SPA	Razorbill Guillemot Kittiwake Herring Gull	Construction / Decommissioning	Disturbance Change in prey availability / habitat loss
			Operation and Maintenance	Barrier effects Displacement Collision risk
	North Caithness Cliffs SPA	Puffin Razorbill Guillemot Kittiwake	Construction / Decommissioning	Disturbance Change in prey availability / habitat loss
			Operation and Maintenance	Barrier effects Displacement Collision risk
	Troup, Pennan and Lion's Heads SPA	Razorbill Guillemot Kittiwake Herring Gull	Construction / Decommissioning	Disturbance Change in prey availability / habitat loss
			Operation and Maintenance	Barrier effects Displacement Collision risk
	Moray Firth pSPA	Eider Great Northern Diver Scaup Long-tailed Duck Common Scoter Velvet Scoter Goldeneye Red-Breasted Merganser Slavonian Grebe Red-throated Diver	Construction	Disturbance Change in prey availability / habitat loss
Marine Mammals	Dornoch Firth and Morrich More SAC	Harbour seal	Construction / Decommissioning	Underwater noise from pile-driving Underwater noise from increased vessel activity Collision risk from increased vessel activity
			Operation	Collision risk from increased vessel activity
	Moray Firth SAC	Bottlenose dolphin	Construction / Decommissioning	Underwater noise from pile-driving Underwater noise from increased vessel activity Collision risk from increased vessel activity

Table 4.6.1: European Sites and Qualifying Features for which LSE has been Identified				
Key Receptor	**European Site**	**Qualifying Feature**	**Phase**	**Potential Impact**
			Operation	Collision risk from increased vessel activity
Habitats	Moray Firth SAC	Subtidal sandbanks	Construction / Decommissioning	Increased suspended sediment concentration and changes to physical processes due to WTG and OSP foundations or cable laying activities.
			Operation	Changes to physical processes (including hydrodynamic processes) due to the presence of WTG and OSP foundations.

5 Development Design Parameters and Mitigation

5.1 Introduction

5.1.1.1 This chapter presents relevant information about the Development to help inform the Appropriate Assessment. The information presented in Tables 5.2.1 to 5.2.3 for ornithology, marine mammals and habitats respectively, reflect the worst case scenarios design parameters that have been identified as having potential to have the greatest effect on the sites and qualifying features included in this RIAA. Tables 5.3.1 to 5.3.3 present the mitigation measures that will be implemented as part the Development to reduce or avoid any adverse effects on the qualifying interests and sites assessed in this RIAA.

5.2 Worst Case Scenario Design Parameters

5.2.1.1 The worst case scenario design parameters presented in Tables 5.2.1 to 5.2.3 below are derived from the Design Envelope parameters described in Chapter 2 of this RIAA and are consistent with those used for assessment in relevant chapters of the Offshore EIA Report. Further detailed explanations of these worst case scenario design parameters is provided within the Offshore EIA Report – Volume 2 (Chapter 6: Physical Processes and Water Quality; Chapter 9: Marine Mammals; and Chapter 10: Ornithology) and the supporting Technical Appendices (EIA Report Volume 4).

Table 5.2.1: Design Envelope Parameters Relevant to the Assessment of Effects on SPAs

Impact	Key Design Parameters Informing the Assessment
Construction (and Decommissioning)	
Disturbance	Total number of vessels = 25 based on at any one time, comprising of installation, support, transport and cable lay vessels, tugs and barges. Total number of return trips = 46 return trips per week during installation (WTGs, OSPs and substructures) and five return trips per week for transport vessels. Duration of construction period = 36 months Maximum spatial WCS for piling = 85 monopiles with maximum 5,000 kj hammer energy for five months. Maximum temporal WCS for piling = 356 pin-piles (85 x 4 legged jacket foundations + 2 jacket OSPs) at 3,000 kj hammer energy for nine months.
Changes to prey availability / habitat loss (indirect impact)	The overall total footprint of disturbance of the Moray West Site and Offshore Export Cable Corridor combined under a worst-case approach is 7,511,214 m^2 (7.511 km^2). Based on installation of 62 x largest (55 m diameter) gravity bases + area of seabed preparation (125 m diameter) for the Model 4 turbines + two OSPs + inter-array cables (275 km), OSP interconnector cables (15 km) and offshore export cables (130 km).
Effects from Pollution	Synthetic compound, heavy metal and hydrocarbon contamination may be released accidentally as a result of offshore infrastructure installation and the presence of various construction vessels during the construction period (up to 25 at any one time, comprising of installation, support, transport and cable lay vessels, tugs, cranes and barges).
Operation and Maintenance	
Displacement	Operation of maximum number of turbines (up to 85 WTGs), within the total area of the Moray West Site (225 km^2), with a minimum spacing 1,200 m downwind and 1,050 m crosswind. Operation of associated transmission infrastructure (up to two OSPs).
Barrier effects	

Table 5.2.1: Design Envelope Parameters Relevant to the Assessment of Effects on SPAs	
Impact	**Key Design Parameters Informing the Assessment**
Construction (and Decommissioning)	
Collision risk	Operation of maximum number of turbines (up to 85 WTGs). Maximum rotor swept area for 85 Model 2 WTGs based on rotor diameter of 195 m, hub height = 132.5 m and lowest rotor tip height of 35 m above the Highest Astronomical Tide (HAT). Other specific parameters are presented in 10.2: CRM Technical Appendix.
Effects from Pollution	Synthetic compound, heavy metal and hydrocarbon contamination may be released accidentally during maintenance operations and from maintenance vessels.

Table 5.2.2: Design Envelope Parameters Relevant to the Assessment of Effects on Marine Mammal SACs	
Impact	**Key Design Parameters Informing the Assessment**
Construction (and Decommissioning)	

Underwater noise from pile-driving	**Worse case (spatial extent, largest impact footprint):**
	Pile-driving of 85 monopile foundations and 2 OSPs with monopile foundations (2 monopiles per OSP)
	• Maximum hammer driving energy 5,000 kJ
	• Hammer energy profile:
	  ○ 1000 kJ for 150 mins
	  ○ 2,000 kJ for 90 mins
	  ○ 3,000 kJ for 50 mins
	  ○ 4,000 kJ for 40 mins
	  ○ 5,000kJ for 30 mins
	• Soft start maximum 30 blows per min
	• Maximum 40 blows per minute
	• Average 30 blows per minute
	• Maximum installation time 8 hours per foundation
	• Maximum 2 piles per 24 hours (assuming simultaneous piling events)
	• Maximum 2 simultaneous piling events
	• Total number of piling days 87 (single vessel), 44 (two vessel)
	
	Worst-case (temporal extent, longest duration of piling):
	Pile-driving of 85 quadropod/jacket foundations (8 MW WTG) and 2 OSPs with pin pile foundations:
	• Up to four pin piles per foundation – total of a maximum of 356 pin piles
	• Maximum hammer driving energy 3,000 kJ.
	• Hammer energy profile:
	  ○ 500 kJ for 170 mins
	  ○ 1,000 kJ for 83.3 mins
	  ○ 1,500 kJ for 67 mins
	  ○ 2,000 kJ for 83.3 mins
	  ○ 3,000kJ for 66.7 mins
	• Soft start maximum 30 blows per min.
	• Maximum 40 blows per minute.
	• Average 30 blows per minute.

Table 5.2.2: Design Envelope Parameters Relevant to the Assessment of Effects on Marine Mammal SACs	
Impact	**Key Design Parameters Informing the Assessment**
Construction (and Decommissioning)	
	• Maximum 6 piles per 24 hours (assuming 2 simultaneous piling events) • Maximum 2 simultaneous piling events. • Total number of piling days 170 (single vessel), 85 (two vessel). Total piling period nine months.
Underwater noise from increased vessel activity	Total number of vessels = 25 based on at any one time, comprising of installation, support, transport and cable lay vessels, tugs and barges. Total number of return trips = 46 return trips per week during installation (WTGs, OSPs and substructures) and five return trips per week for transport vessels. Duration of construction period = 36 months. Seabed preparation activities including dredging and boulder clearance. Inter-array, OSP interconnector and offshore export cable installation (trenching or jetting + rock placement (only where burial not possible)).
Collision risk from increased vessel activity	Total number of vessels = 25 based on at any one time, comprising of installation, support, transport and cable lay vessels, tugs and barges. Total number of return trips = 46 return trips per week during installation (WTGs, OSPs and substructures) and five return trips per week for transport vessels.
Operation and Maintenance	
Collision risk from increased vessel activity	Approximately 150-200 return trips per year. If O&M activity is coordinated entirely from an onshore base, this would mean small crew vessels sailing to and from the Moray West Site on a daily basis from shore. If the SOV option is preferred, the majority of small crew vessels would be operated on a daily basis from a single SOV, although further support vessels are also still likely to transit to and from shore each day. OSPs would require one visit a week maximum.

Table 5.2.3: Design Envelope Parameters Relevant to the Assessment of Effects on Habitat Features of SACs	
Impact	**Key Design Parameters Informing the Assessment**
Construction (and Decommissioning)	
Increased suspended sediment concentration and changes to physical processes due to WTG and OSP foundations or cable laying activities.	Total spoil volume for all WTG and OSP foundations for dredging activities (for 85 x Model 1 or 2 WTGs) = 2,502,141 m^3 **or** total spoil volume (drill arising's from 62 x model 4 monopile foundations) for all WTG and OSP foundations = 565,486 m^3. In both scenarios material will deposit on the seabed within a few 100 m to 1,000 m depending on grade of material (coarse or fine). Foundation installation phase lasting up to 9 months within the 36 month construction phase. Total spoil volume from inter-array, OSP interconnector and offshore export cables = 1,890,000 m^3. Cable installation = 6 months inter-array cables, 3 month OSP interconnector cables and 6 months offshore export cables.
Operation and Maintenance	

Table 5.2.3: Design Envelope Parameters Relevant to the Assessment of Effects on Habitat Features of SACs	
Impact	**Key Design Parameters Informing the Assessment**
Construction (and Decommissioning)	
Changes to physical processes (including hydrodynamic processes) due to the presence of WTG and OSP foundations.	62 x gravity base WTG foundations (Model 4) (55 m diameter + 30 m height) + 2 OSP gravity base foundations (55 m = 20 m height) or 62 x 15 m diameter monopiles. Minimum spacing 1,200 m downwind and 1,050 m crosswind. Total area of cable protection for export cables (26 km x 1.5 m = 39,000 m^2) and for inter-array and interconnector cables (29 km x 1.5 m = 43,500 m^2). Total area of all cable crossings = 14,400 m^2 (2 export cables x 6 cable crossings x 1,200 m^2 per crossing).

5.3 Embedded Mitigation

5.3.1.1 In order to minimise potential effects of the Development on sites and qualifying features, a number of embedded mitigation measures will be implemented. Relevant embedded mitigation measures relating to ornithological, marine mammal and habitat features are presented in Tables 5.3.1 to 5.3.3 below. These are based on those presented within relevant chapters of the Offshore EIA Report – Volume 2 (Chapter 10: Ornithology; Chapter 9: Marine Mammals; and Chapter 6: Physical Processes and Water Quality).

Table 5.3.1: Embedded Measures – Ornithology	
Measures adopted as part of Moray West	**Justification**
General	
An appropriate Environmental Management Plan (EMP) will be produced and followed to cover the construction, operation and maintenance phases of the Development. An appropriate Marine Pollution and Contingency Plan (MPCP) will be produced and followed to cover the construction, operation and maintenance phases of the Development. This will include planning for accidental spills, address all potential contaminant releases and include pollution event response protocols.	Measures will be adopted to ensure that the potential for release of pollutants from construction, operation and maintenance, and decommissioning plant is minimised. In this manner, accidental release of contaminants from rigs and supply/service vessels will be strictly controlled, thus providing protection for birds and their prey species across all phases of the wind farm development.
A vessel management plan (VMP) will be developed which will determine vessel routing to and from construction areas and ports to avoid areas of high risk. This will also include codes of conduct for vessel behaviour and for vessel operators including advice to operators to not deliberately approach aggregations of seabirds. This plan will be informed by emerging information from the monitoring at Beatrice.	The VMP will minimize disturbance of seabird species and allow the identification of standard routes.
Operation and Maintenance	
Installation of appropriate lighting on wind farm structures.	Lighting of wind turbines will meet minimum requirements, namely as set out in the International Association of Marine Aids to Navigation and

Table 5.3.1: Embedded Measures – Ornithology	
Measures adopted as part of Moray West	**Justification**
General	
	Lighthouse Authorities (IALA) Recommendation O-117 on 'The Marking of Offshore Wind Farms' for navigation lighting and by the Civil Aviation Authority in the Air Navigation Orders (CAP 393 and guidance in CAP 764). In keeping with the minimum legal requirements, this will minimise the risks of migrating birds becoming attracted to, or disorientated by turbines at night or in poor weather.
A minimum wind turbine hub-height of 35 m (above HAT) will be used for Moray West. This provides for a lower blade tip height clearance of 35m LAT.	This hub-height is considered appropriately conservative so as to minimise the risk of bird collisions.

Table 5.3.2: Embedded Mitigation Relating to Marine Mammals	
Parameter	**Mitigation measures embedded into the design of the Development**
General	
Vessels	A Vessel Management Plan (VMP) will be developed which will determine vessel routing to and from construction areas and ports to avoid areas of high risk. This will also include codes of conduct for vessel behaviour and for vessel operators including advice to operators to not deliberately approach marine mammals and to avoid abrupt changes in course or speed should marine mammals approach the vessel to bow-ride. This plan will be informed by emerging information from the monitoring at the Beatrice Offshore Wind Farm (BOWL).
Construction	
Pile-driving WTG	**<u>Monopiles (5,000 kJ maximum hammer energy)</u>** A soft start is included, whereby the piling hammer energy is gradually increased over a period of time to ensure that any remaining animals will move out of the area before full hammer energy is reached. A ramp-up has been assumed for monopiles that reach a maximum of up to 5,000 kJ hammer energy. This ramp up involves a constant strike rate of 30 strikes per minute and the following schedule: • 1,000 kJ for 150 mins • 2,000 kJ for 90 mins • 3,000 kJ for 50 mins • 4,000 kJ for 40 mins • 5,000 kJ for 30 mins **<u>Monopiles (3,500 kJ maximum hammer energy)</u>** A ramp-up has been assumed for monopiles that reach a maximum of up to 3,500 kJ hammer energy. This ramp up involves a constant strike rate of 30 strikes per minute and the following schedule: • 1,000 kJ for 150 mins • 2,000 kJ for 90 mins • 2,500 kJ for 50 mins

Table 5.3.2: Embedded Mitigation Relating to Marine Mammals	
Parameter	**Mitigation measures embedded into the design of the Development**
	• 3,000 kJ for 40 mins • 3,500 kJ for 30 mins **Quadropod/jacket (3,000 maximum hammer energy)** A ramp-up has been assumed for monopiles that reach a maximum of up to 3,000 kJ hammer energy. This ramp up involves a constant strike rate of 30 strikes per minute and the following schedule: • 500 kJ for 170 mins • 1,000 kJ for 83 mins • 1,500 kJ for 67 mins • 2,000 kJ for 83 mins • 3,000 kJ for 67 mins
All Pile-driving	A Piling Strategy, incorporating a Marine Mammal Mitigation Plan (MMMP) will be produced for approval by the Scottish Ministers in advance of construction and will subsequently be followed during the construction phase. This will outline the final piling approach, the soft-start procedure, monitoring, and any other agreed mitigation options deemed necessary, to reduce to acceptable levels the potential risk of injury or death to marine mammals in close proximity to piling operations.
Decommissioning	
Embedded mitigation measures implemented in the decommissioning phase are likely to be similar to those implemented during the construction phase.	

Table 5.3.3: Embedded Measures – Physical Processes & Water Quality	
Development Phase	**Measures**
General	• The number, type and dimensions of the foundations used will determine the blockage presented to waves and currents, both locally and by the Moray West Offshore Wind Farm as a whole. However, the design and dimensions of individual foundations also determine the forces exerted on those structures by waves and currents, and the complexity and cost of construction, which will tend to minimise the dimensions of the individual foundations as far as is possible. • Scour formation around the base of foundations or exposed sections of cable also presents an engineering risk. More extensive scour formation is likely to be mitigated by the application of scour protection.
Construction	• Dredging and drilling of the seabed are common activities, both globally and in UK. The vessels, equipment and methods used have been optimised through design over time to maximise the efficiency of the dredging or drilling process and to minimise potential environmental effects (e.g. potential rates of sediment disturbance and release), thereby reducing the magnitude, extent and duration of potential adverse effects. • Cable burial into the seabed and transitioning the cable between the offshore and onshore environment at a landfall is a common activity, both globally and in UK. Cable burial tools and techniques will aim to efficiently and rapidly achieve burial of the cable into the seabed whilst maximising sediment cover. Therefore, by design, the majority of sediment in the trench affected area is

Table 5.3.3: Embedded Measures – Physical Processes & Water Quality	
Development Phase	**Measures**
	likely to remain within or near to the trench (for subsequent backfilling) and would therefore not contribute to effects on Suspended Sediment Concentration (SSC) or sediment deposition elsewhere. Landfall techniques aim to establish long term and stable burial and will therefore minimise any activities that would potentially destabilise or change the affected coastline.
Construction, Operation and Maintenance, Decommissioning	• An appropriate Environmental Management Plan (EMP) will be produced and followed to cover the construction, operation and maintenance phase of the Development. This will include planning for accidental spills, address all potential contaminant releases and include key emergency contact details. A Decommissioning Programme (DP) will also be developed to cover the decommissioning phase. The measures outlined in these documents will be adopted to ensure that the potential for release of contaminants from construction, operation and maintenance, and decommissioning equipment and activities is minimised. In this manner, accidental release of potential contaminants from drilling rigs and other construction / operation and maintenance (O&M) vessels will be strictly controlled, thus providing protection for marine life across all phases of the offshore wind farm development.

6 Assessment of Adverse Effects Upon Site Integrity – Ornithology

6.1 Introduction

6.1.1.1 This assessment of adverse effect on site integrity has been undertaken in accordance with EU and national guidance (EC, 2001; SNH, 2010; EU, 2011) and will ensure that Moray West is compliant with the UK and Scottish Government's international commitments to conserve biodiversity as implemented by national planning and wildlife protection legislation and national planning policies.

6.1.1.2 The Moray West Offshore Wind Farm HRA Screening Report (Moray West, 2017) identified four SPAs and one pSPA where there was a likely significant effect (Table 6.1.1; Figure 6.1.1.).

Table 6.1.1: European Sites and Features for which LSE have been Identified

European Site	Feature
Buchan Ness to Collieston Coast SPA	Fulmar Kittiwake Herring gull Guillemot
East Caithness Cliffs SPA	Fulmar Kittiwake Herring gull Guillemot Razorbill
North Caithness Cliffs SPA	Fulmar Kittiwake Guillemot Razorbill Puffin
Troup, Pennan and Lion's Heads SPA	Fulmar Kittiwake Herring gull Guillemot Razorbill
Moray Firth pSPA	Eider Great Northern Diver Scaup Velvet Scoter Common Scoter Long-tailed Duck Goldeneye Red-breasted Merganser Red-throated Diver Slavonian Grebe Shag

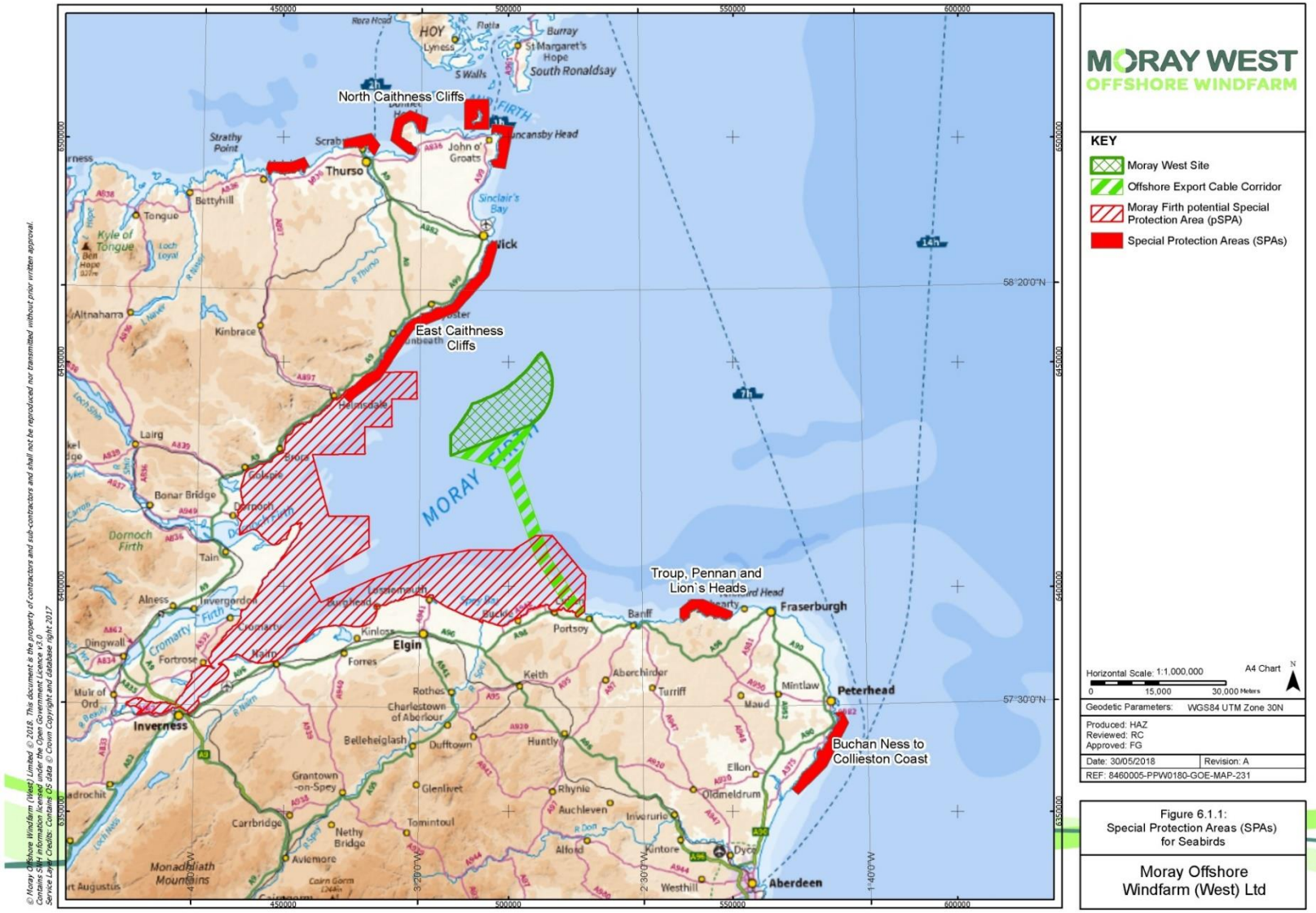


Figure 6.1.1: SPAs for which the potential for LSE was identified

6.2 Conservation Objectives

6.2.1.1 The Appropriate Assessment component of HRA determines whether a proposed project has implications for a designated site's conservation objectives. All four of the SPAs identified in Table 6.1.1 have identical conservation objectives:

6.2.1.2 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.*

6.2.1.3 The conservation objectives for the Moray Firth pSPA are:

6.2.1.4 To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, subject to natural change, thus ensuring that the integrity of the site is maintained in the long-term and it continues to make an appropriate contribution to achieving the aims of the Birds Directive for each of the qualifying species.

6.2.1.5 This contribution will be achieved through delivering the following objectives for each of the site's qualifying features:

a) Avoid significant mortality, injury and disturbance of the qualifying features, so that the distribution of the species and ability to use the site are maintained in the long-term; and

b) To maintain the habitats and food resources of the qualifying features in favourable condition.

6.3 Baseline Characterisation

6.3.1 Desktop Study

6.3.1.1 A literature review was undertaken to provide information on the ornithological interest of the Moray Firth and its importance in a regional, national and international context. This review included general seabird ecology, migration behaviour, population sizes and conservation status, particularly in the Moray Firth, the east coast of Britain and Britain as a whole. Information sources used are summarised in Table 6.3.1.

Table 6.3.1: Summary of Key Reports Consulted as Part of Desktop Study

Title	Source	Year	Author
JNCC Online SPA standard data forms for Natura 2000 sites.	http://jncc.defra.gov.uk/page-1400	Multiple	Multiple
Existing offshore wind farm Environmental Statements and Monitoring Reports.	Multiple	Multiple	Multiple
Moray West Scoping Opinion.	Scoping Response from Marine Scotland	Multiple	Multiple
Wetland Bird Survey (WeBS) Annual Reports and Report Online Interface.	Wetland Bird Survey partnership	Multiple	Multiple

Table 6.3.1: Summary of Key Reports Consulted as Part of Desktop Study			
Title	**Source**	**Year**	**Author**
British Trust for Ornithology (BTO) online profiles of birds occurring in Britain and Ireland, BirdFacts.	British Trust for Ornithology	2016	Robinson
Biologically appropriate, species-specific, geographically non-breeding season population estimates for seabirds.	Natural England	2015	Furness
At-Sea Turnover of Breeding Seabirds	Marine Scotland	2015	Searle *et al.*
Population consequences of displacement from proposed offshore wind energy developments for seabirds breeding at Scottish SPAs	Marine Scotland	2014	Searle *et al.*
Population estimates of birds in Great Britain and the UK.	British Birds journal	2013	Musgrove *et al.*
Survey data relating to the Moray East Offshore Wind Farm.	Moray East	2012	Moray East
Seabird foraging ranges as a preliminary tool for identifying candidate Marine Protected Areas.	British Trust for Ornithology	2012	Thaxter *et al.*
Assessing the risk of offshore wind farm development to migratory birds designated as features of UK SPAs.	Strategic Ornithological Support Services	2012	Wright *et al.*
An analysis of the numbers and distribution of seabirds within the British Fishery Limit aimed at identifying areas that qualify as possible marine SPAs.	JNCC	2010	Kober *et al.*
A review of assessment methodologies for offshore wind farms.	British Trust for Ornithology	2009	Maclean *et al.*
The Migration Atlas.	British Trust for Ornithology	2002	Wernham *et al.*
Atlas of seabird distribution in northwest European waters.	JNCC	1995	Stone *et al.*
East Caithness Cliffs SPA gull Tracking Report 2014.	University of Exeter	2014	Archibald *et al.*
Beatrice Offshore Wind Farm – Ornithology Technical report.	BOWL	2012	RPS
A handbook on environmental impact assessment: Guidance for Competent Authorities, Consultees and others involved in the Environmental Impact Assessment Process in Scotland.	SNH	2013	SNH
Barriers to movement: Modelling energetic costs of avoiding marine wind farms amongst breeding seabirds.	Marine Pollution Bulletin	2010	Masden *et al.*
Developing guidance on ornithological cumulative impact	COWRIE	2009	King *et al.*

Table 6.3.1: Summary of Key Reports Consulted as Part of Desktop Study			
Title	**Source**	**Year**	**Author**
assessment for offshore windfarm developers.			
Developing an avian collision risk model to incorporate variability and uncertainty.	Scottish Marine and Freshwater Science Report	2015	Masden *et al.*
Mapping Seabird Sensitivity to Offshore Wind Farms.	PLOS ONE Journal	2014	Bradbury *et al.*
Non-breeding season populations of seabirds in UK waters.	Natural England	2015	Furness
Joint SNCB Interim Displacement Guidance Note.	JNCC	2017	JNCC *et al.*

6.3.2 Site-Specific Aerial Surveys

6.3.2.1 Contemporary digital aerial site-specific surveys to inform the assessment of the Development commenced in April 2016 and were completed in March 2017. These recent data obtained over a 12-month period are considered the primary dataset to inform the EIA of the Development. It is recognised that a single year of data may incompletely capture the inter-annual variability in seabird presence and abundance at or around the Moray West Site. The process initiated to inform this impact assessment therefore follows that the single year of site-specific surveys is combined with the extensive existing datasets that are available to robustly characterise the baseline for the purposes of impact assessment.

6.3.2.2 A series of DAS strip transects were flown monthly from April 2016 to March 2017 over a defined study area which involved the Moray West Site plus a 4 km buffer area. The survey methodology was designed to provide information suitable to support an EIA and Habitats Regulations Assessment ("HRA") of the potential effects of a large offshore wind farm, for which an accurate assessment of abundance and distribution of seabirds is required.

6.3.2.3 Aerial surveys involved transects placed 2.5 km apart within the Moray West Site plus a 4 km buffer using a transect-based survey design in which strip transects are placed approximately perpendicular to the depth contours along the coast. Such a design ensures that each transect samples a similar range of habitats (primarily relating to water depth) and reduces the difference in bird abundance estimates for each transect.

6.3.2.4 Surveys were undertaken using an aircraft equipped with four HiDef Gen II cameras with sensors set to a resolution of 2 centimetres ("cm") Ground Sample Distance ("GSD"). Each camera sampled a strip of 125 m width, separated from the next camera by ~25m, thus providing a combined sampled width of 500 m within a 575 m overall strip. The surveys covered the Moray West Site plus a 4 km buffer representing an area of 1,230 km^2. Analyses were conducted utilising data from two of the four cameras representing 10% coverage of this area.

6.3.2.5 Full details of the survey methodology and the means by which seabird population estimates and densities were derived are given in Offshore EIA Report (Volume 4) – Technical Appendix 10.1 (Annex 10.1A).

6.3.3 Additional Moray Firth Seabird Data

6.3.3.1 There is an extensive amount of ornithology data available for the Moray Firth as highlighted in the Moray West Offshore Wind Farm Scoping Report (May 2016) and further detailed in the Offshore EIA Report (Volume 2) – Chapter 10: Offshore Ornithology and Volume 4 – Technical Appendix 10.1 and its Annex 10.1A. A number of these datasets (listed below) overlap with the Moray West Site or the 4 km survey buffer.

- Moray East boat-based surveys – Data collected during 28 boat-based surveys between April 2010 and March 2012 covering Moray East Site plus a 4 km buffer;
- BOWL boat-based surveys – Data collected during boat-based surveys of the Beatrice Offshore Wind Farm plus a 4 km buffer between October 2009 and September 2011; and
- BOWL pre-construction aerial surveys – Data collected during aerial surveys of the area between the East Caithness Cliffs SPA and the Beatrice offshore wind farm plus a 10 km buffer between May and August 2015.

6.3.3.2 These data provide information on the densities of key seabird species in addition to data on flight heights, with both surveys overlapping to some extent with the ZoI for the Development (Volume 4: Technical Appendix 10.1 – Annex 10.1A).

6.3.3.3 Further data is available for the Moray Firth from the following aerial surveys:

- Moray East aerial surveys – Data collected during six aerial surveys between May and July 2011 covering a wide strip from the East Caithness Cliffs and North Caithness Cliffs SPAs to the southern coast of the outer Moray Firth; and
- Zonal Surveys commissioned by The Crown Estate / COWRIE – comprising aerial surveys of the Moray Firth Zone (Zone 1) including a 4 km buffer.

6.3.3.4 These data provide contextual information on the densities of key bird species.

6.3.4 Species Accounts

6.3.4.1 Detailed species accounts are provided in the EIA Report (Volume 4) – Technical Appendix 10.1.

6.4 Seabird Phenology and Apportioning

6.4.1.1 The birds present at the Moray West Site may vary in their origin depending on the biological season. The area within which these birds occur can be defined as the Biologically Defined Minimum Population Scale (BDMPS). For example, during the breeding season, birds are less likely to travel as far as they are provisioning chicks and, as such, tend to travel within their 'foraging range'.

6.4.1.2 The distances travelled by birds during the breeding season depends on the species. Thaxter *et al.* (2012) provides data on recorded foraging ranges for a wide range of species, including the mean-maximum and maximum distances travelled. Typically the mean-maximum foraging range (i.e. the mean of the maximum foraging trips recorded across multiple studies and therefore a precautionary approach) has been used as a criterion for establishing whether there is likely to be connectivity (and hence risk of an impact) between an SPA breeding colony and Moray West Site. In some cases site-specific information is available from GPS/satellite tracking studies, for example, the Future of the Atlantic Marine Environment (FAME) / Seabird Tracking and Research (STAR) initiatives.

6.4.1.3 For the identification of the SPAs identified as requiring inclusion in the RIAA, mean-maximum foraging ranges (± 1 SD) as reported by Thaxter *et al.,* (2012) have been used to determine potential connectivity with the Moray West Site and/or Offshore Export Cable Corridor, unless specific relevant tracking data are available (where the latter is deemed to have priority).

6.4.1.4 Outside of the breeding season, migratory birds are more likely to be present within a defined BDMPS, and as such this may introduce birds from a much wider area and therefore range of populations. This has relevance to the overall apportioning of impacts as it defines the relevant populations within a BDMPS against which assessment should be undertaken, both for individual projects (e.g. the Moray West Offshore Wind Farm) and in-combination with other offshore wind farms (See Section 6.6 for further detail on this).

The apportioning values used within this assessment have been calculated following guidance from MSS/SNH and incorporating the methodologies applied and accepted as part of the previous offshore wind farm applications. A full description of the apportioning approach for each species is presented in Appendix 4.2: Phenology and Apportioning for the RIAA.

6.5 Data Limitations

6.5.1.1 It was proposed as part of scoping the EIA for the Moray West Offshore Wind Farm, that, given the availability of extensive existing bird data for the Moray Firth and the adjacent Moray East and Beatrice Offshore Wind Farm Sites, one year (12 months) of additional data collected from aerial surveys (carried out between April 2016 and March 2017) would be sufficient to inform the ornithology impact assessment. This approach, although agreed with MSLOT, MSS and SNH in the Moray West Offshore Wind Farm Scoping Opinion (MS-LOT, 2017) was subject to the subsequent approval of the baseline characterisation for the Moray West Site, in particular with respect to information on inter-annual variation.

6.5.1.2 In addition to characterising the ornithological baseline for purpose of the assessment it has also been necessary to provide further information to reduce the uncertainty associated with having only one year of data and provide appropriate abundance and density metrics for populating assessments in both the RIAA and EIA Report. The process developed to reduce this uncertainty and determine inter-annual variability as part of baseline characterisation for the Moray West Site was the Decision Support System (DSS). The DSS compared the point density estimates from the Moray West DVAS data with the corresponding upper and lower confidence interval from other data sources in other years (e.g. Moray East boat surveys and BOWL pre-construction digital aerial surveys). The DSS then provided a recommended density value to use, which was then extrapolated to the Moray West Site plus 2 km buffer, for displacement assessment, or to the Moray West Site only, for collision risk modelling. Further information can be found in the Offshore EIA Report (Volume 4) – Technical Appendix 10.1 - Annex 10.1A) and which has been incorporated into the assessments for all relevant species.

6.6 Description of Potential Impacts

6.6.1.1 Impacts identified as requiring assessment in the RIAA in Chapter 4 (Table 4.5.3) are summarised below. Further information relating to the selection of species for consideration as part of displacement and collision risk analyses in provided in the Offshore EIA Report (Volume 4) - Technical Appendix 10.3: Analysis of Displacement Impacts on Seabirds and Technical Appendix 10.2: Collision Risk Modelling.

Table 6.6.1: Potential Impacts from Moray West on Offshore Ornithological Site Features

Project Phase	Impact	Description
Construction	Disturbance	The impact of construction activities such as increased vessel activity and underwater noise may result in direct disturbance or displacement of birds from important feeding and roosting areas.
	Changes to prey availability / habitat loss (indirect impact)	The impact of construction activities such as increased vessel activity and underwater noise may result in disturbance or displacement of prey from important bird feeding areas.

Table 6.6.1: Potential Impacts from Moray West on Offshore Ornithological Site Features		
Project Phase	**Impact**	**Description**
	Effects from Pollution	Accidental release of pollutants (e.g. diesel / fuel spills from vessels) could have a direct impact on birds due to oiling of features and affect their ability to forage.
Operation and maintenance	Displacement	The impact of physical displacement from an area around turbines and other ancillary structures during the operational phase of the development may result in effective habitat loss and reduction in species survival rates and fitness.
	Barrier effects	The impact of barrier effects caused by the physical presence of turbines and ancillary structures may prevent clear transit of birds between foraging and breeding sites, or on migration. Additional energetic costs incurred may reduce fitness and survival rate of a species.
	Collision	Collisions with rotating turbine blades will result in direct mortality of an individual. Increased mortality may reduce species' survival rates.
	Effects from Pollution	Accidental release of pollutants during operation (e.g. diesel / fuel spills from vessels) could have a direct impact on birds due to oiling of features and affect their ability to forage.
Decommissioning	Effects are assumed to be similar to those predicted during the construction phase.	

6.6.1.2 A description of these impacts is provided below.

6.6.2 Disturbance

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

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

6.6.3 Reduction in Prey Availability

6.6.3.1 The physical presence of foundation and potential scour protection, as well as potential changes in commercial fishing activities may impact upon the availability of prey species. Indirect effects from the presence of foundations include potential changes to the wave climate, creation of

hard substrate around turbine foundations and inter-array / export cables, increases in sedimentation in the water column and noise and vibration from operational turbines. The potential reduction in fishing activity within the vicinity of turbines could have a positive benefit on prey stocks as could the aggregation of fish and shellfish around the introduced hard substrates.

6.6.4 Pollution Effects

6.6.4.1 During construction, support vessels and machinery present will contain a fuel supply and lubricants which, in the event of an incident such as a collision, may be released into the surrounding sea. During the operation phase, each turbine will undergo a routine service every year. As part of this process, hydraulic fluids, gearbox oils and lubricants will be replaced and solid consumables such as filters will be disposed of.

6.6.4.2 Although likelihood and risks are low, seabirds utilising the environment in the vicinity of a pollution incident may be vulnerable to either direct mortality from oil coverage preventing flight for example, or indirectly via a reduction in ability to forage.

6.6.5 Displacement and Barrier Effects and Analysis

Overview

6.6.5.1 The presence of wind turbines has the potential to directly disturb and displace birds from within and around Moray West Offshore Wind Farm. As displacement effectively leads to exclusion from areas of suitable habitat, it can be regarded as being similar to habitat loss in its effect on birds, although it may be more spatially extensive. This indirect habitat loss would reduce the area available for feeding, loafing and moulting for seabird species that may occur at the Moray West Site. In addition there is the potential for seabird species to be affected by disturbance impacts resulting from construction, operation and maintenance and decommissioning activities along the Offshore Export Cable Corridor.

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

6.6.5.3 Following recently published joint SNCB interim guidance JNCC *et al*. (2017), displacement impacts for each relevant species are presented using a wide range of potential displacement and mortality rates. These have been presented as separate matrix tables, one for each of the seasons being assessed as applicable (e.g. 'breeding', 'post-breeding', 'non-breeding' and 'pre-breeding') in the Offshore EIA Report (Volume 4) – Technical Appendix 10.3: Ornithology Displacement. The matrices and assessments presented in this chapter take into consideration three species-specific factors: (i) intensity of displacement within a given area (i.e. what proportion of the population is displaced); (ii) spatial extent – to what distance from turbines any individuals within the population will be displaced; and (iii) seasonality – what magnitude of impact there will be within a population (taken as percentage mortality), based on the species' particular sensitivity during a particular stage in the life cycle.

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

offshore wind farms (e.g. Krijgsveld *et al.,* 2011). For some species, such as auks, the reported levels of displacement have been variable.

6.6.5.5 The period of time and constancy that individuals within a population may be subject to displacement impacts is uncertain. It is likely that the impacts will be felt at greatest intensity during the first year of exposure, before there is any opportunity for habituation. Mortality is likely to be greatest in this year while in subsequent years it is possible that birds may become habituated to a certain extent, thereby reducing mortality rates. However, if the population has a large number of non-breeding 'floaters' then mortality rates may stay at similar levels for a number of years until this pool is used up.

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

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

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

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

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

Species for Consideration

6.6.5.11 The Offshore EIA Report (Volume 4) – Technical Appendix 10.3: Analysis of Displacement Impacts on Seabirds presents information to inform the assessments presented in this chapter relating to the significance of displacement impacts. These analyses have been informed by recent guidance published jointly by the UK SNCBs (JNCC *et al.,* 2017).

6.6.5.12 The full process applied to identify species that may be impacted by displacement effects is documented in the Ornithology Technical Report (Offshore EIA Report (Volume 4) – Technical Appendix 10.1).

6.6.5.13 The following species were identified for inclusion in the displacement assessment for potential displacement impacts associated with the Moray West Offshore Wind Farm:

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

6.6.5.14 In addition, potential disturbance and displacement impacts associated with the Offshore Export Cable Corridor have been considered for nine Valued Ornithological Receptors (VORs): scaup, eider, long-tailed duck, common scoter, velvet scoter, goldeneye, red-breasted merganser, red-throated diver, and great northern diver.

Spatial Scales

6.6.5.15 JNCC *et al.* (2017) interim guidance recommends that for the species of highest sensitivity (divers and sea ducks), the Moray West Site plus 4 km buffer should be used when assessing displacement, whereas a 2 km buffer should be used for all other species. In both cases JNCC *et al.* (2017) recommended that no gradient of impact of displacement level should be applied to the buffer zone, as there is not sufficient evidence to underpin any such gradient application on a species-by-species basis. This is a precautionary approach that doesn't represent the reality that some degree of gradient will occur in respect to how close individual birds will approach a source of disturbance influenced by, for example, past exposure to the event (habituation), need to feed chicks and ability to forage as successfully elsewhere.

6.6.5.16 For all species included in the displacement analysis for impacts associated with the Moray West Offshore Wind Farm, a 2 km buffer around the Moray West Site is used with no gradient of impact of displacement level applied to the buffer zone. Species deemed particularly sensitive to displacement, such as divers and seaduck did not qualify as VORs in this assessment for the Moray West Site due to either being absent or recorded in only very small numbers (during site-specific aerial surveys (Offshore EIA Report (Volume 4) – Technical Appendix 10.1: Ornithology Technical Report). Red-throated diver and common scoter did however qualify as VORs for consideration in relation to construction phase disturbance impacts arising from the Offshore Export Cable Corridor.

6.6.5.17 Significant degrees of precaution are built into the assessment of displacement effects. The JNCC *et al.* (2017) interim guidance underpins the process followed. The assessment applies the mean peak number of birds recorded within the Moray West Site (plus an appropriate buffer) during appropriate seasons defined for each VOR. Populations (for guillemot, razorbill, puffin and kittiwake) used in the assessment of displacement have been derived through a 'decision support system' process by which the single year of data collected for Moray West is compared against overlapping data from surveys of Beatrice Offshore wind Farm and the MORL EDA (now Moray East Offshore Wind Farm) (Offshore EIA Report (Volume 4) – Technical Appendix 10.1 - Annex 10.1A). Mean peak population estimates for fulmar have been taken directly from the outputs of the single year of digital aerial survey for Moray West (Offshore EIA Report (Volume 4) – Technical Appendix 10.1: Ornithology Technical Report).

6.6.5.18 The mean peak number (i.e. the mean of the highest population estimates within a particular season) is considered sufficiently precautionary for the realistic worst-case. It is considered likely that displacement responses by seabirds are highly likely to decline the further distant from the

disturbance source. A notable example of this was recorded for red-throated divers at Kentish Flats Offshore Wind Farm (Percival, 2010). However, in general, species specific information is lacking on geographically defined displacement rates and therefore on a precautionary basis a consistent displacement rate is applied through the Moray West Site plus buffer. This therefore means that assessments of displacement effects are associated with a significant degree of in-built precaution.

Displacement Rates

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

6.6.5.20 JNCC *et al. (*2017) indicates that SNCBs intend to use 'Disturbance Susceptibility' scores from Bradbury *et al*. (2014) (which have in fact been updated by Wade *et al.* (2016)) as a general guide to the appropriate displacement levels to apply for a species. JNCC *et al.* (2017) suggests that displacement rates of 90-100% should be used for species with a high vulnerability, 30-70% should be used for species with a moderate vulnerability and 10% should be used for species with a low vulnerability. Since the publication of JNCC *et al.* (2017) further advice from SNH has been provided on the appropriate species specific rates that should be applied to impact assessments (e.g. SNH advice to scoping opinions for Forth and Tay wind farms). In addition to these recommended rates, attempts have been made in this EIA Report below to summarise available published evidence on displacement and provide alternative suggested displacement rates if considered appropriate.

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

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

Fulmar

6.6.5.23 Fulmar is considered to have a very low vulnerability to displacement from offshore wind farms, being assigned a score of 1 (out of 5) by Wade *et al.* (2016). JNCC *et al.* (2017) suggests that a 10% displacement rate would be assumed for species such as fulmar.

6.6.5.24 There was no significant effect on the abundance of fulmar at the Thortonbank offshore wind farm between the pre-construction and operational phases (Vanerman *et al.,* 2017). Leopold *et*

al. (2011) was unable to draw conclusive results at Egmond aan Zee due to low numbers of birds although Krijgsveld *et al.* (2011), using data collected at the same project, identified fulmar as a lower sensitivity species with a displacement rate of 28%. Barton *et al*. (2009) noted "highly significant" declines in the abundance of fulmar at the Arklow Bank wind farm although declines appear to have occurred across the study area.

6.6.5.25 Available published evidence for fulmar is limited and while a displacement rate of 10% is considered appropriate, the results at a range of 10-30% are presented.

Auks

6.6.5.26 Guillemot and razorbill are considered to have a high vulnerability to displacement from offshore wind farms, being assigned a score of 4 (out of 5) by Wade *et al.* (2016). Puffin is assigned a score of 3 and considered to be moderately vulnerable to displacement. JNCC *et al.* (2017) suggests that a 30-100% displacement rate range would be assumed for species with moderate or high vulnerability.

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

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

6.6.5.29 The abundance of razorbill at the Robin Rigg offshore wind farm was not significantly affected by the development phase of the wind farm, although densities of razorbill on the sea did increase within the wind farm area between the pre-construction and operational phases (Nelson *et al.,* 2014). The spatial abundance of guillemot changed between time periods, but it did not appear to be linked with the presence of the wind farm. The abundance of guillemot at the Thortonbank offshore wind farm was shown to have decreased once the wind farm was operational (69% in the wind farm plus 500 m buffer area) with these decreases significant within the wind farm plus 500 m buffer area. Although decreases were also noted in the buffer area (500 m to 3 km) these were not statistically significant. The abundance of razorbill decreased within the wind farm area but increased in the surrounding buffer. When these two areas were combined there was no apparent effect on the abundance of razorbill due to the presence of the wind farm (Vanerman *et al*., 2017). Similar results were found at the Alpha Ventus offshore wind farm with the abundance of guillemot statistically significantly lower after the construction of the wind farm (Mendel *et al*., 2014). At Blighbank offshore wind farm both guillemot and razorbill appeared to avoid the wind farm area with decreases of 75% and 67%, respectively however, decreases were lower (and not significant) in the buffer area (49 and 32%, respectively) (Vanerman *et al*., 2016).

6.6.5.30 It is important to note that some of the high displacement rates reported in the studies summarised here apply to the wind farm alone whereas the displacement analyses for this Development calculate the number birds displaced from the Moray West Site plus a 2 km buffer. A number of studies did, however, find no significant effect on the number of birds present in

buffer areas around wind farms. It is therefore considered that there is considerable precaution in any proposed likely displacement rate, which should be considered when framing the assessment of the resultant predictions of mortality.

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

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

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

Kittiwake

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

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

Mortality Rates

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

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

- Guillemot and razorbill: 1%

- Puffin and kittiwake: 2%

6.6.5.38 Fulmar have extensive foraging ranges during the breeding season (*Thaxter et al.,* 2012) providing the species with sufficient alternative foraging opportunities. A mortality rate of 1% is therefore considered appropriate in the breeding season.

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

Population Consequences of Displacement / Barrier Effects

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

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

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

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

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

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

At-Sea Turnover of Breeding Seabirds

6.6.5.45 Searle *et al.* (2015) reviewed the 'turnover' of individual seabirds at sea during the breeding season and assessed how this may lead population estimates derived from boat or aerial surveys to underestimate the total number of birds that use an area during the course of the breeding

season. In this context, turnover was defined as the total number of birds that will use a particular area of sea at any point during the breeding season, divided by the number of birds that will be present in that area at a particular snapshot in time.

6.6.5.46 Searle *et al.* (2015) estimated turnover using modelled foraging densities of the Forth-Tay area derived from GPS tracking data (as generated by Searle *et al.,* 2014 for the CEH displacement model) to simulate the daily foraging locations of individual birds on individual days throughout the breeding season. By assuming that birds rest at their foraging locations, and fly in a straight line between the colony and foraging location, these simulations were used to evaluate the locations that are associated with foraging, commuting and resting at sea. Empirical data on the daily activity budget of birds was used for simulating the number of birds that would be seen performing each behaviour (foraging, commuting, resting at sea) within each wind farm footprint during a "snapshot" survey of the entire footprint area. This enabled for four species (kittiwake, guillemot, razorbill and puffin) in the Forth-Tay region, a direct estimate of turnover to be quantified for site fidelity at a range of spatial scales and levels (i.e. none to complete).

6.6.5.47 What this Marine Scotland commissioned study has not enabled is the provision of specific estimates of turnover at a given location until further data on both the level and spatial scale of site fidelity of these species become available. The findings therefore provide a guide to describing how the level of turnover changes with site fidelity behaviours and patterns, and with the spatial scale of wind farm footprints. Quantifying the fate of birds that lie within the development footprint is a related but separate task that was outside of the study's remit.

6.6.5.48 In general however, it can be supposed that the higher the turnover the less often any individual is likely to be using the Site, and therefore the lower the impact to any one individual. So, by not assessing turnover, and assuming the mean peak represents birds dependent on the Site, the assessment is highly likely to be conservative.

6.6.6 Collision Risk Analysis

6.6.6.1 Collision Risk Modelling (CRM) has been undertaken to quantify the potential risk of additional mortality through collisions with operational turbines above the current baseline for each species. The most frequently used collision risk model in the UK is commonly referred to as 'the Band model'. This model was originally devised in 1995 and has since been subject to a number of iterations, most recently to facilitate application in the offshore environment (Band, 2011), to allow for the use of flight height distribution data and to include a methodology for considering birds on migration (Band, 2012).

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

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

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

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

6.6.6.5 Both the Basic and Extended models of Band (2012) allow for the use of two 'Options' termed Options 1-4. Options 1 and 2 use the Basic model with Options 3 and 4 utilising the Extended model. The difference between the two Options under each model is linked to the use of flight height data. Options 2 and 3 use generic data from Johnston *et al.* (2014) whereas Options 1 and 4 use data derived from site-specific surveys.

6.6.6.6 The Band (2012) CRM requires monthly densities of each species assessed to be provided. Offshore EIA Report (Volume 4) – Technical Appendix 10.1 - Annex 10.1A presents the process by which appropriate densities have been selected to inform the CRM. In order to express the uncertainty associated with the collision risk estimates used in the assessment, modelling has been conducted incorporating upper and lower confidence intervals associated with both species densities and flight height distributions.

6.6.6.7 The flight height data collected as part of site-specific digital aerial surveys of the Moray West Site plus 4 km buffer have been thoroughly reviewed and are concluded to be of limited use in collision risk modelling. For the majority of species the number of records falls below a usable sample size in order to derive any degree of confidence in the estimate (i.e. considerably below 100 records for most species). In addition, flight height estimates have tended to fall considerably outside of the confidence limits associated with generic flight height information (Johnston *et al.*, 2014) with no valid ecological reason as to why this should occur. Further to this, the majority of records in the dataset have associated wide confidence intervals and there are a significant number of records that are assigned a negative flight height. It was therefore agreed with SNH and MSS that the data was unsuitable to inform the CRM in the assessment of Moray West Offshore Wind Farm.

6.6.6.8 There exists a considerable amount of flight height data that were collected during boat-based surveys conducted to support the application for the Moray East Offshore Wind Farm. Surveys were conducted between April 2010 and March 2012 using standard survey methodologies (Camphuysen *et al*., 2004).

6.6.6.9 A proportion of the survey area overlaps with the Moray West Site (see Offshore EIA Report (Volume 4) – Technical Appendix 10.1 - Annex 10.1A). A full description of the surveys conducted is presented in the Moray East ES 2012. These data have been applied to Option 1 of the Moray West Offshore Wind Farm Band (2012) CRM. However, the flight height bands used to collect flight height data during these surveys do not correspond with the turbine models used in collision risk modelling for the Moray West Offshore Wind Farm. Therefore, although results using Option 1 are presented in Offshore EIA Report (Volume 4) – Technical Appendix 10.2:

Collision Risk Modelling they are not used for assessment purposes as they are considered to greatly over-estimate the likely collision risk at the Moray West Site.

6.6.6.10 Collision risk estimates calculated using Options 2 and 3 of the Band (2012) model which make use of aggregated flight height data contained in Johnston *et al.* (2014) are therefore used to inform the assessments presented.

6.6.6.11 The proportion collision height (PCH) calculated for each species are presented in Offshore EIA Report (Volume 4) – Technical Appendix 10.2: Collision Risk Modelling.

Collision Risk to Regularly Occurring Seabirds

6.6.6.12 With regard to this RIAA, collision risk modelling has been conducted for the following two species of regularly occurring seabird:

- Kittiwake; and
- Herring gull

6.6.6.13 Gannet is not an SPA species and therefore does not need to be considered in this RIAA and great black-backed gull has been screened out of the RIAA for reasons presented in Chapter 4.

6.6.6.14 CRM for these species has been conducted using the Band (2012) CRM, as agreed with SNH and MSS. Bird biometric parameters for each of these species is presented in the Offshore EIA Report (Volume 4) – Technical Appendix 10.2: Collision Risk Modelling.

6.6.6.15 The avoidance rates applied for each species are also presented in the Offshore EIA Report (Volume 4) Appendix 10.2: Collision Risk Modelling. The rates applied are in general, taken from Cook *et al*. (2014) which presents avoidance rates for both species included in the modelling for the Moray West Offshore Wind Farm. Cook *et al.* (2014) recommended avoidance rates for use with the Basic model for both species and with the Extended model for herring gull. Cook *et al*. (2014) were unable to recommend an avoidance rate for use in the Extended model for kittiwake and as such a 'default' 98% avoidance rate is applied in the modelling conducted for this Development.

6.6.6.16 In a joint response, UK SNCBs supported the recommended avoidance rates of Cook *et al.* (2014) with the exception of kittiwake (JNCC *et al.,* 2014). The SNCBs did not agree with the application of avoidance rates calculated for the 'small gull' category used in Cook *et al.* (2014) to kittiwake and recommended that the avoidance rate calculated for the 'all gull' category should be applied instead. Collision risk modelling for this Development is presented at a range of avoidance rates; it is however therefore focussed on the avoidance rates presented in Table 6.6.2 taking into account the recommendations in JNCC *et al.* (2014).

Table 6.6.2: Avoidance Rates Applied in Collision Risk Modelling for Kittiwake and Herring Gull

Band (2012) model	Kittiwake	Herring gull
Basic	98.9 / 99.2 (±0.2)	99.5 (±0.1)
Extended	98.0	99.0 (±0.2)

6.6.6.17 Outputs from the collision risk modelling undertaken for both kittiwake and herring gull are presented in the Offshore EIA Report (Volume 4) – Technical Appendix 10.2: Collision Risk Modelling.

Assumptions and Precaution in Collision Risk Modelling Parameters

6.6.6.18 To quantify bird collision risk, collision risk models (CRM) such as 'the Band model' (Band 2012) used in the current assessment, use technical specifications of the turbines, bird morphological

and behavioural parameters together with site-specific bird data e.g. densities. Models are often finally corrected to take account of behavioural responses of birds to the presence of wind farms and the turbines within, by multiplying the model's outcome with a correction factor that takes into account, among other things, avoidance (action taken by a bird, when close to an operational wind farm, which prevents collision), termed the "avoidance rate".

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

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

6.6.6.21 The recent publication of the ORJIP Bird Collision Avoidance (BCA) study (Skov *et al.* 2018) provides important and enhanced input for some of the required data used in the Band model, including species-specific data on flight speeds, empirical evidence on nocturnal activity and the best available empirical information to account for avoidance behaviour in seabirds which can be readily applied in CRM. This section considers these existing opportunities to refine the CRM in order to more accurately account for bird movement and behaviour. Moreover MacArthur Green's (2017) calculated update of collision mortality to reflect actual wind farm designs, has highlighted the ornithological 'headroom' that exists - the difference between the two estimates. This additional existing opportunity to update CRM parameters by means of reviewing consented and as-built scenarios, is given further consideration in Section 6.9.2.

Bird Flight Speed

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

6.6.6.23 At present, flight speed data for use in CRM relies on published data (Pennycuick 1997; Alerstram *et al.,* 2007) based on very small sample sizes ranging from 32 (northern gannet) down to two (black-legged kittiwake). On the other hand, the laser rangefinder track data recorded by Skov *et al.* (2018) at Thanet Offshore Wind Farm, off the Kent coast, offer species-specific empirical data on flight speeds from large numbers of individuals, albeit in non-adverse weather conditions. As such, those data are a valuable source of information on more realistic mean flight speeds and associated variability in offshore wind farms necessary for improving estimates of the flux of birds for the species in question.

6.6.6.24 Table 6.6.4 provides a comparison between the species-specific mean flight speeds often used in CRM and those recorded by Skov *et al.,* (2018). For the former, the total track time for

the two radar recordings of kittiwake was 660 seconds. Furthermore, the flight speed data for all kittiwake and herring gull was restricted to radar recordings from migration flight which are expected to be birds flying at an airspeed close to that associated with maximum lift-drag ratio (Alerstram *et al.* 2007). This would imply that the very small sample sizes of flight speed data used at present in CRM are not necessarily behaviourally representative of bird flight at sea. Indeed the flight speeds recorded by Skov *et al. (*2018) were markedly lower than the generic speeds typically recommended in guidance (Alerstam *et al.,* 2007).

Table 6.6.3: Species-Specific Mean Flight Speeds (m/s) Often Used in CRM, and those Measured from Single Rangefinder Segments Recorded at Thanet (SD is shown in brackets)

Species	Flight Speed Commonly Used (no. of tracks)	Flight Speed Estimated by the Study
Herring gull	12.8** (n=18)	9.80 (3.63)*** [n=790]
Kittiwake	13.1** (n=2)	8.71 (3.16) [n= 287]

* Pennycuick (1997)
**Alerstram *et al.* (2007)
***Estimated with data for all large gulls combined

6.6.6.25 Against this background, the flight speeds from Skov *et al.* (2018) are therefore the best available evidence to inform the collision risk assessment of the Moray West Offshore Wind Farm as presented in Offshore EIA Report (Volume 4) – Technical Appendix 10.2: Collision Risk Modelling. Collision risk estimates calculated using flight speeds from Alerstam *et al.* (2007) or Pennycuick (1987) are however also presented in Offshore EIA Report (Volume 4) – Technical Appendix B of Appendix 10.2: Collision Risk Modelling. Further information on the influence of flight speed parameters in Collision Risk Modelling (CRM) and comparative results using different flight speeds for kittiwake and herring gull are also presented in Appendix 4.7 of this RIAA Report.

Avoidance Rates

6.6.6.26 Species specific generic avoidance rates currently used are often based on mortality rates observed at onshore wind farms with no consideration of actual avoidance behaviour. The ORJIP BCA study, 2014 – 2017 (Skov *et al.,* 2018), was designed to improve the evidence base for seabird avoidance behaviour and collisions around offshore wind farms. This study generated the most extensive dataset of observations of seabird behaviour in and around an operational offshore wind farm (Thanet Offshore Wind Farm, off the Kent coast) that is currently available. A bird monitoring system was developed for the study, that allowed detecting and tracking bird movements at the species level in and around an operational offshore wind farm. Bird behaviour was monitored by the study at Thanet Offshore Wind Farm, deploying a multiple sensor monitoring system partly operated by experienced seabird observers (laser rangefinders and radar equipment), and partly automated through the collection of video evidence, with a focus on five target species: gannet, kittiwake and three species of large gulls (lesser black-backed gull, herring gull, great black-backed gull).

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

currently advised for use in collision risk assessment in the UK. Those rates should be closer to those indicated by the EARs derived in this study.

6.6.6.28 The empirical avoidance rates quantified by Skov *et al.* (2018) are considered applicable in the basic and extended version of the Band model (Band 2012). Thus, provided that empirically derived input parameters on flight speed in offshore wind farms and flight height outside offshore wind farms are applied, Skov *et al.* (2018) advise that the empirical avoidance rates can be readily used in the Band model. The empirical avoidance rates are provided below with standard deviation below calculated so as to reflect both variability and uncertainty.

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

6.6.6.29 The SNCBs are however currently assessing how the empirically estimated avoidance rates estimated as by Skov *et al.* (2018) should (or should not) be fed into a Band (2012) basic, and/or Band (2012) extended, model. In the absence from this review of recommendations by the SNCBs to date, the CRM of Volume 4 – Technical Appendix 10.2: Collision Risk Modelling is conducted using the avoidance rates presented in Table 1.3, taking into account the recommendations in both Cook *et al.* (2014) and JNCC *et al.* (2014).

Nocturnal Flight Activity

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

6.6.6.31 Offshore EIA Report (Volume 4) – Technical Appendix 10.2: Collision Risk Modelling considers Skov *et al. (*2018) findings on the levels of bird flight activity by night in the context of other recent studies and the advice from Marine Scotland and SNH on the nocturnal activity factors to be used in collision risk modelling. Against this background, Annex C of Appendix 10.2: Collision Risk Modelling (Offshore EIA Report Volume 4) presents an analysis of the potential change in collision risk estimates as a result of updating the nocturnal activity factors used in collision risk modelling at previously consented projects.

6.6.7 Population Viability Analysis

6.6.7.1 Where estimates of mortality (through predi8ctions from displacement and collision impacts) are estimated, typically Population Viability Analysis (PVA) has been conducted for the species and SPA in question. Appendix 4.5 of this RIAA presents for detail of the PVA conducted. Metrics selected for use in the assessment of adverse effects follows interpretation following the guidance given in Cook *et al*. 2015, 2016).

6.7 Summary of SPA Species and Impacts Requiring Assessment in the RIAA

6.7.1.1 Table 6.7.1 below summarises all SPAs and species requiring inclusion in the RIAA and the impacts to be assessed for each species.

Table 6.7.1: SPA Qualifying Features and Impacts Requiring Assessment in the RIAA							
SPA	**Qualifying Feature**	**Impacts Requiring Assessment in the RIAA**					
		Disturbance (Construction and Decommissioning)	**Changes to Prey Availability / Habitat Loss (Construction, Operation and Decommissioning)**	**Displacement (Operation)**	**Barrier Effects (Operation)**	**Collision Risk (Operation)**	**Effects of Pollution (Construction, Operation and Decommissioning)**
Buchan Ness to Collieston Coast SPA	Fulmar	Yes	Yes	Yes	Yes	No	Yes
	Guillemot	Yes	Yes	Yes	Yes	No	Yes
	Kittiwake (within foraging range of Offshore Export Cable Corridor only)	Yes	Yes	No	No	No	Yes
	Herring gull	No	No	No	No	Yes	Yes
East Caithness Cliffs SPA	Fulmar	Yes	Yes	Yes	Yes	No	Yes
	Razorbill	Yes	Yes	Yes	Yes	No	Yes
	Guillemot	Yes	Yes	Yes	Yes	No	Yes
	Kittiwake	Yes	Yes	Yes	Yes	Yes	Yes
	Herring gull	No	No	No	No	Yes	Yes
North Caithness Cliffs SPA	Fulmar	Yes	Yes	Yes	Yes	No	Yes
	Puffin	Yes	Yes	Yes	Yes	No	Yes
	Razorbill	Yes	Yes	Yes	Yes	No	Yes
	Guillemot	Yes	Yes	Yes	Yes	No	Yes
	Kittiwake	Yes	Yes	Yes	Yes	Yes	Yes
Troup, Pennan and Lion's Head SPA	Fulmar	Yes	Yes	Yes	Yes	No	Yes
	Razorbill	Yes	Yes	Yes	Yes	No	Yes
	Guillemot	Yes	Yes	Yes	Yes	No	Yes
	Kittiwake	Yes	Yes	Yes	Yes	Yes	Yes

Table 6.7.1: SPA Qualifying Features and Impacts Requiring Assessment in the RIAA							
SPA	**Qualifying Feature**	**Impacts Requiring Assessment in the RIAA**					
		Disturbance (Construction and Decommissioning)	**Changes to Prey Availability / Habitat Loss (Construction, Operation and Decommissioning)**	**Displacement (Operation)**	**Barrier Effects (Operation)**	**Collision Risk (Operation)**	**Effects of Pollution (Construction, Operation and Decommissioning)**
	Herring gull	No	No	No	No	Yes	Yes
Moray Fith pSPA	Eider	Yes	Yes	No	No	No	Yes
	Great northern diver	Yes	Yes	No	No	No	Yes
	Scaup	Yes	Yes	No	No	No	Yes
	Velvet scoter	Yes	Yes	No	No	No	Yes
	Common scoter	Yes	Yes	No	No	No	Yes
	Long-tailed duck	Yes	Yes	No	No	No	Yes
	Goldeneye	Yes	Yes	No	No	No	Yes
	Red-breasted merganser	Yes	Yes	No	No	No	Yes
	Red-throated diver	Yes	Yes	No	No	No	Yes
	Slavonian grebe	Yes	Yes	No	No	No	Yes
	Shag	Yes	Yes	No	No	No	Yes

6.8 Assessment of Adverse Effects – Project Alone

6.8.1 Prey Availability and Habitat Loss – All Sites and All Species

6.8.1.1 The vulnerability of bird species to changes in habitat or abundance and distribution of prey depends on their foraging flexibility, in particular their specific habitat and dietary requirements.

Fulmar

6.8.1.2 Wade *et al.* (2016) identifies fulmar as having a high habitat flexibility meaning that the species is able to exploit a wide range of foraging opportunities across a wide area. In the breeding season, any changes to the availability of prey associated with activities at the wind farm are likely to be negligible when considering the area of the Moray West site in relation to the total potential foraging range of fulmar (400 ± 245.8 km; Thaxter *et al.,* 2012). In non-breeding seasons fulmars are also likely to forage over significantly large areas as they are unrestricted by the necessity to provision young and as such it can be concluded that will be no adverse environment effects on any of the SPAs included in this RIAA.

Kittiwake

6.8.1.3 Wade *et al.* (2016) consider that kittiwake has a high habitat use flexibility as birds forage across the continental shelf within the 200 m depth contour, and are extremely pelagic, particularly in winter months. This has been shown in recent studies by Fredericksen *et al*. (2012) for example, where birds range widely across the North Sea and Atlantic. Langston (2010) also rated the species as being of low vulnerability to habitat and prey interactions.

6.8.1.4 It is considered that the construction of the Moray West Offshore Wind Farm and Offshore Export Cable Route would not affect foraging resources for kittiwake and that there would therefore be no detectable consequences of the impact on any of the SPAs included in this RIAA.

Guillemot

6.8.1.5 Guillemot was classified as having a moderate habitat use flexibility by Wade *et al*. (2016).

6.8.1.6 Based on respective densities of guillemot at the Moray West Site in comparison with the wider Moray Firth area, there evidence that the Moray West Site is of importance in at least a regional context during breeding and post-breeding period (Offshore EIA Report (Volume 4) – Technical Appendix 10.1: Ornithology Technical Report).

6.8.1.7 Guillemot may preferentially forage for sandeels, but they also obtain wide-ranging mobile prey species during this period. Whilst there may be intermittent displacement of prey from a region around the wind farm, there is no indication that the overall availability of prey for auk species will be reduced. It is expected that for those periods when auk peak abundance and construction activities coincide that auk species will redistribute themselves in relation to the availability of prey abundance.

6.8.1.8 The significance of impacts on seabird prey resource and habitats from the effects of construction impacts, as detailed in the Offshore EIA Report (Volume 2) – Chapter 7: Benthic and Intertidal Ecology and Chapter 8: Fish and Shellfish Ecology are assessed at most as minor adverse. It is therefore considered that the construction of the Moray West Offshore Wind Farm would not affect foraging resources for guillemot to an extent that it would have a detectable effect on any of the guillemot SPA populations included in this RIAA.

Razorbill

6.8.1.9 Razorbill feed mainly on sandeels, sprat and herring and typically forage offshore with inshore and pelagic feeding less common. Razorbill was classified as having a moderate habitat use flexibility by Wade *et al*. (2016).

6.8.1.10 Based on respective densities of razorbill at the Moray West Site in comparison with the wider Moray Firth area, there evidence that Moray West Site is of importance in at least a regional

context during breeding and post-breeding period (Offshore EIA Report (Volume 4) - Appendix 10.1: Ornithology Technical Report).

6.8.1.11 Razorbill may preferentially forage for sandeels, but they also obtain wide-ranging mobile prey species during this period. Whilst there may be intermittent displacement of prey from a region around the wind farm, there is no indication that the overall availability of prey for auk species will be reduced. It is expected that for those periods when auk peak abundance and construction activities coincide that auk species will redistribute themselves in relation to the availability of prey abundance.

6.8.1.12 The significance of impacts on seabird prey resource and habitats from the effects of construction impacts, as detailed in the Offshore EIA Report (Volume 2) Chapter 7: Benthic and Intertidal Ecology and Chapter 8: Fish and Shellfish Ecology are assessed at most as minor adverse. It is therefore considered that the construction of the Moray West Offshore Wind Farm would not affect foraging resources for razorbill to an extent that it would have a detectable effect on any of the guillemot SPA populations included in this RIAA.

Puffin

6.8.1.13 Puffin feed mainly on sandeels, sprat and herring and typically forage offshore with inshore and pelagic feeding less common. Puffin was classified as having a moderate habitat use flexibility by Wade *et al*. (2016).

6.8.1.14 Based on respective densities of puffin at the Moray West Site in comparison with the wider Moray Firth area, there is evidence that Moray West Site is of importance in at least a regional context during breeding and post-breeding period (Offshore EIA Report (Volume 4 – Technical Appendix 10.1: Ornithology Technical Report).

6.8.1.15 Puffin may preferentially forage for sandeels, but they also obtain wide-ranging mobile prey species during this period. Whilst there may be intermittent displacement of prey from a region around the wind farm, there is no indication that the overall availability of prey for auk species will be reduced. It is expected that for those periods when auk peak abundance and construction activities coincide that auk species will redistribute themselves in relation to the availability of prey abundance.

6.8.1.16 The significance of impacts on seabird prey resource and habitats from the effects of construction impacts, as detailed in Offshore EIA Report (Volume 2) - Chapter 7: Benthic and Intertidal Ecology and Chapter 8: Fish and Shellfish Ecology are assessed at most as minor adverse. It is expected that for those periods when auk peak abundance and construction activities coincide that auk species will redistribute themselves in relation to the availability of prey abundance.

6.8.2 Pollution Effects – All Sites and All Species

6.8.2.1 Species that spend large amounts of time in the water (e.g. divers and pursuit feeders such as auks) or on the sea surface (loafing) (auks) are considered to be more vulnerable to pollution incidents (such as the accidental release of synthetic compounds, fuels or other substances) than surface feeding species such as kittiwake and fulmar.

6.8.2.2 With regard to this Development, the main source of pollution is potential leaks or spills of fuel supply (diesel or oil) from vessels involved in construction or maintenance activities. The quantities of potentially polluting substances associated with the WTGs, OSPs, substructures and cables (e.g. lubricants and grout) are limited, and if released would be of insufficient quantities to result in a population level effect.

6.8.2.3 In the event a spill or leak does occur (which is considered highly unlikely as would involve a vessel collision or significant damage to a vessel), given that the majority of vessels involved in construction and maintenance activities will be smaller support or guard vessels, the quantities of fuel released are likely to also be limited. Furthermore, where a pollution incident does occur,

given the offshore location of the Moray West Site it is likely that any released substances will be rapidly diluted, dispersed and broken down by natural hydrodynamic processes.

6.8.2.4 Should a pollution incident occur, the potential for this to have a population level effect is limited due to the low quantities of pollutants that are likely to ever be released. Although the likelihood of an pollution event occurring is very low, there are specific industry best practice requirement for developers to implement specific pollution prevention measures in order to ensure that the risk of a pollution incident remains low and to set out procedures and processes to be put in place should a pollution incident occur in order to minimise the potential effects of that incident. Taking these measures into account (outlined in Chapter 5), it can be concluded that there would be no effect on any of the qualifying features of the any of the SPAs included in this RIAA.

6.8.3 Buchan Ness to Collieston Coast SPA – Disturbance/Displacement/Barrier Effects and Collision Risk

Site Description

6.8.3.1 Buchan Ness to Collieston Coast SPA is located on the eastern mainland Scottish coast covering sea cliff areas to the south of Peterhead and the adjacent marine area out to 2 km. The SPA provides suitable nesting habitat for a number of seabird species and the SPA is designated for a breeding seabird assemblage incorporating breeding populations of kittiwake, guillemot, herring gull and fulmar (shag has been screened out based on foraging range – see Chapter 4).

SPA Apportioning

6.8.3.2 The apportioning of birds occurring at the Moray West Site to the Buchan Ness to Collieston Coast SPA using the approach presented in Appendix 4.2: Phenology and Apportioning has been undertaken for guillemot and herring gull as described below.

Guillemot

6.8.3.3 It is not possible to age guillemot during site-specific surveys and as such a theoretical approach has been applied in order to estimate the contribution of different breeding colonies to the total population of birds present at the Moray West Site. This approach is described in Appendix 4.2: Phenology and Apportioning, and when applied estimates that of those birds present at Moray West, 57.5% will be adult birds.

6.8.3.4 Following guidance from Marine Scotland, it has been assumed that the proportion of sabbatical birds associated with a breeding colony is 7%, with this taken into account when impacts are apportioned to the SPA. Using the approach presented in Appendix 4.2: Phenology and Apportioning, the proportion of any impact attributable to the breeding adult guillemot population at Buchan Ness to Collieston Coast SPA was calculated as 0.01.

6.8.3.5 For apportioning in non-breeding seasons (post- and non-breeding seasons), population data from Furness (2015) were used to calculate the contribution of birds from Buchan Ness to Collieston Coast SPA to a wider population present within the North Sea.

Herring Gull

6.8.3.6 Data from boat-based surveys undertaken for the Moray East have been analysed to provide information on the age structure of herring gull at the Moray West Site. The sample size obtained from the Moray West aerial surveys was too small to allow for the calculation of a representative age structure. Using the boat-based data 84.1% of herring gull present at the Moray West Site are considered to be adult birds.

6.8.3.7 Following guidance from Marine Scotland guidance, it has been assumed that the proportion of sabbatical birds associated with a breeding colony is 35%, with this taken into account when impacts are apportioned to the SPA.

6.8.3.8 Using the approach presented in Appendix 4.2: Phenology and Apportioning, apportioning species at the Moray West Site to SPAs, the proportion of any impact attributable to the breeding adult herring gull population at Buchan Ness and Collieston Coast SPA was calculated as 0.03.

6.8.3.9 For apportioning in the non-breeding season, population data from Furness (2015) were used to calculate the contribution of birds from Buchan Ness to Collieston Coast SPA to a wider population present within the North Sea.

Fulmar

6.8.3.10 Although LSEs have been identified for fulmar based on likely connectivity between SPAs and the Moray West Site, and therefore the species is included in this RIAA, it is considered unlikely that the magnitude of any impact is sufficient enough to warrant apportioning between SPA populations. As such, no apportioning has been undertaken for fulmar. However, where necessary qualitative consideration has been given to the likely contribution of SPAs to the population of fulmar present at the Moray West Site.

Kittiwake

6.8.3.11 No apportioning was undertaken for this site for kittiwake on the basis that the foraging range for kittiwake overlaps with the Offshore Export Cable Corridor only.

Disturbance/Displacement/Barrier Effects

6.8.3.12 It is assumed that displacement resulting from operation of the Moray West Offshore Wind Farm represents the worst case scenario with respect to overall disturbance impacts on fulmar and guillemot. Therefore, the analysis of disturbance during construction/decommissioning is treated equivalently to the assessment of displacement presented below.

6.8.3.13 Displacement matrices for fulmar and guillemot are provided in Appendix 4.6: Displacement Matrices.

6.8.3.14 Conclusions from the assessment of disturbance/displacement and barrier effects on fulmar and guillemot informed by these displacement matrices are presented in Table 6.8.1 below.

Table 6.8.1: Disturbance/Displacement/Barrier Effects on Fulmar and Guillemot with Respect to Buchan Ness to Collieston Coast SPA													
Species	**Total SPA Breeding Population**	**Vulnerability Based on Wade *et al.* (2016)**	**Displacement Rate (%)**	**Mortality Rate (%)**	**Season**	**Results - Displacement**							**Conclusion (Impact)**
						Apportioned Mean-Peak Population Estimate Within the Moray West Site + 2 km buffer	**Unapportioned Mean-Peak Population Estimate Within the Moray West Site + 2 km Buffer**	**Apportioned Mortality**	**Unapportioned Mortality**	**% SPA Breeding Population**	**Increase in Background Mortality %**	**Increase in Background Mortality (# Birds)**	
Fulmar	3,530 breeding adults	Low	10-30	1	Breeding	-	581	-	1-2	0.02-0.05	0.26-0.77	226	Negligible increase in the baseline mortality of the SPA population. No adverse effect.
					Post-breeding	-	68	-	<1	negligible	negligible	226	
					Non-breeding	-	1,223	-	1-4	0.03-0.1	0.54-1.62	226	
					Pre-breeding	-	1,630	-	2-5	0.05-0.14	0.72-2.16	226	
Guillemot	17,280 breeding adults	High	50-60	1	Breeding	120	-	1	-	<0.01	0.06-0.07	1,054	Negligible increase in the baseline mortality of the SPA population. No adverse effect.
					Post-breeding	1,488	-	2-3	-	0.01-0.02	0.23-0.28	1,054	
					Non-breeding	105	-	7-9	-	<0.01	0.05-0.06	1,054	

Kittiwake (not included in displacement matrices as temporary construction impacts only)

6.8.3.15 In the maximum design scenario layout (Table 5.2.1), maximum area of disturbance and associated seabed habitat loss during installation of the export cables will be 1.95 km^2 which equates to approximately 1% of the total area of seabed along the Offshore Export Cable Corridor.

6.8.3.16 Kittiwake were considered to have only a low vulnerability to disturbance impacts associated with vessel movements by Wade *et al.* (2016) and are not considered to be affected by impacts during construction of the export cable circuits. Indeed, Chapter 10 of the Offshore EIA Report did not scope in this species for the assessment of construction activity disturbance.

6.8.3.17 It is considered that any disturbance would not affect foraging resources for kittiwake and that there would therefore be no detectable consequences of the impact.

Collision Risk

Herring Gull

6.8.3.18 Herring gull was rated as having a relatively high vulnerability to collision impacts by Wade *et al*. (2016), due to the proportion of flights likely to occur at potential risk height and percentage of time in flight. The recently published report for Marine Scotland (Cook *et al*., 2014) considers that a 99.0% avoidance rate is appropriate for the 'Extended' Band Model and a 99.5% avoidance rate is appropriate for the 'Basic' Band model.

6.8.3.19 An assessment of collision risk has been undertaken for herring gull using Band (2012). The results for Options 2 and 3 of this model are presented in Table 6.8.2.

6.8.3.20 Collision risk modelling, using Option 3, predicts a total collision risk mortality of ten collisions/annum at Moray West (99.0% avoidance) with less than one of these apportioned to the Buchan Ness to Collieston Coast SPA. This represents a negligible proportion of the SPA population (4,292 pairs) and therefore a negligible increase in baseline mortality (1,425 individuals). When using Option 2, a total collision risk mortality of 13 collisions/annum is predicted (99.5% avoidance rates) with less than one apportioned to the SPA. This represents a negligible proportion of the SPA population and a negligible increase in baseline mortality.

Table 6.8.2: Collision Risk Estimates for Herring Gull Calculated Using Options 2 and 3 of the Band (2012) CRM Apportioned to Buchan Ness to Collieston Coast SPA

Season	Predicted no. of collisions		Apportioning			No. of collisions apportioned to SPA	
	Option 2 (99.5% avoidance rate	Option 3 (98% avoidance rate	Proportion of adults	Sabbaticals	SPA apportioning	Option 2 (99.5% avoidance rate	Option 3 (98% avoidance rate
Breeding	12	10	0.841	0.65	0.035	0	0
Non-breeding	1	1	-	-	0.013	0	0
Total	13	11				0	0

Conclusions

Fulmar

6.8.3.21 The predicted level of mortality considered likely to occur due to reduction in prey availability, disturbance, displacement and barrier impacts associated with the Moray West Offshore Wind Farm represents a negligible proportion of the SPA population and a negligible increase in the baseline mortality of the SPA population. There is therefore no indication of an adverse effect on the integrity of the fulmar feature of the SPA as a result of disturbance, displacement and barrier impacts.

6.8.3.22 This conclusion assumes all fulmar are attributable to the Buchan Ness and Collieston Coast SPA. However, the fulmar population at Buchan Ness to Collieston Coast is the smallest of the four SPAs for which an LSE was identified during screening representing less than 5% of the total breeding adult population from these SPAs. The Buchan Ness to Collieston Coast SPA is also the furthest of these four SPAs from the Moray West Site. It is therefore considered that fulmars present at the Moray West Site are more likely to originate from the other three SPAs and that the impact on the Buchan Ness to Collieston Coast SPA would be much lower than predicted above.

Guillemot

6.8.3.23 The guillemot feature of Buchan Ness to Collieston Coast SPA has been assessed for impacts associated with the Moray West Offshore Wind Farm (displacement and barrier effects) and the OfTI in particular the offshore export cable route (disturbance and changes in prey availability).

6.8.3.24 The proportion of the SPA population affected by displacement mortality is low in all seasons and also represents less than a 1% increase in baseline mortality of the population. If seasonal displacement impacts were to be combined, noting that this is likely to over-estimate the total impact, the resulting total (10 birds) would also represent less than a 1% increase in the baseline mortality of the SPA population. There is therefore considered to be no indication of an adverse effect on the integrity of the guillemot feature of the SPA as a result of displacement impacts.

6.8.3.25 Effects associated with the installation of the offshore export cable circuits will be localised with an extremely low level of interaction between the offshore export cable route and populations of guillemot. There is therefore no indication of an adverse effect on the integrity of the guillemot feature of the SPA as a result of disturbance / changes in prey availability due to construction and decommissioning activities.

Herring gull

6.8.3.26 The herring gull feature of Buchan Ness to Collieston Coast SPA has been assessed for collision risk impacts associated with the Moray West Offshore Wind Farm. The predicted level of collision mortality apportioned to the SPA represents a negligible proportion of the SPA population and a negligible increase in the baseline mortality of the SPA population. There is therefore no indication of an adverse effect on the integrity of the herring gull feature of the SPA as a result of collision risk impacts.

Kittiwake

6.8.3.27 The kittiwake feature of Buchan Ness to Collieston Coast SPA has been assessed for impacts associated with the Moray West export cable route (disturbance and changes in prey availability). Effects associated with the installation of the export cable will be localised with an extremely low level of interaction between the export cable route and populations of kittiwake. There is no indication of an adverse effect on the integrity of the kittiwake feature of the SPA as a result of disturbance / changes in prey availability due to construction and decommissioning activities.

6.8.4 East Caithness Cliffs SPA- Disturbance/Displacement/Barrier Effects and Collision Risk

Site Description

6.8.4.1 East Caithness Cliffs SPA is located on the north-eastern mainland Scottish coast covering the sea cliff areas between Wick and Helmsdale and the adjacent marine area out to 2 km. The SPA provides suitable nesting habitat for a number of seabird species and the SPA is designated for guillemot (106,700 individuals), razorbill (15,800 individuals), herring gull (9,400 pairs), kittiwake (32,500 pairs), shag (2,300 pairs) and a breeding seabird assemblage incorporating additional breeding populations of great black-backed gull, cormorant and fulmar. The SPA is also designated for six breeding pairs of peregrine. Shag, great black-backed gull and cormorant are screened out of the HRA for reasons presented in Chapter 4.

Species Apportioning

Kittiwake

6.8.4.2 The Moray West Site is within foraging range of kittiwake from East Caithness Cliffs SPA based on the mean-maximum foraging range reported for the species by Thaxter *et al.* (2012).

6.8.4.3 Whilst it is possible to distinguish first year kittiwake from older birds, it is not possible to reliably separate other immature birds from adult birds. It is also not possible to separate breeding and non-breeding adult birds.

6.8.4.4 Data from aerial surveys undertaken for the Moray West Site, boat-based surveys undertaken for the Moray East Offshore Wind Farm and pre-construction survey data collected for the Beatrice Offshore Wind Farm have been analysed to provide information on the age structure of kittiwake at Moray West. A full review of these data sources are provided in Appendix 4.2: Phenology and Apportioning. Using these data 91.5-97.4% of kittiwake present at Moray West are considered to be adult birds. However, there are a number of reasons why these proportions will over-estimate the true proportion of kittiwakes present at the Moray West Site:

- Neither value accounts for adults in the population not breeding in a given year – this could account for a further reduction of c5-10% (Coulson 2011, Marine Scotland 2017a, b);
- A smaller proportion of first year birds are likely to be present in natal waters with a much greater proportion of older age classes of immature birds showing affinity with natal waters; and
- Immature birds are not likely to be evenly distributed within the North Sea and will show aggregations near to foraging resources. If the area within which the Moray West Offshore Wind Farm lies is seen to be notable for kittiwake foraging, immatures may be present in large numbers.

6.8.4.5 Following guidance from Marine Scotland, it has been assumed that the proportion of sabbatical birds associated with a breeding colony is 10%, with this taken into account when impacts are apportioned to the SPA.

6.8.4.6 East Caithness Cliffs SPA is not the only SPA from which birds may occur at the Moray West Site. Using the approach presented in Appendix 4.2: Phenology and Apportioning, the proportion of any impact attributable to the breeding adult kittiwake population at East Caithness Cliffs SPA was calculated as 0.86.

6.8.4.7 For apportioning in non-breeding seasons (post- and pre-breeding seasons), population data from Furness (2015) were used to calculate the contribution of birds from East Caithness Cliffs to a wider population present within the North Sea.

Herring gull

6.8.4.8 The Moray West Site is within foraging range of herring gull from East Caithness Cliffs SPA based on the mean-maximum foraging range reported for the species by Thaxter *et al.* (2012).

However, tracking work undertaken at this colony in 2014 found that no tracked birds foraged within the boundary of the Moray West Site (Moray East, 2015).

6.8.4.9 The apportioning approach for herring gull applied to determine the proportion of any impact attributable to the herring gull population at East Caithness Cliffs SPA follows the approach described in Appendix 4.2: Phenology and Apportioning. The equivalent proportion of 0.048.

Guillemot

6.8.4.10 The apportioning approach for guillemot applied to determine the proportion of any impact attributable to the guillemot population at East Caithness Cliffs SPA follows the approach described in Appendix 4.2: Phenology and Apportioning. The equivalent proportion of birds attributable to East Caithness Cliffs SPA is 0.84.

Razorbill

6.8.4.11 It is not possible to age razorbill during site-specific surveys and as such a theoretical approach has been applied in order to estimate the contribution of different breeding colonies to the total population of birds present at the Moray West Site. This approach is described in Appendix 4.2: Phenology and Apportioning, and when applied estimates that of those birds present at the Moray West Site, 57.1% will be adult birds.

6.8.4.12 Following guidance from Marine Scotland, it has been assumed that the proportion of sabbatical birds associated with a breeding colony is 7%, with this taken into account when impacts are apportioned to the SPA.

6.8.4.13 East Caithness Cliffs SPA is not the only SPA from which birds may occur at the Moray West Site. Using the approach presented in Appendix 4.2: Phenology and Apportioning, the proportion of any impact attributable to the breeding adult razorbill population at East Caithness Cliffs SPA was calculated as 0.91.

6.8.4.14 For apportioning in non-breeding seasons (post- and non-breeding seasons), population data from Furness (2015) were used to calculate the contribution of birds from East Caithness Cliffs to a wider population present within the North Sea.

Fulmar

6.8.4.15 Although LSEs have been identified for fulmar based on likely connectivity between SPAs and the Moray West Site, and therefore the species is included in this RIAA, it is considered unlikely that the magnitude of any impact is sufficient enough to warrant apportioning between SPA populations. As such, no apportioning has been undertaken for fulmar. However, where appropriate qualitative consideration is given to the likely contribution of SPAs to the population of fulmar present at the Moray West Site.

Disturbance/Displacement/Barrier Effects

6.8.4.16 It is assumed that displacement resulting from operation of the Moray West Offshore Wind Farm represents the worst case scenario with respect to overall disturbance impacts on fulmar, kittiwake, guillemot and razorbill. Therefore, the analysis of disturbance during construction / decommissioning is treated equivalently to the assessment of displacement presented below.

6.8.4.17 Displacement matrices for fulmar, kittiwake, guillemot and razorbill are provided in Appendix 4.4: Displacement Matrices.

6.8.4.18 Conclusions from the assessment of disturbance/displacement and barrier effects on fulmar, kittiwake, guillemot and razorbill informed by these displacement matrices are presented in Table 6.8.3 below.

Table 6.8.3: Disturbance/Displacement/Barrier Effects on Fulmar, Kittiwake, Guillemot and Razorbill with Respect to East Caithness Cliffs SPA														
Species	**Total SPA Breeding Population**	**Vulnerability Based on Wade *et al.* (2016)**	**Displacement Rate (%)**	**Mortality Rate (%)**	**Season**	**Results - Displacement**								
						Apportioned Mean-Peak Population Estimate within the Moray West Site + 2 km Buffer	**Unapportioned Mean-Peak Population Estimate within the Moray West Site + 2 km Buffer**	**Apportioned Mortality**	**Unapportioned Mortality**	**% SPA Breeding Population**	**Increase in Background Mortality %**	**Increase in Background Mortality (# Birds)**	**Conclusion (Impact)**
Fulmar	30,000 breeding birds	Low	10-30	1	Breeding	-	581	-	1-2	up to 0.01	0.03-0.09	1,920	No adverse effect on SPA feature
					Post-breeding	-	68	-	<1	negligible	negligible	1,920	
					Non-breeding	-	1,223	-	1-4	up to 0.01	0.06-0.19	1,920	
					Pre-breeding	-	1,630	-	2-5	0.01-0.02	0.08-0.25	1,920	
Kittiwake	65,000 breeding adults	Low	30	2	Breeding	4,888	-	29	-	0.05	0.31	9,490	No adverse effect on SPA feature
					Post-breeding	86	-	1	-	<0.01	0.01	9,490	
					Pre-breeding	83	-	<1	-	negligible	negligible		
Guillemot	142,978 breeding adults	High	50-60	1	Breeding	11,031	-	55-66	-	0.04-0.05	0.63-0.76	8,722	No adverse effect on SPA feature
					Post-breeding	3,519	-	18-21	-	0.01	0.20-0.24	8,722	
					Non-breeding	758	-	4-5	-	<0.01	0.04-0.05	8,722	
Razorbill	21,172 breeding adults	High	40-60	1	Breeding	1,351	-	5-8	-	0.03-0.04	0.24-0.36	2,223	No adverse effect on SPA feature
					Post-breeding	150	-	1	-	<0.01	0.03-0.04	2,223	
					Non-breeding	6	-	<1	-	negligible	negligible	2,223	
					Pre-breeding	151	-	1	-	<0.01	0.02-0.04	2,223	

Collision Risk

Kittiwake

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

6.8.4.20 An assessment of collision risk has been undertaken for kittiwake using Band (2012). The results for Options 2 and 3 of this model are presented in Table 6.8.4 and Table 6.8.5.

6.8.4.21 Collision risk modelling, using Option 3, predicts a total collision risk mortality of 78 collisions/annum associated with the Moray West Offshore Wind Farm across a full annual cycle (98% avoidance) with 30 of these apportioned to the East Caithness Cliffs SPA. This represents 0.05% of the SPA population (32,500 pairs) and 0.31% increase in baseline mortality (9,490 individuals). When using Option 2, a total collision risk mortality of 79-109 collisions/annum is predicted (99.2% and 98.9% avoidance rates) with 42-58 apportioned to the SPA. This represents 0.06-0.09% of the SPA population and a 0.44-0.61% increase in baseline mortality.

6.8.4.22 East Caithness Cliffs SPA was designated based on the kittiwake breeding population estimated in 1985-88 (32,500 pairs). This population had increased to 40,140 pairs in 1999 but has since declined to 24,460 pairs in 2015.

6.8.4.23 If additional mortality of 50 birds per annum is assumed for PVA modelling (the closest modelled output to the predicted in-combination total) then the model predicts a reduction in growth rate of 0.23%. Under this scenario, the predicted median impacted population size after 35-50 years would be approximately 90-93% of that which the model predicts would occur in the in the absence of any additional in-combination impact.

6.8.4.24 The PVA model predicts a positive growth rate for the kittiwake population at East Caithness Cliffs SPA with a resulting end population size higher than that designated at the SPA. However, the population at the SPA has exhibited a declining population trend in recent years with this trend potentially likely to continue regardless of the presence of the Moray West Offshore Wind Farm (Table 6.8.6).

Table 6.8.4: Collision Risk Estimates for Kittiwake Calculated using Option 2 of the Band (2012) CRM Apportioned to East Caithness Cliffs SPA

Season	Predicted no. of Collisions		Apportioning			No. of Collisions Apportioned to SPA	
	Option 2 (98.9% Avoidance Rate	Option 2 (99.2% Avoidance Rate	Proportion of Adults	Sabbaticals	SPA Apportioning	Option 2 (98.9% Avoidance Rate	Option 2 (99.2% Avoidance Rate
Breeding	79	57	0.915	0.9	0.860	56	41
Post-breeding	24	17	-	-	0.058	1	1
Pre-breeding	7	5	-	-	0.078	1	0
Total	109	79				58	42

Table 6.8.5: Collision Risk Estimates for Kittiwake Calculated using Option 3 of the Band (2012) CRM Apportioned to East Caithness Cliffs SPA					
Season	**Predicted no. of Collisions**	**Apportioning**			**No. of Collisions Apportioned to SPA**
	Option 3 (98% Avoidance rate	**Proportion of Adults**	**Sabbaticals**	**SPA Apportioning**	**Option 3 (98% Avoidance Rate**
Breeding	40	0.915	0.9	0.860	29
Post-breeding	12	-	-	0.058	1
Pre-breeding	3	-	-	0.078	0
Total	56				30

Table 6.8.6: PVA Outputs for Kittiwake at East Caithness Cliffs SPA Assuming a Mortality of 50 Birds					
Impact Scenario	**Years**	**% Change in Growth Rate**	**Ratio of Unimpacted to Impacted Growth Rate**	**Ratio of Unimpacted to Impacted Population Size**	**Centile for Impacted Population**
Unimpacted	-	-	-	1	0.50
Impacted	35	-0.23	0.998	0.93	0.43
	50			0.90	0.41

Herring gull

6.8.4.25 Herring gull was rated as having a relatively high vulnerability to collision impacts by Wade *et al*. (2016), due to the proportion of flights likely to occur at potential risk height and percentage of time in flight. The recently published report for Marine Scotland (Cook *et al*., 2014) considers that a 99.0% avoidance rate is appropriate for the 'Extended' Band Model and a 99.5% avoidance rate is appropriate for the 'Basic' Band model.

6.8.4.26 An assessment of collision risk has been undertaken for herring gull using Band (2012). The results for Options 2 and 3 of this model are presented in Table 6.8.7.

6.8.4.27 Collision risk modelling, using Option 3, predicts a total collision risk mortality of 11 collisions/annum associated with the Moray West Offshore Wind Farm (99.0% avoidance) with three of these apportioned to the East Caithness Cliffs SPA. This represents 0.02% of the SPA population (9,400 pairs) and 0.1% increase in baseline mortality (3,121 individuals). When using Option 2, a total collision risk mortality of 13 collisions/annum is predicted (99.5% avoidance rates) with four apportioned to the SPA. This represents 0.02% of the SPA population and a 0.09% increase in baseline mortality.

Table 6.8.7: Collision Risk Estimates for Herring Gull Calculated using Options 2 and 3 of the Band (2012) CRM Apportioned to East Caithness Cliffs SPA							
Season	**Predicted no. of Collisions**		**Apportioning**			**No. of Collisions Apportioned to SPA**	
	Option 2 (99.5% Avoidance Rate	**Option 3 (99.0% Avoidance Rate**	**Proportion of Adults**	**Sabbaticals**	**SPA Apportioning**	**Option 2 (99.5% Avoidance Rate**	**Option 3 (99.0% Avoidance Rate**
Breeding	12	10	0.841	0.65	0.035	4	3
Non-breeding	1	1	-	-	0.013	0	0
Total	13	11				4	3

Conclusions

Fulmar

6.8.4.28 The fulmar feature of East Caithness Cliffs SPA has been assessed for reductions in prey availability, disturbance, displacement and barrier impacts associated with the Moray West Offshore Wind Farm. The predicted level of mortality considered likely to occur represents a negligible proportion of the SPA population and a negligible increase in the baseline mortality of the SPA population. There is therefore no indication of an adverse effect on the integrity of the fulmar feature of the SPA as a result of disturbance, displacement and barrier impacts.

Kittiwake

6.8.4.29 The kittiwake feature of East Caithness Cliffs SPA has been assessed for impacts associated with the Moray West array area (collision risk and displacement) and the Moray West export cable route (disturbance and changes in prey availability).

6.8.4.30 The proportion of the SPA population affected by displacement mortality is negligible in the post-breeding and pre-breeding seasons. Displacement mortality of 29 birds is predicted in the breeding season, representing a negligible proportion of the SPA population and less than a 1% increase in baseline mortality. If seasonal displacement impacts were to be combined, noting that this is likely to over-estimate the total impact, the resulting total (30 birds) would also represent less than a 1% increase in the baseline mortality of the SPA population. There is therefore considered to be no indication of an adverse effect on the integrity of the kittiwake feature of the SPA as a result of displacement impacts.

6.8.4.31 The predicted level of collision mortality apportioned to the SPA represents an increase of less than 1% of baseline mortality of the SPA population. PVA modelling for the East Caithness Cliffs SPA kittiwake population has been undertaken to identify any potential population level consequences.

6.8.4.32 If collision and displacement impacts were to be combined the resulting mortality (72 - 86 birds) would represent a negligible proportion of the SPA population (0.22%) and a negligible increase in the baseline mortality of the SPA population. There is therefore considered to be no adverse effect on the integrity of the kittiwake feature of the SPA as a result of combined displacement and collision impacts.

6.8.4.33 Effects associated with the installation of the export cable will be localised with an extremely low level of interaction between the export cable route and populations of kittiwake. There is

no indication of an adverse effect on the integrity of the kittiwake feature of the SPA as a result of disturbance / changes in prey availability due to construction and decommissioning activities.

Herring gull

6.8.4.34 The herring gull feature of East Caithness Cliffs SPA has been assessed for collision risk impacts associated with the Moray West Site. The predicted level of collision mortality apportioned to the SPA represents a negligible proportion of the SPA population and a negligible increase in the baseline mortality of the SPA population. There is therefore no indication of an adverse effect on the integrity of the herring gull feature of the SPA as a result of collision risk impacts.

Guillemot

6.8.4.35 The guillemot feature of East Caithness Cliffs SPA has been assessed for impacts associated with the Moray West Offshore Wind Farm (displacement and barrier effects) and the OfTI (offshore export cable route) (disturbance and changes in prey availability).

6.8.4.36 The proportion of the SPA population affected by displacement mortality is low in all seasons and also represents less than a 1% increase in baseline mortality of the population. In addition PVA modelling does not indicate any population level effects on the guillemot population at East Caithness Cliffs SPA as a result of impacts occurring in the breeding season.

6.8.4.37 If seasonal displacement impacts were to be combined, noting that this is likely to over-estimate the total impact, a total mortality of 92 birds would be predicted. PVA modelling indicates that this level of mortality is not considered to result in population level effects with the final population size still likely to be above the population originally designated for the SPA (See Appendix 4.5: PVA modelling for full details). There is therefore considered to be no indication of an adverse effect on the integrity of the guillemot feature of the SPA as a result of displacement impacts.

6.8.4.38 Effects associated with the installation of the export cable will be localised with an extremely low level of interaction between the export cable route and populations of guillemot. There is therefore no indication of an adverse effect on the integrity of the guillemot feature of the SPA as a result of disturbance / changes in prey availability due to construction and decommissioning activities.

Razorbill

6.8.4.39 The razorbill feature of East Caithness Cliffs SPA has been assessed for impacts associated with the Moray West Offshore Wind Farm (displacement and barrier effects) and the OfTI (offshore export cable route) (disturbance and changes in prey availability).

6.8.4.40 The proportion of the SPA population affected by displacement mortality is low in all seasons and also represents less than a 1% increase in baseline mortality of the population. If seasonal displacement impacts were to be combined, noting that this is likely to over-estimate the total impact, the resulting total (13 birds) would also represent less than a 1% increase in the baseline mortality of the SPA population. PVA modelling indicates that this level of mortality is not considered to result in population level effects with the final population size still likely to be above the population originally designated for the SPA (see Appendix 4.5: PVA modelling for full results). There is therefore considered to be no indication of an adverse effect on the integrity of the razorbill feature of the SPA as a result of displacement impacts.

6.8.4.41 Effects associated with the installation of the export cable will be localised with an extremely low level of interaction between the export cable route and populations of guillemot. There is therefore no indication of an adverse effect on the integrity of the guillemot feature of the SPA as a result of disturbance / changes in prey availability due to construction and decommissioning activities.

6.8.5 North Caithness Cliffs SPA - Disturbance/Displacement/Barrier Effects and Collision Risk

Site Description

6.8.5.1 North Caithness Cliffs SPA is located on the northern mainland Scottish coast covering four areas between Wick and Strathy Point and the island of Stroma. In addition to terrestrial areas, the SPA also covers adjacent marine areas out to 2 km. The SPA provides suitable nesting habitat for a number of seabird species and the SPA is designated for guillemot (38,300 individuals) and a breeding seabird assemblage incorporating additional breeding populations of fulmar, kittiwake, razorbill and puffin. The SPA is also designated for six breeding pairs of peregrine.

Species Apportioning

Kittiwake

6.8.5.2 The apportioning approach for kittiwake applied to determine the proportion of any impact attributable to the kittiwake population at North Caithness Cliffs SPA follows the approach described in Appendix 4.2: Phenology and Apportioning. The equivalent proportion of birds attributable to North Caithness Cliffs SPA is 0.03.

Guillemot

6.8.5.3 The apportioning approach for guillemot applied to determine the proportion of any impact attributable to the guillemot population at North Caithness Cliffs SPA follows the approach described in Appendix 4.2: Phenology and Apportioning. The equivalent proportion of birds attributable to North Caithness Cliffs SPA is 0.05.

Razorbill

6.8.5.4 The apportioning approach for razorbill applied to determine the proportion of any impact attributable to the razorbill population at North Caithness Cliffs SPA follows the approach described in Appendix 4.2: Phenology and Apportioning. The equivalent proportion of birds attributable to North Caithness Cliffs SPA is 0.02.

Puffin

6.8.5.5 It is not possible to age puffin during site-specific surveys and as such a theoretical approach has been applied in order to estimate the contribution of different breeding colonies to the total population of birds present at the Moray West Site. This approach is described in Appendix 4.2: Phenology and Apportioning, and when applied estimates that of those birds present at Moray West, 49.0% will be adult birds.

6.8.5.6 Following guidance from Marine Scotland, it has been assumed that the proportion of sabbatical birds associated with a breeding colony is 7%, with this taken into account when impacts are apportioned to the SPA.

6.8.5.7 North Caithness Cliffs SPA is not the only SPA from which birds may occur at the Moray West Site. Using the approach presented in Appendix 4.2: Phenology and Apportioning, the proportion of any impact attributable to the breeding adult puffin population at North Caithness Cliffs SPA was calculated as 0.32.

6.8.5.8 For apportioning in non-breeding seasons (post- and non-breeding seasons), population data from Furness (2015) were used to calculate the contribution of birds from North Caithness Cliffs to a wider population present within the North Sea.

Fulmar

6.8.5.9 Although LSEs have been identified for fulmar based on likely connectivity between SPAs and the Moray West Site, and therefore the species is included in this RIAA, it is considered unlikely that the magnitude of any impact is sufficient enough to warrant apportioning between SPA populations. As such, no apportioning has been undertaken for fulmar. However, where

appropriate qualitative consideration is given to the likely contribution of SPAs to the population of fulmar present at the Moray West Site.

Disturbance/Displacement/Barrier Effects

6.8.5.10 It is assumed that displacement resulting from operation of the Moray West Offshore Wind Farm represents the worst case scenario with respect to overall disturbance impacts on fulmar, kittiwake, guillemot and razorbill. Therefore, the analysis of disturbance during construction / decommissioning is treated equivalently to the assessment of displacement presented below.

6.8.5.11 Displacement matrices for fulmar, kittiwake, guillemot and razorbill are provided in Appendix 4.6: Displacement Matrices.

6.8.5.12 Conclusions from the assessment of disturbance/displacement and barrier effects on fulmar, kittiwake, guillemot, razorbill and puffin informed by these displacement matrices are presented in Table 6.8.8 below.

Table 6.8.8: Disturbance/Displacement/Barrier Effects on Fulmar, Kittiwake, Guillemot, Razorbill and Puffin with Respect to North Caithness Cliffs SPA														
Species	**Total SPA Breeding Population**	**Vulnerability Based on Wade *et al.* (2016)**	**Displacement Rate (%)**	**Mortality Rate (%)**	**Season**	**Results - Displacement**								
						Apportioned Mean-Peak Population Estimate within the Moray West Site + 2 km Buffer	**Unapportioned Mean-Peak Population Estimate within the Moray West Site + 2 km Buffer**	**Apportioned Mortality**	**Unapportioned Mortality**	**% SPA Breeding Population**	**Increase in Background Mortality %**	**Increase in Background Mortality (# Birds)**	**Conclusion (Impact)**
Fulmar	29,400 breeding adults	Low	10-30	1	Breeding	-	581	-	1-2	up to 0.01	0.03-0.09	1,882	No adverse effect on SPA feature
					Post-breeding	-	68	-	<1	negligible	negligible	1,882	
					Non-breeding	-	1,223	-	1-4	up to 0.01	0.07-0.20	1,882	
					Pre-breeding	-	1,630	-	2-5	0.02-0.06	0.09-0.26	1,882	
Kittiwake	26,200 breeding adults	Low	30	2	Breeding	372	-	1	-	<0.01	0.03	3,825	No adverse effect on SPA feature
					Post-breeding	22	-	<1	-	negligible	negligible	3,825	
					Pre-breeding	21	-	<1	-	negligible	negligible	3,825	
Guillemot	51,322 breeding adults	High	50-60	1	Breeding	691	-	3-4	-	0.01	0.11-0.13	3,131	No adverse effect on SPA feature
					Post-breeding	1,553	-	8-9	-	0.02	0.25-0.30	3,131	
					Non-breeding	334	-	2	-	<0.01	0.05-0.06	3,131	
Razorbill	5,360 breeding adults	High	40-60	1	Breeding	31	-	<1	-	negligible	negligible	563	No adverse effect on SPA feature
					Post-breeding	19	-	<1	-	negligible	negligible	563	
					Non-breeding	1	-	<1	-	negligible	negligible	563	
					Pre-breeding	20	-	<1	-	negligible	negligible	563	

Table 6.8.8: Disturbance/Displacement/Barrier Effects on Fulmar, Kittiwake, Guillemot, Razorbill and Puffin with Respect to North Caithness Cliffs SPA														
Species	**Total SPA Breeding Population**	**Vulnerability Based on Wade *et al.* (2016)**	**Displacement Rate (%)**	**Mortality Rate (%)**	**Season**	**Results - Displacement**							
						Apportioned Mean-Peak Population Estimate within the Moray West Site + 2 km Buffer	**Unapportioned Mean-Peak Population Estimate within the Moray West Site + 2 km Buffer**	**Apportioned Mortality**	**Unapportioned Mortality**	**% SPA Breeding Population**	**Increase in Background Mortality %**	**Increase in Background Mortality (# Birds)**	**Conclusion (Impact)**
Puffin	3,500 breeding adults	Moderate	50-60	2	Breeding	165	-	2	-	0.05-0.06	0.5-0.6	329	No adverse effect on SPA feature
					Post-breeding	5	-	<1	-	negligible	negligible	329	
					Non-breeding	<1	-	<1	-	negligible	negligible	329	

Collision Risk

Kittiwake

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

6.8.5.14 An assessment of collision risk has been undertaken for kittiwake using Band (2012). The results for Options 2 and 3 of this model are presented in Table 6.8.9 and Table 6.8.10.

6.8.5.15 Collision risk modelling, using Option 3, predicts a total collision risk mortality of 56 collisions/annum at Moray West (98% avoidance) with one of these apportioned to the North Caithness Cliffs SPA. This represents 0.01% of the SPA population (13,100 pairs) and 0.04% increase in baseline mortality (3,825 individuals). When using Option 2, a total collision risk mortality of 79-109 collisions/annum is predicted (99.2% and 98.9% avoidance rates) with 2-3 apportioned to the SPA. This represents 0.01% of the SPA population and a 0.05-0.07% increase in baseline mortality.

Table 6.8.9: Collision risk estimates for kittiwake calculated using Option 2 of the Band (2012) CRM apportioned to North Caithness Cliffs SPA

Season	Predicted no. of collisions		Apportioning			No. of collisions apportioned to SPA	
	Option 2 (98.9% avoidance rate	Option 2 (99.2% avoidance rate	Proportion of adults	Sabbaticals	SPA apportioning	Option 2 (98.9% avoidance rate	Option 2 (99.2% avoidance rate
Breeding	179	57	0.915	0.9	0.034	2	2
Post-breeding	24	17	-	-	0.015	0	0
Pre-breeding	7	5	-	-	0.019	0	0
Total	109	79				3	2

Table 6.8.10: Collision risk estimates for kittiwake calculated using Option 3 of the Band (2012) CRM apportioned to North Caithness Cliffs SPA					
Season	**Predicted no. of collisions**	**Apportioning**			**No. of collisions apportioned to SPA**
	Option 3 (98% avoidance rate	**Proportion of adults**	**Sabbaticals**	**SPA apportioning**	**Option 3 (98% avoidance rate**
Breeding	40	0.915	0.9	0.034	1
Post-breeding	12	-	-	0.015	0
Pre-breeding	3	-	-	0.019	0
Total	56				1

Conclusions

Fulmar

6.8.5.16 The fulmar feature of North Caithness Cliffs SPA has been assessed for disturbance, displacement and barrier impacts associated with operation of the Moray West Offshore Wind Farm. The predicted level of mortality considered likely to occur represents a negligible proportion of the SPA population and a negligible increase in the baseline mortality of the SPA population. There is therefore no indication of an adverse effect on the integrity of the fulmar feature of the SPA as a result of disturbance, displacement and barrier impacts.

Kittiwake

6.8.5.17 The kittiwake feature of North Caithness Cliffs SPA has been assessed for impacts associated with the Moray West Offshore Wind Farm (collision risk and displacement) and the OfTI (offshore export cable route) (disturbance and changes in prey availability).

6.8.5.18 The proportion of the SPA population affected by displacement mortality is negligible in all seasons and also represents less than a 1% increase in baseline mortality of the population. If seasonal displacement impacts were to be combined, noting that this is likely to over-estimate the total impact, the resulting total (two birds) would also represent less than a 1% increase in the baseline mortality of the SPA population. There is therefore considered to be no indication of an adverse effect on the integrity of the kittiwake feature of the SPA as a result of displacement impacts.

6.8.5.19 The predicted level of collision mortality apportioned to the SPA represents a negligible proportion of the SPA population and a negligible increase in the baseline mortality of the SPA population. There is therefore no indication of an adverse effect on the integrity of the kittiwake feature of the SPA as a result of collision risk impacts.

6.8.5.20 If collision and displacement impacts were to be combined the resulting mortality (seven birds) would represent a negligible proportion of the SPA population and a negligible increase in the baseline mortality of the SPA population. There is therefore considered to be no adverse effect on the integrity of the kittiwake feature of the SPA as a result of combined displacement and collision impacts.

6.8.5.21 Effects associated with the installation of the export cable will be localised with an extremely low level of interaction between the export cable route and populations of kittiwake. There is no indication of an adverse effect on the integrity of the kittiwake feature of the SPA as a result of disturbance / changes in prey availability due to construction and decommissioning activities.

Guillemot

6.8.5.22 The guillemot feature of North Caithness Cliffs SPA has been assessed for impacts associated with the Moray West Offshore Wind Farm (displacement and barrier effects) and the OfTI (export cable route) (disturbance and changes in prey availability).

6.8.5.23 The proportion of the SPA population affected by displacement mortality is low in all seasons and also represents less than a 1% increase in baseline mortality of the population. In addition PVA modelling (Appendix 4.5) does not indicate any population level effects on the guillemot population at East Caithness Cliffs SPA as a result of impacts occurring in the post-breeding season.

6.8.5.24 If seasonal displacement impacts were to be combined, noting that this is likely to over-estimate the total impact, a total mortality of 34 birds would be predicted. If additional mortality of 50 birds per annum is assumed for PVA modelling (the closest modelled output to the predicted in-combination total) then the model predicts a reduction in growth rate of 0.26% (Table 6.8.11). Under this scenario, the predicted median impacted population size after 35-50 years would be approximately 88-91% of that which the model predicts would occur in the in the absence of any additional in-combination impact.

Table 6.8.11: PVA outputs for guillemot at North Caithness Cliffs SPA assuming a mortality of 50 birds

Impact scenario	Years	% change in growth rate	Ratio of unimpacted to impacted growth rate	Ratio of unimpacted to impacted population size	Centile for impacted population
Unimpacted	-	-	-	1	0.50
Impacted	35	-0.26	0.997	0.91	0.26

6.8.5.25 PVA modelling (Appendix 4.5) indicates that this level of mortality is not considered to result in population level effects with the final population size still likely to be above the population originally designated for the SPA. There is therefore considered to be no indication of an adverse effect on the integrity of the guillemot feature of the SPA as a result of displacement impacts.

6.8.5.26 Effects associated with the installation of the export cable will be localised with an extremely low level of interaction between the export cable route and populations of guillemot. There is therefore no indication of an adverse effect on the integrity of the guillemot feature of the SPA as a result of disturbance / changes in prey availability due to construction and decommissioning activities.

Razorbill

6.8.5.27 The razorbill feature of North Caithness Cliffs SPA has been assessed for impacts associated with the Moray West Offshore Wind Farm (displacement and barrier effects) and the OfTI (offshore export cable route) (disturbance and changes in prey availability).

6.8.5.28 The proportion of the SPA population affected by displacement mortality is negligible in all seasons and also represents less than a 1% increase in baseline mortality of the population. If seasonal displacement impacts were to be combined, noting that this is likely to over-estimate the total impact, the resulting total (one bird) would also represent less than a 1% increase in

the baseline mortality of the SPA population. There is therefore considered to be no indication of an adverse effect on the integrity of the razorbill feature of the SPA as a result of displacement impacts.

6.8.5.29 Effects associated with the installation of the export cable circuits will be localised with an extremely low level of interaction between the export cable route and populations of guillemot. There is therefore no indication of an adverse effect on the integrity of the guillemot feature of the SPA as a result of disturbance / changes in prey availability due to construction and decommissioning activities.

Puffin

6.8.5.30 The puffin feature of North Caithness Cliffs SPA has been assessed for impacts associated with the Moray West Offshore Wind Farm (displacement and barrier effects) and the OfTI (offshore export cable route) (disturbance and changes in prey availability).

6.8.5.31 The proportion of the SPA population affected by displacement mortality is negligible in all seasons and also represents less than a 1% increase in baseline mortality of the population. If seasonal displacement impacts were to be combined, noting that this is likely to over-estimate the total impact, the resulting total (two birds) would also represent less than a 1% increase in the baseline mortality of the SPA population. There is therefore considered to be no indication of an adverse effect on the integrity of the razorbill feature of the SPA as a result of displacement impacts.

6.8.5.32 Effects associated with the installation of the export cable will be localised with an extremely low level of interaction between the export cable route and populations of guillemot. There is therefore no indication of an adverse effect on the integrity of the puffin feature of the SPA as a result of disturbance / changes in prey availability due to construction and decommissioning activities.

6.8.6 Troup, Pennan and Lion's Heads SPA – Disturbance/Displacement/Barrier Effects and Collision Risk

Site Description

6.8.6.1 Troup, Pennan and Lion's Heads SPA is located on the north-eastern mainland Scottish coast covering an area of sea cliff between Banff and Rosehearty and the adjacent marine area out to 2 km. The SPA provides suitable nesting habitat for a number of seabird species and the SPA is designated for a breeding seabird assemblage incorporating main component breeding populations of kittiwake and guillemot alongside smaller breeding populations of fulmar, herring gull and razorbill.

Species Apportioning

Kittiwake

6.8.6.2 The apportioning approach for kittiwake applied to determine the proportion of any impact attributable to the kittiwake population at Troup, Pennan and Lion's Heads SPA follows the approach described in Appendix 4.2: Phenology and Apportioning. The equivalent proportion of birds attributable to Troup, Pennan and Lion's Heads SPA is 0.08.

Herring gull

6.8.6.3 The apportioning approach for herring gull applied to determine the proportion of any impact attributable to the herring gull population at Troup, Pennan and Lion's Heads SPA follows the approach described in Appendix 4.2: Phenology and Apportioning. The equivalent proportion of birds attributable to Troup, Pennan and Lion's Heads SPA is 0.06.

Guillemot

6.8.6.4 The apportioning approach for guillemot applied to determine the proportion of any impact attributable to the guillemot population at Troup, Pennan and Lion's Heads SPA follows the approach described in Appendix 4.2 Phenology and Apportioning The equivalent proportion of birds attributable to Troup, Pennan and Lion's Heads SPA is 0.06.

Razorbill

6.8.6.5 The apportioning approach for razorbill applied to determine the proportion of any impact attributable to the razorbill population at Troup, Pennan and Lion's Heads SPA follows the approach described in Appendix 4.2: Phenology and Apportioning. The equivalent proportion of birds attributable to Troup, Pennan and Lion's Heads SPA is 0.06.

Fulmar

6.8.6.6 Although LSEs have been identified for fulmar based on likely connectivity between SPAs and the Moray West Site, and therefore the species is included in this RIAA, it is considered unlikely that the magnitude of any impact is sufficient enough to warrant apportioning between SPA populations. As such, no apportioning has been undertaken for fulmar. However, where appropriate qualitative consideration is given to the likely contribution of SPAs to the population of fulmar present at the Moray West Site.

Disturbance/Displacement/Barrier Effects

6.8.6.7 It is assumed that displacement resulting from operation of the Moray West Offshore Wind Farm represents the worst case scenario with respect to overall disturbance impacts on fulmar, kittiwake, guillemot and razorbill. Therefore, the analysis of disturbance during construction / decommissioning is treated equivalently to the assessment of displacement presented below.

6.8.6.8 Displacement matrices for fulmar, kittiwake, guillemot and razorbill are provided in Appendix 4.6: Displacement Matrices.

6.8.6.9 Conclusions from the assessment of disturbance/displacement and barrier effects on fulmar, kittiwake, guillemot and razorbill and guillemot informed by these displacement matrices are presented in Table 6.8.12 below.

Table 6.8.12: Disturbance/Displacement/Barrier Effects on Fulmar and Guillemot with Respect to Troup, Pennan and Lion's Head SPA

Species	Total SPA Breeding Population	Vulnerability Based on Wade *et al.* (2016)	Displacement Rate (%)	Mortality Rate (%)	Season	Results - Displacement							
						Apportioned Mean-Peak Population Estimate within the Moray West Site + 2 km Buffer	Unapportioned Mean-Peak Population Estimate within the Moray West Site + 2 km Buffer	Apportioned Mortality	Unapportioned Mortality	% SPA Breeding Population	Increase in Background Mortality %	Increase in Background Mortality (# Birds)	Conclusion (impact)
Fulmar	8,800 breeding adults	Low	10-30	1	Breeding	-	581	-	1-2	0.01-0.02	0.10-0.31	563	No adverse effect on SPA feature
					Post-breeding	-	68	-	<1	negligible	negligible	563	
					Non-breeding	-	1,223	-	1-4	0.01-0.04	0.22-0.65	563	
					Pre-breeding	-	1,630	-	2-5	0.02-0.06	0.29-0.87	563	
Kittiwake	63,200 breeding adults	Low	30	2	Breeding	894	-	3	-	<0.01	0.03	9,272	No adverse effect on SPA feature
					Post-breeding	32	-	<1	-	negligible	negligible	9,272	
					Pre-breeding	31	-	<1	-	negligible	negligible	9,272	
Guillemot	59,764 breeding adults	High	50-60	1	Breeding	743	-	4	-	0.01	0.10-0.12	3,646	No adverse effect on SPA feature
					Post-breeding	361	-	2	-	<0.01	0.05-0.06	3,646	
					Non-breeding	78	-	<1	-	negligible	negligible	3,646	
Razorbill	6,432 breeding adults	High	40-60	1	Breeding	86	-	up to 1	-	0.01	0.05-0.08	675	No adverse effect on SPA feature
					Post-breeding	21	-	<1	-	<0.01	0.01-0.02	675	
					Non-breeding	1	-	<1	-	negligible	negligible	675	
					Pre-breeding	21	-	<1	-	negligible	negligible	675	

Collision Risk

Kittiwake

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

6.8.6.11 An assessment of collision risk has been undertaken for kittiwake using Band (2012). The results for Options 2 and 3 of this model are presented in Table 6.8.13 and Table 6.8.14.

6.8.6.12 Collision risk modelling, using Option 3, predicts a total collision risk mortality of 56 collisions/annum at associated with the Moray West Offshore Wind Farm (98% avoidance) with three of these apportioned to the Troup, Pennan and Lion's Heads SPA. This represents less than 0.01% of the SPA population (31,600 pairs) and 0.03% increase in baseline mortality (9,227 individuals). When using Option 2, a total collision risk mortality of 79-109 collisions/annum is predicted (99.2% and 98.9% avoidance rates) with 4-6 apportioned to the SPA. This represents 0.01% of the SPA population and a 0.05-0.07% increase in baseline mortality.

Table 6.8.13: Collision risk estimates for kittiwake calculated using Option 2 of the Band (2012) CRM apportioned to Troup, Pennan and Lion's Heads SPA

Season	Predicted no. of collisions		Apportioning			No. of collisions apportioned to SPA	
	Option 2 (98.9% avoidance rate	Option 2 (99.2% avoidance rate	Proportion of adults	Sabbaticals	SPA apportioning	Option 2 (98.9% avoidance rate	Option 2 (99.2% avoidance rate
Breeding	79	57	0.915	0.9	0.082	5	4
Post-breeding	24	17	-	-	0.022	1	0
Pre-breeding	7	5	-	-	0.028	0	0
Total	109	79				6	4

Table 6.8.14: Collision risk estimates for kittiwake calculated using Option 3 of the Band (2012) CRM apportioned to Troup, Pennan and Lion's Heads SPA

Season	Predicted no. of collisions	Apportioning			No. of collisions apportioned to SPA
	Option 3 (98% avoidance rate	Proportion of adults	Sabbaticals	SPA apportioning	Option 3 (98% avoidance rate
Breeding	40	0.915	0.9	0.082	3
Post-breeding	12	-	-	0.022	0
Pre-breeding	3	-	-	0.028	0

Table 6.8.14: Collision risk estimates for kittiwake calculated using Option 3 of the Band (2012) CRM apportioned to Troup, Pennan and Lion's Heads SPA					
Season	**Predicted no. of collisions**	**Apportioning**			**No. of collisions apportioned to SPA**
	Option 3 (98% avoidance rate	**Proportion of adults**	**Sabbaticals**	**SPA apportioning**	**Option 3 (98% avoidance rate**
Total	56				3

Herring Gull

6.8.6.13 Herring gull was rated as having a relatively high vulnerability to collision impacts by Wade *et al*. (2016), due to the proportion of flights likely to occur at potential risk height and percentage of time in flight. The recently published report for Marine Scotland (Cook *et al*., 2014) considers that a 99.0% avoidance rate is appropriate for the 'Extended' Band Model and a 99.5% avoidance rate is appropriate for the 'Basic' Band model.

6.8.6.14 An assessment of collision risk has been undertaken for herring gull using Band (2012). The results for Options 2 and 3 of this model are presented in Table 6.8.15.

6.8.6.15 Collision risk modelling, using Option 3, predicts a total collision risk mortality of 11 collisions/annum associated with the Moray West Offshore Wind Farm (99.0% avoidance) with less than one of these apportioned to the Troup, Pennan and Lion's Heads SPA. This represents a negligible proportion of the SPA population (4,200 pairs) and negligible increase in baseline mortality (1,394 individuals). When using Option 2, a total collision risk mortality of 13 collisions/annum is predicted (99.5% avoidance rates) with less than one collision apportioned to the SPA. This also represents a negligible proportion of the SPA population and a negligible increase in baseline mortality.

Table 6.8.15: Collision Risk Estimates for Herring Gull Calculated Using Options 2 and 3 of the Band (2012) CRM Apportioned to Troup, Pennan and Lion's Heads SPA							
Season	**Predicted no. of collisions**		**Apportioning**			**No. of collisions apportioned to SPA**	
	Option 2 (99.5% avoidance rate	**Option 3 (98% avoidance rate**	**Proportion of adults**	**Sabbaticals**	**SPA apportioning**	**Option 2 (99.5% avoidance rate**	**Option 3 (98% avoidance rate**
Breeding	12	10	0.841	0.65	0.035	0	0
Non-breeding	1	1	-	-	0.013	0	0
Total	13	11				0	0

Conclusion

Fulmar

6.8.6.16 The fulmar feature of Troup, Pennan and Lion's Heads SPA has been assessed for reduction in prey availability, disturbance, displacement and barrier impacts associated with the Moray West Offshore Wind Farm. The predicted level of mortality considered likely to occur represents a negligible proportion of the SPA population and a negligible increase in the baseline mortality of the SPA population. There is therefore no indication of an adverse effect on the integrity of the fulmar feature of the SPA as a result of disturbance, displacement and barrier impacts.

Kittiwake

6.8.6.17 The kittiwake feature of Troup, Pennan and Lion's Heads SPA has been assessed for impacts associated with the Moray West Offshore Wind Farm (collision risk and displacement) and the OfTI (offshore export cable route) (disturbance and changes in prey availability).

6.8.6.18 The proportion of the SPA population affected by displacement mortality is negligible in all seasons and also represents less than a 1% increase in baseline mortality of the population. If seasonal displacement impacts were to be combined, noting that this is likely to over-estimate the total impact, the resulting total (six birds) would also represent less than a 1% increase in the baseline mortality of the SPA population. There is therefore considered to be no indication of an adverse effect on the integrity of the razorbill feature of the SPA as a result of displacement impacts.

6.8.6.19 The predicted level of collision mortality apportioned to the SPA represents a negligible proportion of the SPA population and a negligible increase in the baseline mortality of the SPA population. There is therefore no indication of an adverse effect on the integrity of the kittiwake feature of the SPA as a result of collision risk impacts.

6.8.6.20 If collision and displacement impacts were to be combined the resulting mortality (11 birds) would represent a negligible proportion of the SPA population and a negligible increase in the baseline mortality of the SPA population. There is therefore considered to be no adverse effect on the integrity of the kittiwake feature of the SPA as a result of combined displacement and collision impacts.

6.8.6.21 Effects associated with the installation of the export cable will be localised with an extremely low level of interaction between the export cable route and populations of kittiwake. There is no indication of an adverse effect on the integrity of the kittiwake feature of the SPA as a result of disturbance / changes in prey availability due to construction and decommissioning activities.

Herring gull

6.8.6.22 The herring gull feature of Troup, Pennan and Lion's Heads SPA has been assessed for collision risk impacts associated with the Moray West Offshore Wind Farm. The predicted level of collision mortality apportioned to the SPA represents a negligible proportion of the SPA population and a negligible increase in the baseline mortality of the SPA population. There is therefore no indication of an adverse effect on the integrity of the herring gull feature of the SPA as a result of collision risk impacts.

Guillemot

6.8.6.23 The guillemot feature of Troup, Pennan and Lion's Heads SPA has been assessed for impacts associated with the Moray West Offshore Wind Farm (displacement and barrier effects) and the OfTI (offshore export cable route) (disturbance and changes in prey availability).

6.8.6.24 The proportion of the SPA population affected by displacement mortality is negligible in all seasons and also represents less than a 1% increase in baseline mortality of the population. If seasonal displacement impacts were to be combined, noting that this is likely to over-estimate the total impact, the resulting total (one bird) would also represent less than a 1% increase in

the baseline mortality of the SPA population. There is therefore considered to be no indication of an adverse effect on the integrity of the guillemot feature of the SPA as a result of displacement impacts.

6.8.6.25 Effects associated with the installation of the export cable will be localised with an extremely low level of interaction between the export cable route and populations of guillemot. There is therefore no indication of an adverse effect on the integrity of the guillemot feature of the SPA as a result of disturbance / changes in prey availability due to construction and decommissioning activities.

Razorbill

6.8.6.26 The razorbill feature of Troup, Pennan and Lion's Heads SPA has been assessed for impacts associated with the Moray West Offshore Wind Farm (displacement and barrier effects) and the OfTI (offshore export cable route) (disturbance and changes in prey availability).

6.8.6.27 The proportion of the SPA population affected by displacement mortality is negligible in all seasons and also represents less than a 1% increase in baseline mortality of the population. If seasonal displacement impacts were to be combined, noting that this is likely to over-estimate the total impact, the resulting total (one bird) would also represent less than a 1% increase in the baseline mortality of the SPA population. There is therefore considered to be no indication of an adverse effect on the integrity of the razorbill feature of the SPA as a result of displacement impacts.

6.8.6.28 Effects associated with the installation of the export cable will be localised with an extremely low level of interaction between the export cable route and populations of guillemot. There is therefore no indication of an adverse effect on the integrity of the guillemot feature of the SPA as a result of disturbance / changes in prey availability due to construction and decommissioning activities.

6.8.7 Moray Firth pSPA

Site Description

6.8.7.1 The Moray Firth pSPA covers a large area stretching seaward from the Helmsdale coast in the north to Portsoy in the east, including the outer Dornoch and Cromarty Firths, Beauly and Inverness Firths as well as part of the wider Moray Firth. The pSPA contains a variety of habitats including shallow sandy substrates, coastal rocky outcrops and a deep muddy channel alongside numerous firths, inlets and sandy bays. These habitats provide areas that are used by birds for moulting, roosting, resting and feeding. In the winter the pSPA is important for large concentrations of seaduck and divers and in breeding months for shag.

Features and Impacts Screened into the Assessment

6.8.7.2 A summary of the results from the assessment of LSE (screening assessment) for this SPA is provided in Table 6.8.16 below.

Table 6.8.16: Results of the Screening Process with Respect to the Moray Firth pSPA

Feature	Project Phase	Potential Impact	Likely Significant Effect
Scaup Eider Velvet scoter Common scoter	Construction/ decommissioning	Disturbance	Yes
		Changes to prey availability	Yes

Table 6.8.16: Results of the Screening Process with Respect to the Moray Firth pSPA			
Feature	**Project Phase**	**Potential Impact**	**Likely Significant Effect**
Long-tailed duck Goldeneye Red-breasted merganser Red-throated diver Great northern diver Slavonian grebe Shag	Operation	Barrier effects	No
		Collision risk	No
		Displacement	No

Scaup

6.8.7.3 Scaup occurred in small concentrations in the Moray Firth pSPA, usually of less than 50 birds, widely dispersed along both margins of the Firth, and close inshore. The largest flocks were in the Inner Moray Firth and off the coast of Nairn (SNH, 2016). There is no apparent overlap of the Offshore Export Cable Corridor with observations of this species.

6.8.7.4 Due to a lack of connectivity between concentrations of scaup within the Moray Firth pSPA and those areas that will be impacted by activities associated with installation of the offshore export cable circuits there is considered to be no adverse effect on the scaup feature of the Moray Firth pSPA as a result of any impacts associated with the Development.

Eider

6.8.7.5 Eiders were recorded during all surveys that informed the site selection process for the Moray Firth pSPA and were mainly observed along the south coast of the Moray Firth. They were usually recorded close inshore, in very shallow water, along the whole of this coast, from Buckie to Nairn. While the Moray West cable corridor is proposed to be located in areas where eider are known to occur, these areas hold relatively low densities (1-4 birds per km^2) compared to areas further west near Lossiemouth (>8 birds per km^2).

Disturbance

6.8.7.6 Considering the limited overlap between areas of notable eider concentrations and the Offshore Export Cable Corridor there is considered to be no adverse effect on the site integrity of the Moray Firth pSPA as a result of disturbance effects.

Changes to Prey Availability

6.8.7.7 Considering the limited overlap between areas of notable eider concentrations and the Offshore Export Cable Corridor there is considered to be no adverse effect on the site integrity of the Moray Firth pSPA as result of indirect effects on prey species.

Velvet Scoter

6.8.7.8 Velvet scoter were less widely distributed than other seaduck in the Moray Firth pSPA. They were generally concentrated close inshore between Burghead and Nairn, around the mouth of the inner Dornoch Firth, in Spey Bay and on the Riff Bank. There is no apparent overlap of the Offshore Export Cable Corridor with observations of these species.

6.8.7.9 Due to a lack of connectivity between concentrations of velvet scoter within the Moray Firth pSPA and those areas that will be impacted by activities associated with the offshore export cable route there is considered to be no adverse effect on the velvet scoter feature of the Moray Firth pSPA as a result of any impacts associated with the Development.

Common Scoter

6.8.7.10 Common scoter were less widely distributed than other seaduck in the Moray Firth pSPA. They were generally concentrated close inshore between Burghead and Nairn, around the mouth of the inner Dornoch Firth, in Spey Bay and on the Riff Bank. There is no apparent overlap of the Offshore Export Cable Corridor with observations of these species.

6.8.7.11 Due to a lack of connectivity between concentrations of common scoter within the Moray Firth pSPA and those areas that will be impacted by activities associated with the installation of the offshore export cable circuits there is considered to be no adverse effect on the common scoter feature of the Moray Firth pSPA as a result of any impacts associated with the Development.

Long-tailed Duck

6.8.7.12 Long-tailed duck were abundant and widely dispersed throughout the whole of the Moray Firth pSPA survey area and, in contrast to other species, in water up to 40m deep. They were recorded most frequently in Spey Bay and along the south coast of the Moray Firth and, least frequently, in the Dornoch Firth. Long-tailed duck distribution is similar to that of eider but in even lower densities in the vicinity of the proposed Moray West cable corridor (<2 birds per km^2).

Disturbance

6.8.7.13 Considering the limited overlap between areas of notable long-tailed duck concentrations and the Offshore Export Cable Corridor there is considered to be no adverse effect on the site integrity of the Moray Firth pSPA as a result of disturbance effects.

Changes to Prey Availability

6.8.7.14 Considering the limited overlap between areas of notable long-tailed duck concentrations and the construction of the Offshore Export Cable Corridor there is considered to be no adverse effect on the site integrity of the Moray Firth pSPA as result of indirect effects on prey species.

Goldeneye

6.8.7.15 Goldeneye were one of the least abundant waterfowl on the coast during the surveys that informed the site selection process for the Moray Firth pSPA. Goldeneye were mainly distributed either in the most southerly and shallow parts of the Inverness Firth, in the Dornoch Firth or occasionally on the southern shore in the Culbin/ Findhorn area. There is no apparent overlap of the Offshore Export Cable Corridor with observations of this species.

6.8.7.16 Due to a lack of connectivity between concentrations of goldeneye within the Moray Firth pSPA and those areas that will be impacted by activities associated with the installation of the offshore export cable circuits there is considered to be no adverse effect on the goldeneye feature of the Moray Firth pSPA as a result of any impacts associated with the Development.

Red-breasted Merganser

6.8.7.17 Red-breasted mergansers occurred at a number of localities in the Moray Firth pSPA including along the southern shore and in the inner firth, but a large aggregation was present only in the Beauly Firth. There is no apparent overlap of the Offshore Export Cable Corridor with observations of this species.

6.8.7.18 Due to a lack of connectivity between concentrations of red-breasted merganser within the Moray Firth pSPA and those areas that will be impacted by activities associated with the installation of the offshore export cable circuits there is considered to be no adverse effect on the red-breasted merganser feature of the Moray Firth pSPA as a result of any impacts associated with the Development.

Red-throated diver

6.8.7.19 The distribution of diver species is treated in a merged fashion in the site selection documents for the pSPA (SNH, 2016). However, red-throated divers are noted more widely and were the most common diver throughout the pSPA. Key aggregations of divers in the Moray Firth occur in Dornoch Firth and along the coast east of Lossiemouth. The latter aggregation is in relative close proximity to the Offshore Export Cable Corridor (<10 km), although densities in the proximity of the Offshore Export Cable Corridor are relatively low (<1 bird per km^2).

Disturbance

6.8.7.20 Considering that it is likely that only very small numbers of red-throated divers would be affected from an impact of limited spatial extent and of intermittent nature, there is considered to be no adverse effect on the site integrity of the Moray Firth pSPA as result of disturbance effects.

Changes to Prey Availability

6.8.7.21 Herring and sprat are amongst the most frequently recorded prey species of red-throated divers (Cramp & Simmons 1977 - 1994), although this species is considered to be an opportunistic feeder, taking a rather broad range of fish species (Guse *et al*., 2009). The species however shows limited flexibility in feeding habitats, being dependant on shallow feeding grounds with shellfish banks (Furness *et al*. 2012; Wade *et al*., 2016). In consequence, the species is amongst those more likely to be adversely impacted by loss of habitat if construction activities take place within areas that they would otherwise use for foraging.

6.8.7.22 Numbers of divers affected will depend on the overlap of such activity with food resources at any particular time. Moreover in addition the above mentioned spatial and temporal parameters of the cable installation, the findings of the EIA Report (Volume 2) - Chapter 8: Fish and Shellfish Ecology are considered which state that the relevant significance of effects of construction impacts on prey species is no greater than minor. This equally applies when also considering the installation of the offshore export cable circuits.

6.8.7.23 Considering that it is likely that only very small numbers of red-throated divers would be affected from an impact of limited spatial extent and of intermittent nature, there is considered to be no adverse effect on the site integrity of the Moray Firth pSPA as result of indirect effects on prey species.

Great Northern Diver

6.8.7.24 The distribution of both species of diver is treated in a merged fashion in SNH (2016) although red-throated divers were noted more widely and were the commonest diver throughout the Moray Firth. The impacts described above for red-throated diver are therefore considered to apply to great northern diver, although it is noted that there is an increased level of certainty that few, if any, individuals would be affected.

Disturbance

6.8.7.25 Considering that it is likely that only very small numbers of great northern divers would be affected from an impact of limited spatial extent and of intermittent nature, there is considered to be no adverse effect on the site integrity of the Moray Firth pSPA as result of disturbance effects.

Changes to prey availability

6.8.7.26 Considering that it is likely that only very small numbers of great northern divers would be affected from an impact of limited spatial extent and of intermittent nature, there is considered to be no adverse effect on the site integrity of the Moray Firth pSPA as result of indirect effects on prey species.

Slavonian Grebe

6.8.7.27 Slavonian grebes were only recorded in low numbers around the coasts of the Moray Firth with a mean-peak within the pSPA of 43 birds (SNH, 2016). Birds were widely distributed with very few recorded east of Lossiemouth and none in the vicinity of the Offshore Export Cable Corridor.

6.8.7.28 Due to a lack of connectivity between concentrations of Slavonian grebe within the Moray Firth pSPA and those areas that will be impacted by activities associated with the installation of the offshore export cable circuits there is considered to be no adverse effect on the Slavonian grebe feature of the Moray Firth pSPA as a result of any impacts associated with the Development.

Shag

6.8.7.29 In the breeding season, shag are concentrated in the north of the pSPA to the south of the breeding colony at the East Caithness Cliffs SPA. There is therefore considered to be no connectivity between the shag breeding feature of the pSPA and any impacts associated with the Development.

6.8.7.30 Two distinct non-breeding distributions of shag exist in the pSPA. Of most relevance is the non-breeding distribution on the Moray coast immediately west of Portsoy (SNH, 2016) which is in the vicinity of the Offshore Export Cable Corridor.

Disturbance

6.8.7.31 Although there is potential for construction activity to coincide with aggregations of shag, the impact is predicted to be of local spatial extent, medium term duration, intermittent and with high reversibility. It is predicted that the impact will affect the receptor (which is considered to be relatively highly sensitive to disturbance) directly. It is considered unlikely that the levels of disturbance predicted would have any population level effects on shag. There is therefore considered to be no adverse effect on the shag feature of the Moray Firth pSPA as a result of any impacts associated with the Development.

Changes to Prey Availability

6.8.7.32 Shag is considered to have low-medium vulnerability to changes in habitat / prey interactions. Based on an impact of limited spatial extent and of intermittent nature, there is considered to be no adverse effect on the site integrity of the Moray Firth pSPA as result of indirect effects on prey species.

6.9 Assessment of Adverse Effects – In Combination

6.9.1 Overview

6.9.1.1 The in-combination assessment considers the impacts associated with the Development together with other projects and plans. The projects and plans selected as relevant to the assessments presented within this section are based upon the results of a CIA screening exercise (Appendix 4.3). Each project has been considered on a case by case basis for scoping in or out of this chapter's assessment based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved.

6.9.1.2 In undertaking the in-combination assessment for the Development, it is important to bear in mind that other projects and plans under consideration vary in terms of their current status and therefore the extent to which they will potentially contribute to an in-combination impact alongside the Development. For example, some projects that are still at the consenting stage may not gain consent or end up being developed, where-as there is increased certainty of the potential for in-combination effects with projects that have been, or are in construction.

Identification of Other Project and Plans Requiring Consideration in the HRA

6.9.1.3 With respect to in-combination effects on ornithological receptors projects were identified on the following basis:

- For impacts during the breeding season – only projects that are located within the foraging range of a feature from an SPA identified as requiring consideration in the RIAA (e.g. Buchan Ness and Collieston Coast SPA, East Caithness Cliffs SPA, North Caithness Cliffs SPA and Troup, Pennan and Lion's Head SPA); and
- For impacts during the non-breeding season all projects based on the relevant BDMPS scale defined in Furness (2015) and therefore includes projects throughout the North Sea. These projects apply to in-combination effects for those species considered for displacement and collision risk impacts only.

Projects Requiring Consideration with Respect In-Combination Effects During the Breeding Season

6.9.1.4 With respect to the SPAs identified as requiring assessment during the breeding season these are listed in Table 6.9.1 below.

Table 6.9.1: Projects Considered for Breeding Season In-Combination Effects

SPA	Project requiring consideration in the breeding season	Assessed Project Parameters
Buchan Ness and Collieston Coast SPA	Beatrice Offshore Wind Farm	As built parameters included in the DSLP (84 x 7 MW turbines)
	Moray East Offshore Wind Farm	Consented (186 turbines)
	Hywind Floating Pilot Farm	As built (6 x 5 MW turbines)
	Kincardine Offshore Wind Project	7 x 6 MW turbines (planned)
East Caithness Cliffs SPA	Beatrice Offshore Wind Farm	As built parameters included in the DSLP (84 x 7 MW turbines)
	Moray East Offshore Wind Farm	Consented (186 turbines)
North Caithness Cliffs SPA	Beatrice Offshore Wind Farm	As built parameters included in the DSLP (84 x 7 MW turbines)

Table 6.9.1: Projects Considered for Breeding Season In-Combination Effects		
SPA	**Project requiring consideration in the breeding season**	**Assessed Project Parameters**
	Moray East Offshore Wind Farm	Consented (186 turbines)
Troup, Pennan and Lions's Head SPA	Beatrice Offshore Wind Farm	As built parameters included in the DSLP (84 x 7 MW turbines)
	Moray East Offshore Wind Farm	Consented (186 turbines)
Moray Firth pSPA	No overlap with construction periods therefore no requirement to assess in-combination effects relating to disturbance	N/A

Projects Requiring Assessment with Respect to In-Combination Effects During the Non-Breeding Season

6.9.1.5 The projects considered as part of the non-breeding season in-combination assessment are listed in Table 6.9.3. These projects also include the Moray East, Beatrice, Hywind and Kincardine projects. Further discussion on the consented and as-built scenario's included in the in-combination assessment for these projects is provided in paragraphs 6.9.2.22 to 6.9.2.26.

Identification of In-Combination Effects Requiring Assessment

6.9.1.6 No projects are considered to act in-combination with the Development during the construction phase as there is no spatial or temporal overlap with the construction phases of Moray West and other projects. As such no in-combination assessment has been undertaken for disturbance effects or changes to prey availability that may occur in the construction phase.

6.9.1.7 The suite of projects considered for operational impacts is species and season dependent. In the breeding season, the suite of projects is restricted to those projects that are in foraging range of a feature from an SPA, in addition to the Development. In non-breeding seasons, the suite of projects is defined based on the relevant BDMPS scale defined in Furness (2015) and therefore includes projects throughout the North Sea, for those species considered for displacement and collision risk impacts.

6.9.1.8 Impacts assessed for the key sites are listed in Table 6.9.1 below.

Table 6.9.2: Sites and Qualifying Features Requiring Assessment for In-Combination Effects		
European Site	**Impact Assessed**	**Feature Assessed**
Buchan Ness to Collieston Coast SPA	Displacement	Guillemot
	Collision Risk	Herring gull
East Caithness Cliffs SPA	Displacement	Guillemot Razorbill
	Collision Risk	Kittiwake Herring gull
North Caithness Cliffs SPA	Displacement	Guillemot Razorbill Puffin

Table 6.9.2: Sites and Qualifying Features Requiring Assessment for In-Combination Effects		
European Site	**Impact Assessed**	**Feature Assessed**
	Collision Risk	Kittiwake
Troup, Pennan and Lion's Heads SPA	Displacement	Guillemot Razorbill
	Collision Risk	Kittiwake Herring gull
Moray Firth pSPA	No overlap in construction periods – no impacts	N/A

6.9.2 Assessment Methodology

Displacement

6.9.2.1 Predicted operational displacement effects on features of SPAs for which LSEs were identified (Table 6.1.1) associated with the Moray West Site during the operation and maintenance phase are discussed in depth in Section 6.5 above. With respect to this in-combination assessment of displacement effects, suitable information was obtained from each of the relevant project's EIA Report (previously referred to as Environmental Statements (ESs)) chapters, Technical Reports or other submitted documents.

6.9.2.2 Recently published interim guidance by JNCC *et al*. (2017) state that displacement impacts for each relevant species should be assessed based on a wide range of potential displacement and mortality rates in a 'matrix'. While some recent EIA Reports / ESs use this matrix approach (e.g. Hornsea Project One, Aberdeen European Offshore Wind Deployment Centre, Dogger Bank Creyke Beck Projects A and B, Dogger Bank Teesside Project A and Sofia (formerly Dogger Bank Teesside B), and Seagreen Alpha and Bravo), many older projects do not. Instead of discounting data from all projects without a matrix approach, their data has been considered here where possible using the methodology outlined in the following section.

6.9.2.3 For the Development, the mean peak population estimates were calculated for the Moray West Site plus 2 km buffer, following JNCC *et al*. (2017). Predicted displacement mortality is not expected to occur on a year on year basis; it is considered more likely to relate to a singular event following which seabirds will respond by either redistribution or habituation.

6.9.2.4 No species where JNCC *et al*. (2017) recommend a 4 km buffer (divers and seaduck) are relevant to the assessment of the Moray West Site.

6.9.2.5 The effect of displacement from the Moray West Offshore Wind Farm alone on fulmar was assessed as being of no change or negligible magnitude in the EIA Report (Volume 2) - Chapter 10: Offshore Ornithology. It is considered highly unlikely that the current level of in-combination mortality would result in an adverse effect on any SPA at which fulmar is a qualifying feature and that the impact attributable to each SPA from the Moray West Site would materially alter the current level of in-combination mortality. Fulmar was not assessed of being at risk at either the Moray East (MORL, 2012) or the Beatrice Offshore Wind Farm in any season. Fulmar ranges widely in the non-breeding season and have not been considered to be of any risk at additional wind projects in the North Sea with the species often not presented as part of assessments for displacement based on the sensitivity of the species to such impacts (e.g. see Wade *et al.,* 2016). On this basis, it fulmar is not considered for in combination effects in this HRA Report

Methodology

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

6.9.2.7 Some applications are still within the planning process at the time of writing. It is therefore considered that the figures provided in such cases have not been finalised. The levels of mortality predicted are therefore subject to change, and so the confidence level in their results is low.

6.9.2.8 Auk species are amongst the most sensitive of species exposed to displacement effects and are widespread across the North Sea throughout an annual cycle. In the breeding season the in-combination assessment includes all of those projects within the foraging range of each species from relevant SPAs. In non-breeding seasons the suite of projects identified incorporates all of those projects included in the relevant BDMPS for each species.

6.9.2.9 The impact of displacement from the Moray West Offshore Wind Farm alone has also been considered for kittiwake. Kittiwakes have large foraging areas in all seasons and have a particularly high degree of habitat flexibility (Wade *et al.*, 2016). On this basis, the suite of projects considered to contribute to in-combination displacement impacts is restricted to those located in the Moray Firth, with impacts from these projects likely to disproportionately impact kittiwake from the SPAs screened into this RIAA when compared to other impacts from other projects in the North Sea which are considered more likely to affect birds from other SPAs in close proximity to the respective project.

6.9.2.10 With regards to data sources that have been used to determine the potential levels of displacement and mortality from wind farms included in the in-combination assessment, the principal source is of population data held in individual wind farm project EIA Reports / ESs and Habitats Regulations Assessments / Appraisals (HRAs). Monthly population estimates have been collated where available. For some projects data is not available for the relevant buffer area and the data has been scaled up or down based on data from other project areas.

- Population data held in individual wind farm project EIA Reports / ESs and Habitats Regulations Assessments / Appraisals (HRAs) consisting of population estimates for individual project areas rather than raw survey data; and
- Density data provided in the Natural England.

6.9.2.11 The latter dataset has been compiled from the JNCC's European Seabirds at Sea database from boat surveys; Wildfowl and Wetlands Trust (Consulting) Ltd.'s aerial survey database and several publically available boat based survey datasets from surveys for offshore wind farms and comprises predicted densities at a resolution of 3 km x 3 km grid cells.

6.9.2.12 For the data from WWT and MacArthur Green (2013), GIS has been used to derive mean densities for common guillemot, razorbill, and puffin and for individual wind farm project areas. GIS has also been used to calculate the development area plus a 2 km buffer for each wind farm project. Numbers of birds present within the footprint of each project (and project + buffer) has then been calculated through simply multiplying area (in km^2) by mean density. The Natural England data is presented for both breeding and non-breeding seasons, with no further division into a post-breeding dispersion season.

6.9.2.13 Upon obtaining mean-peak population estimates for the individual projects the numbers of birds affected through displacement and subsequent mortality has been calculated using the

displacement and mortality rates outlined in the EIA Report (Volume 4) – Technical Appendix 10.3: Displacement Matrices.

6.9.2.14 For earlier Round 1 and 2 projects monthly population data is not available and it has not been possible to derive specific apportioned displacement and mortality values. where a project lies in English waters, a combination of Natural England data (Seabird Sensitivity Mapping for English Territorial Waters - WWT and MacArthur Green, 2013) and available project data has been used to derive representative values. This has been undertaken by comparing known project population estimates against those from the WWT and MacArthur Green (2013) and deriving appropriate scaling factors that can then be applied to projects for which the population estimate data is lacking.

Collision Risk

Confidence in Collision Risk Data Available from Other Projects

6.9.2.15 Direct comparison of the collision risks predicted by projects considered in-combination can prove problematic due to the differing assumptions made in the calculations used in the different studies, and the limited amount of species data presented in EIA Report / ES chapters (Maclean *et al*., 2009). Nevertheless, a combined quantitative assessment of the in-combination impacts posed by Moray West in conjunction with other projects has been undertaken, based on the information presented in other projects' supporting documentation available to date.

6.9.2.16 The in-combination assessment has been separated into seasonal mortality in order for impacts within each season to be apportioned against the relevant reference population. In-combination impacts of the Development and other relevant projects during the breeding season have been based on mean-maximum foraging range from Thaxter *et al*. (2012). However, it is also important to consider the populations of immature and non-breeding individuals that may be impacted by wind farms considered in-combination with the Moray West Offshore Wind Farm to which a proportion of collision impacts will be attributable.

6.9.2.17 During the non-breeding period, it is assumed that individuals present from each species will originate from a wider range of colonies, with intermixing throughout the North Sea, and so the most appropriate reference populations (e.g. east coast or flyway) have been incorporated where relevant in the assessment (e.g. apportioning), based on literature evidence available (Furness, 2015). A greater range of projects are also included in the in-combination assessment, reflecting the wider movements of birds (i.e. all east coast UK wind farm projects).

Collision Risk Modelling

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

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

6.9.2.20 The most recent projects have run collision risk analyses using the Band model, updated for the offshore environment (Band, 2012; sometimes the draft version Band (2011)). The updates

within Band (2012) mean that projects that have used the Band (2012) or Band (2011) models are likely to produce more realistic mortality rates than earlier projects that had to interpret the onshore Band models. This is particularly the case for those that undertook modelling using the Extended Option 3 or 4 variants.

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

Consideration of precaution in in-combination assessments

6.9.2.22 Assessments conducted for this RIAA use the worst case scenario for collision risk modelling. This involves applying the levels of mortality predicted in the submission documents for each project. These numbers are, in general, those that have informed a developments consent, where it has got to that stage. These assessments are however conducted long before construction commences and often the 'as-built scenario' will consist of fewer, higher capacity turbines that typically result in lower collision risk rates. A process has therefore been developed for this RIAA to identify differences in turbine scenarios which is described below. This allows the worst case scenario assessment to be set into context of the likely lower level of in combination collision risk.

6.9.2.23 In recent years there have been numerous developments in the understanding of bird behaviour that have changed the way in which certain aspects of collision risk modelling have been conducted. Some of these developments (e.g. species specific avoidance rates) have been incorporated into the in-combination assessment on a common currency basis. However, there are a number of other parameters (e.g. flight speed, nocturnal activity factors) where the evidence base is increasingly suggesting that parameters used in previous collision risk modelling have been overly conservative. It is considered that the evidence base for one of these parameters, nocturnal activity, is robust enough to provide quantitative context on the parameters used in previous modelling within the in-combination assessment presented in this report. Specifically, updates are to those projects applying different nocturnal activity factors to those used at many older projects how advised by SNH and Marine Scotland.

6.9.2.24 The elements of precaution identified in this section have not been quantified as part of the main (i.e. worst case) in-combination assessments presented in the SPA-specific sections in this RIAA. Consideration of these aspects of precaution are presented in separate sections (termed "*Consideration of precaution within the assessment*") where these finding are further discussed as part of the conclusions on adverse effect on integrity for each species.

Consented and As-Built Scenarios

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

6.9.2.26 In order to provide an appraisal of this likely over-estimation of the cumulative collision risk totals for each species, a simple analysis has been conducted comparing the turbine scenario used for CRM for projects considered cumulatively with the respective as-built turbine scenario. Table 6.9.3 identifies the assessed, consented and as-built or planned turbine scenarios for each of the projects considered cumulatively in addition to the possible change that may result if CRM was conducted utilising the as-built turbine scenario.

Table 6.9.3: Assessed, Consented and As-Built / Planned Turbine Scenarios for Projects Considered Cumulatively for Collision Risk Impacts									
Offshore Wind Farm	**Assessed Turbine Scenario**	**Assessed Capacity (MW)**	**Consented Capacity (MW)**	**Consented Number of Turbines**	**As-Built Scenario / Turbine Scenario Currently Being Considered**	**As-Built / Currently Planned Capacity**	**Is there a Difference between the Assessed Turbine Scenario and either the Consented or As-Built/Planned Turbine Scenario (Y/N)**	**Implications for Cumulative Assessment**	**Correction Factors Applied to Consideration of Collison Assessment Precaution**
Operational									
Dudgeon	168 x 3 MW	504	560	77	67 x 6 MW	402	Yes – consented number of turbines (77) lower than that assessed (168). In addition, constructed number of turbines lower than consented	Reduction of 54% - assessed vs consented number of turbines Potential additional 6% reduction if as built scenario vs assessed scenario taken into account.	Yes – Correction factor from MacArthur Green (2017) applied
Greater Gabbard	140	Unavailable	-	-	140 x 3.6 MW	504	No – assessed scenario consistent with as-built scenario	-	-
Humber Gateway	83 x 3.6 MW	298.8	300	83	73 x 3 MW	219	Yes – as-built number of turbines (73) lower than assessed (83) however capacity of as-built turbines lower than assessed	Reduction of 12% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	Yes – Correction factor from MacArthur Green (2017) applied
Kentish Flats Extension	17 x 3 MW	51	-	-	15 x 3.3 MW	49.5	Yes – as-built scenario has fewer turbines than assessed scenario	Reduction of 12% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	Yes – Correction factor from MacArthur Green (2017)

Table 6.9.3: Assessed, Consented and As-Built / Planned Turbine Scenarios for Projects Considered Cumulatively for Collision Risk Impacts

Offshore Wind Farm	Assessed Turbine Scenario	Assessed Capacity (MW)	Consented Capacity (MW)	Consented Number of Turbines	As-Built Scenario / Turbine Scenario Currently Being Considered	As-Built / Currently Planned Capacity	Is there a Difference between the Assessed Turbine Scenario and either the Consented or As-Built/Planned Turbine Scenario (Y/N)	Implications for Cumulative Assessment	Correction Factors Applied to Consideration of Collison Assessment Precaution
Lincs	83 x 3 MW	249	250	83	75 x 3.6 MW	270	Yes – as-built scenario has fewer turbines than assessed scenario	Reduction of 10% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	Yes – Correction factor from MacArthur Green (2017) applied
London Array	271 x 3 MW	813	1000	341	175 x 3.6 MW	630	Yes – as-built scenario has fewer turbines than assessed scenario	Reduction of 35% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	No – correction factor presented in MacArthur Green (2017) is not applicable as it uses different turbine scenarios
Sheringham Shoal	108 x 3 MW	324	316.8	108	88 x 3.6 MW	316.8	Yes – as-built scenario has fewer turbines than assessed scenario	Reduction of 19% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	No – collision risk estimates are unavailable for species considered in this RIAA
Teesside	30	Unavailable	100	30	27 x 2.3 MW	62.1	Yes – as-built scenario has fewer turbines than assessed scenario	Reduction of 10% in terms of number of turbines however the assessed turbine capacity is unknown and therefore it is not known if the reduction can be applied.	Yes – Correction factor from MacArthur Green (2017) applied

Table 6.9.3: Assessed, Consented and As-Built / Planned Turbine Scenarios for Projects Considered Cumulatively for Collision Risk Impacts									
Offshore Wind Farm	**Assessed Turbine Scenario**	**Assessed Capacity (MW)**	**Consented Capacity (MW)**	**Consented Number of Turbines**	**As-Built Scenario / Turbine Scenario Currently Being Considered**	**As-Built / Currently Planned Capacity**	**Is there a Difference between the Assessed Turbine Scenario and either the Consented or As-Built/Planned Turbine Scenario (Y/N)**	**Implications for Cumulative Assessment**	**Correction Factors Applied to Consideration of Collison Assessment Precaution**
Thanet	60 x 5 MW	300	300	-	100 x 3 MW	300	Yes – as-built scenario has more turbines than assessed scenario	As-built scenario was assessed within the Environmental Statement but was not the maximum design scenario. As this scenario has ultimately been built the collision risk estimates used for Thanet represent the 100 x 3 MW turbine scenario.	Yes – Correction factor from MacArthur Green (2017)
Westermost Rough	50 x 3.6 MW	180	245	80	35 x 6 MW	210	Yes – as-built scenario has fewer turbines than assessed scenario	Reduction of 30% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	Yes – Correction factor from MacArthur Green (2017) applied
Under Construction									
Beatrice	277 x 3.6 MW	817.2	750	125	84 x 7 MW	588	Yes – consented number of turbines (125) lower than that assessed (277). In addition, constructed number of turbines lower than consented	Collision risk estimates calculated for Beatrice use the as-built turbine scenario.	No - collision risk estimates calculated for Beatrice use the as-built turbine scenario
Blyth Demonstration Project	15 x 8 MW	120	-	-	5 x 8 MW	40	Yes – as-built scenario has fewer turbines than assessed scenario	Reduction of 67% - assessed vs consented number of turbines.	No – no correction factor presented in

Table 6.9.3: Assessed, Consented and As-Built / Planned Turbine Scenarios for Projects Considered Cumulatively for Collision Risk Impacts

Offshore Wind Farm	Assessed Turbine Scenario	Assessed Capacity (MW)	Consented Capacity (MW)	Consented Number of Turbines	As-Built Scenario / Turbine Scenario Currently Being Considered	As-Built / Currently Planned Capacity	Is there a Difference between the Assessed Turbine Scenario and either the Consented or As-Built/Planned Turbine Scenario (Y/N)	Implications for Cumulative Assessment	Correction Factors Applied to Consideration of Collison Assessment Precaution
									MacArthur Green (2017)
East Anglia ONE	325 x 3.6 MW	1,170	1,200	240	102 x 7 MW	714	Yes – consented number of turbines (240) lower than that assessed (325). In addition, project has committed to building only 102 turbines but using a different turbine scenario	Reduction of 26% - assessed vs consented number of turbines Potential additional 42% reduction if as built scenario vs assessed scenario taken into account.	No – qualitative discussion only
Galloper	140 x 3.6 MW	504	504	140	56 x 6.3 MW	352.8	Yes – as-built scenario has fewer turbines than assessed scenario	Reduction of 60% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	Yes – Correction factor from MacArthur Green (2017) applied
Hornsea Project One	240 x 5 MW	1,200	1,200	-	174 x 7 MW	1,218	Yes – as-built scenario has fewer turbines than assessed scenario	Reduction of 28% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	No – qualitative discussion only
Hywind	5 x 6 MW	30	30	-	5 x 6 MW	30	No – assessed scenario consistent with as-built scenario	-	-

Table 6.9.3: Assessed, Consented and As-Built / Planned Turbine Scenarios for Projects Considered Cumulatively for Collision Risk Impacts									
Offshore Wind Farm	**Assessed Turbine Scenario**	**Assessed Capacity (MW)**	**Consented Capacity (MW)**	**Consented Number of Turbines**	**As-Built Scenario / Turbine Scenario Currently Being Considered**	**As-Built / Currently Planned Capacity**	**Is there a Difference between the Assessed Turbine Scenario and either the Consented or As-Built/Planned Turbine Scenario (Y/N)**	**Implications for Cumulative Assessment**	**Correction Factors Applied to Consideration of Collison Assessment Precaution**
Race Bank	206	Unavailable	580	-	91	-	Yes - as-built scenario has fewer turbines than assessed scenario	Reduction of 56% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	Yes – Correction factor from MacArthur Green (2017) applied
Rampion	175	700	700	175	116 x 3.45 MW	400.2	Yes – as-built scenario has fewer turbines than assessed/consented scenario	Reduction of 34% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	No – qualitative discussion only
Consented and Awarded CfD									
Aberdeen European Offshore Wind Deployment Centre	11 x 7 MW	77	100	-	11 x 8.4 MW	92.4	Yes – same number of turbines, however capacity of turbines higher for as-built scenario	Potential for a minor change in collision risk due to change in turbine scenario.	No – qualitative discussion only
Hornsea Project Two	300 x 5 MW	1,800	1,800	300	92-231	1,368	Yes – planned turbine scenario has fewer turbines than assessed scenario	Reduction of 23-69% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	No – qualitative discussion only

Table 6.9.3: Assessed, Consented and As-Built / Planned Turbine Scenarios for Projects Considered Cumulatively for Collision Risk Impacts									
Offshore Wind Farm	**Assessed Turbine Scenario**	**Assessed Capacity (MW)**	**Consented Capacity (MW)**	**Consented Number of Turbines**	**As-Built Scenario / Turbine Scenario Currently Being Considered**	**As-Built / Currently Planned Capacity**	**Is there a Difference between the Assessed Turbine Scenario and either the Consented or As-Built/Planned Turbine Scenario (Y/N)**	**Implications for Cumulative Assessment**	**Correction Factors Applied to Consideration of Collison Assessment Precaution**
Moray East (Consented Telford, Steveson and MacColl wind farms)	339 (139 x 3.6, 100 x 5 and 100 x 5 MW)	1,500	1,116	186[7]	100 x 9.5 MW	950	Yes – consented number of turbines (186) lower than that assessed (339). In addition, planned turbine scenario is lower than consented	Updated collision risk estimates are presented in Appendix 5 of MS-LOT (2017) using a turbine scenario comprising 157 turbines. There is therefore a potential reduction of 36% - assessed vs as-built scenario however change in capacity of turbines may influence collision risk estimates	No – qualitative discussion only
Neart na Gaoithe	128 x 3.6 MW	460.8	450	75	56 x 8 MW	450	Yes – consented number of turbines (75) lower than that assessed (128). In addition, planned turbine scenario is lower than consented	Reduction of 41% - assessed vs consented number of turbines Potential additional 15% reduction if as built scenario vs assessed scenario taken into account.	No – qualitative discussion only
Triton Knoll	288 x 3.6 MW	1,036.8	1,200	288	90 x 9.5 MW	855	Yes – planned turbine scenario has fewer turbines than assessed scenario	Reduction of 69% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	No – qualitative discussion only
Consented – No CfD									

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

Table 6.9.3: Assessed, Consented and As-Built / Planned Turbine Scenarios for Projects Considered Cumulatively for Collision Risk Impacts									
Offshore Wind Farm	**Assessed Turbine Scenario**	**Assessed Capacity (MW)**	**Consented Capacity (MW)**	**Consented Number of Turbines**	**As-Built Scenario / Turbine Scenario Currently Being Considered**	**As-Built / Currently Planned Capacity**	**Is there a Difference between the Assessed Turbine Scenario and either the Consented or As-Built/Planned Turbine Scenario (Y/N)**	**Implications for Cumulative Assessment**	**Correction Factors Applied to Consideration of Collison Assessment Precaution**
Dogger Bank Creyke Beck A and B	400 x 6 MW	2,400	2,400	400	-	-	No	Project was consented in 2015 and it is likely that a larger capacity turbine scenario, resulting in fewer turbines, will be constructed.	-
Dogger Bank Teesside A and Sofia (formerly Dogger Bank Teesside B)	400 x 6 MW	2,400	2,400	400	240-400	Unavailable	No	Project was consented in 2015 and it is likely that a larger capacity turbine scenario, resulting in fewer turbines, will be constructed.	-
East Anglia Three	172 x 7 MW	1,204	-	-	172 x 7 MW	1204	No	-	-
Inch Cape	213	784	-	-	72	Unavailable	Yes – planned turbine scenario has fewer turbines than assessed scenario	Reduction of 66% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	No – qualitative discussion only
Kincardine	8 x 6 MW	6 to 8	Up to 50 MW	-	7	Unavailable	Yes - planned turbine scenario has fewer turbines than assessed scenario	Reduction of 13% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	No – qualitative discussion only
Methil	1	Unavailable	-	-	2	Unavailable	Yes - planned turbine scenario has more	Increase of 100% in terms of number of turbines however	No – qualitative discussion only

Table 6.9.3: Assessed, Consented and As-Built / Planned Turbine Scenarios for Projects Considered Cumulatively for Collision Risk Impacts									
Offshore Wind Farm	**Assessed Turbine Scenario**	**Assessed Capacity (MW)**	**Consented Capacity (MW)**	**Consented Number of Turbines**	**As-Built Scenario / Turbine Scenario Currently Being Considered**	**As-Built / Currently Planned Capacity**	**Is there a Difference between the Assessed Turbine Scenario and either the Consented or As-Built/Planned Turbine Scenario (Y/N)**	**Implications for Cumulative Assessment**	**Correction Factors Applied to Consideration of Collison Assessment Precaution**
							turbines than assessed scenario	change in capacity of turbines may influence collision risk estimates.	
Seagreen Alpha	75 x 7 MW	525	525		35-60	525	Yes - planned turbine scenario has more turbines than assessed scenario	Reduction of 20-53% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	No – qualitative discussion only
Seagreen Bravo	75 x 7 MW	525	525		35-60	525	Yes - planned turbine scenario has more turbines than assessed scenario	Reduction of 20-53% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	No – qualitative discussion only

6.9.2.27 Where differences arise between the assessed turbine scenario and the as-built/planned turbine scenario (i.e. those projects for which consideration in the assessment is qualitative) further analysis utilising the correction factors calculated by MacArthur Green (2017), has been applied in the "*Consideration of precaution within the assessment*" sections for each relevant species in order to calculate the likely change in collision risk estimates for a project. This is then incorporated qualitatively as part of determining the overall conclusion on site integrity.

6.9.2.28 MacArthur Green (2017) presents an appraisal of the likely 'headroom' that exists in current cumulative collision risk estimates due to assessed turbine scenarios representing a higher collision risk to birds than as-built or planned turbine scenarios. The correction factors have only been applied if the assessed turbine scenario presented in Table 6.9.3 matches that used by MacArthur Green (2017) in order to calculate the relevant correction factor. The correction factors presented in MacArthur Green (2017) can be applied for seven projects that are included in Table 6.9.4

Table 6.9.4: Correction Factors from MacArthur Green (2017) Applied to Collision Risk Estimates

Offshore Wind Farm	Correction Factors from MacArthur Green (2017)	
	Kittiwake	Herring Gull
Galloper	0.42	0.43
Humber Gateway	0.39	0.42
Kentish Flats Extension	0.72	0.80
Lincs	1.04	
Race Bank	0.59	
Teesside	0.67	0.67
Westermost Rough	0.82	0.82

6.9.2.29 The exercise presented therefore does not account for considerable reductions that are likely to occur in the assessed collision risk estimates calculated for Hornsea Project Two, Neart na Gaoithe, Seagreen Alpha and Seagreen Bravo due to these projects currently planning to deploy turbine scenarios that will meet the consented maximum project capacity but using fewer higher capacity turbines. Reductions in collision risk estimates are also likely for London Array, Beatrice, Blyth Demonstration, East Anglia One and Triton Knoll as these projects are currently planning or operating turbine scenarios that are below the consented maximum capacity for the project. Based on the changes that have occurred between assessment and construction, it is considered highly likely that the eventual as-built turbine scenarios for projects such as Dogger Bank Creyke Beck A&B, Dogger Bank Teesside A, Sofia (formerly Dogger Bank Teesside B) and Inch Cape will also contain fewer higher capacity turbines that will lead to reductions in the collision risk estimates incorporated into the cumulative assessments presented below.

Nocturnal activity factors

6.9.2.30 Annex C of Appendix 10.2: Collision Risk Modelling (EIA Report - Volume 4) presents an analysis of the potential change in collision risk estimates as a result of updating the nocturnal activity factors used in collision risk modelling at previously consented projects. Collision risk modelling conducted for projects considered in-combination are considered to have most certainly used the nocturnal activity factors from Garthe and Hüppop (2004) and therefore it is necessary to correct the collision risk estimates to account for this over-estimation.

6.9.2.31 The correction factor to apply to the collision risk estimates for each project considered in-combination will depend on the latitude at which a project is located. An analysis has been conducted in Annex C of Appendix 10.2: Collision Risk Modelling (EIA Report - Volume 4) that calculates correction factors for four geographic areas into which each of the projects considered in-combination have been assigned (Table 6.9.5). Two correction factors are presented, a minimum representing the minimum monthly change that can be applied cross all months and the total representing the total change in collision risk estimates in each area using a generic wind farm scenario. The 'total' correction factor may potentially under or over-estimate the collision risk for an individual project and therefore this is applied in the following species sections as guidance only. The application of the 'minimum' correction factor is considered to be precautionary as this represents the minimum change that would occur across all months.

Table 6.9.5: Reductions to Apply to Collision Risk Estimates for Projects in Each Geographic Region

Geographic Region	Projects within Region	% Reduction in Collision Risk Estimates
East Anglia and English Channel	East Anglia One East Anglia Three Galloper Greater Gabbard Kentish Flats Extension London Array Thanet	9.2
Southern North Sea	Dogger Bank Creyke Beck A & B Dogger Bank Teesside A & B Dudgeon Hornsea Project One Hornsea Project Two Humber Gateway Lincs Race Bank Sheringham Shoal Teesside Triton Knoll Westermost Rough	8.5
Firth of Forth	Aberdeen (EOWDC) Inch Cape Kincardine[8] Methil Neart na Gaoithe Seagreen Alpha Seagreen Bravo	7.8
Moray Firth	Beatrice Hywind	7.1

[8] Collision risk modelling for Kincardine used a nocturnal activity factor of 1 for gannet and therefore only the gull correction factor has been applied

6.9.3 Buchan Ness to Collieston Cliffs SPA

Herring Gull

Overview

6.9.3.1 In the breeding season it has been assumed that Moray West may act in-combination with the Moray East, Beatrice, Kincardine and Hywind offshore wind farms based on the foraging range of herring gull from the SPA. In the non-breeding season, Moray West is assumed to act in-combination with all wind farms located in the non-breeding BDMPS for herring gull as described by Furness (2015).

6.9.3.2 The apportioning approach used for Moray West in the breeding season is consistent with that applied in the Development alone assessment as described in Appendix 4.2: Phenology and Apportioning.

6.9.3.3 For other projects, apportioning values for the breeding season have been obtained from project-specific documentation. For Moray East, a value of 95.1% has been used with this obtained from information submitted as part of post-application consultation. For Beatrice a value of 92.9% has been used with this obtained from the Beatrice Ornithological HRA Technical Report. The HRA Report for Hywind apportioned 54.4% of the total collision risk estimate to the breeding colony at Buchan Ness to Collieston Coast SPA with this value applied in the assessment presented here.

6.9.3.4 No apportioning was conducted for herring gull in the assessments for Kincardine as the estimated number of collisions was very low. A total collision risk estimate of less than one bird was predicted across the breeding season and therefore no collisions have been attributed to the breeding colony at Buchan Ness to Collieston Coast SPA from Kincardine.

6.9.3.5 In the non-breeding season, the approach applied for the Moray West Offshore Wind Farm alone has been applied for all other cumulative projects.

Collision risk

6.9.3.6 During the breeding season, a foraging range approach has been used to identify those plans and projects that may have connectivity with Buchan Ness to Collieston Coast SPA. Projects that may act in-combination with the Moray West Offshore Wind Farm have been identified using the mean-maximum foraging range of herring gull (Thaxter *et al.,* 2012). For projects within foraging range, project-specific apportioning values have been used where available. This therefore applies to Moray East, Beatrice, Kincardine and Hywind with these values obtained from project-specific documentation. In the non-breeding season the 'UK North Sea & Channel waters' BDMPS as defined by Furness (2015) has been used to identify those projects that may act in-combination with the Moray West Offshore Wind Farm.

6.9.3.7 Table 6.6.4 presents collision risk estimates sourced for all projects considered in-combination across all biological seasons relevant for herring gull. Collision risk estimates are presented based on the Basic model of Band (2012). Seasonal collision risk estimates are provided along with seasonal apportioning values and the resulting collision estimates apportioned to the SPA.

6.9.3.8 A total in-combination collision risk mortality of six herring gull is apportioned to the SPA across a full annual cycle. This represents 0.07% of the SPA population (4,292 pairs) and a 0.44% increase in baseline mortality (1,425 individuals).

Conclusion

6.9.3.9 An in-combination mortality of six birds has been predicted for the herring gull population at the Buchan Ness to Collieston Coast SPA. This level of mortality does not represent a significant increase in the baseline mortality of the SPA population. In addition, the Moray West Offshore Wind Farm contributes less than one collision to the in-combination collision total and therefore does not materially alter the current level of in-combination mortality.

6.9.3.10 As only a negligible proportion of the SPA population is affected by predicted mortality resulting in a negligible increase in the baseline mortality of the SPA population , there is considered to be no adverse effect on the herring gull feature of the Buchan Ness to Collieston Coast SPA as a result of in-combination collision risk impacts.

Table 6.9.6: Predicted In-Combination Collision Mortality for Herring Gull from the Buchan Ness to Collieston Cliffs SPA [9]				
Project	**Band Model**	**Annual Unapportioned Collision Mortality**	**Seasonal Collision Mortality Apportioned to SPA**	
			Breeding	**Non-Breeding**
Breeding and Non-Breeding Season				
Moray West	Band (2012)	13	0	0
Moray East	Band (2012)	58	0	1
Beatrice	Band (2012)	69	0	1
Hywind	Band (2011/12)	8	2	0
Kincardine	Band (2012)	1	0	0
Non-Breeding Season				
Aberdeen European Offshore Wind Deployment Centre	Band (2012)	5		0
Blyth Demonstration Project	Band *et al*. (2007)	11		0
East Anglia One	Band (2012)	57		1
East Anglia Three	Band (2012)	19		0
Galloper	Band *et al*. (2007)	20		0
Hornsea Project One	Band (2012)	14		0
Humber Gateway	Not available	2		0
Inch Cape	Band (2012)	13		0
Kentish Flats Extension	Band (2012)	2		0
Neart na Gaoithe	Band (2012)	32		0

[9] The collision risk estimates presented in this table have not been corrected for either differences between assessed and as-built turbine scenarios or updated nocturnal activity factors

Table 6.9.6: Predicted In-Combination Collision Mortality for Herring Gull from the Buchan Ness to Collieston Cliffs SPA [9]				
Project	**Band Model**	**Annual Unapportioned Collision Mortality**	**Seasonal Collision Mortality Apportioned to SPA**	
			Breeding	**Non-Breeding**
Seagreen Alpha	Band (2012)	19		0
Seagreen Bravo	Band (2012)	12		0
Teesside	Band (2000)	43		0
Thanet	Band (2000)	9		0
Westermost Rough	Band *et al*. (2007)	0		0
Total			2	4

Guillemot

Overview

6.9.3.11 In the breeding season it has been assumed that the Moray West Offshore Wind Farm may act in-combination with the Moray East, Beatrice, Kincardine and Hywind offshore wind farms based on the foraging range of guillemot from the SPA. In the non-breeding season, Moray West is assumed to act in-combination with all wind farms located in the non-breeding BDMPS for guillemot as described by Furness (2015).

6.9.3.12 The apportioning approach used for the Moray West Offshore Wind Farm in the breeding season is consistent with that applied in the Development alone and Appendix 4.2: Phenology and Apportioning. For other projects, information on the apportioning approach applied in the breeding season has been obtained from project-specific documentation. For Moray East and Beatrice the apportioning approaches applied assumed that no birds present at each project originated from the Buchan Ness to Collieston Coast SPA breeding colony and as such no impacts were apportioned to the SPA. The HRA for Hywind applied an apportioning value of 57.2% with assessments at Kincardine using an apportioning value of 10%.

6.9.3.13 In the non-breeding season, the approach to apportioning applied for the Moray West Offshore Wind Farm has been applied for all projects (i.e. using the contribution of the SPA population to the wider regional BDMPS population).

Displacement

6.9.3.14 The predicted displacement of guillemot from other wind farm projects in-combination with the Moray West Offshore Wind Farm is summarised for the breeding and non-breeding seasons in Table 6.9.7.

Breeding season

6.9.3.15 During the breeding season in-combination displacement potentially affects 475 birds (Table 6.6.5), which leads to mortality of 2-3 individuals (assuming displacement of 50-60% and mortality of 1%) (Table 6.9.8). The predicted mortality comprises 0.01-0.02% of the SPA breeding population (17,280 breeding individuals) and an increase in baseline mortality (1,054 individuals) of 0.23-0.27%.

Non-breeding season

6.9.3.16 During the non-breeding season in-combination displacement potentially affects 1,316 birds (Table 6.6.5), which leads to mortality of 7-8 individuals (assuming displacement of 50-60% and mortality of 1%) (Table 6.9.9). The predicted mortality comprises 0.04-0.05% of the SPA breeding population (17,280 breeding individuals) and an increase in baseline mortality (1,054 individuals) of 0.62-0.75%.

Conclusion

6.9.3.17 The predicted in-combination mortality of guillemot in the breeding season represents a negligible proportion of the SPA population and a negligible increase in the baseline mortality of the population.

6.9.3.18 In the non-breeding season, the predicted in-combination total, 64% of which is contributed by the Moray West Site, represents more than a 1% increase in the baseline mortality of the SPA population. The in-combination total is increased considerably by the large population of guillemot recorded in the post-breeding season at the Moray West Site. This population is calculated using data collected for the Beatrice offshore wind farm which is then extrapolated to the Moray West Site. The data collected at Beatrice only covers a small proportion of the Moray West Site and therefore the extrapolation of these data to the entire Moray West Site is likely to represent a considerable over-estimate. As such, it is considered that the actual in-

combination total in the non-breeding season would be considerably lower than that predicted in Table 6.9.7. Taking account of this likely overestimate, it is considered that there will be no adverse effect on the guillemot population of the Buchan Ness to Collieston Coast SPA as a result of in-combination displacement impacts.

Table 6.9.7: Predicted in-combination displacement mortality for guillemot from the Buchan Ness to Collieston Cliffs SPA				
Project	**Mean-peak population in breeding season**	**Mean-peak population apportioned to SPA in breeding season**	**Mean-peak population in non-breeding season**	**Mean-peak population apportioned to SPA in non-breeding season**
Breeding and non-breeding season				
Moray West	24,426	120	38,174	488
Moray East	9,820	0	1,245	16
Beatrice	13,610	0	2,755	35
Hywind	511	292	0	0
Kincardine	632	63	0	0
Non-breeding season				
Aberdeen			225	3
Blyth Demonstration			1,274	16
Dogger Bank Creyke Beck A			6,724	86
Dogger Bank Creyke Beck B			11,302	145
Dogger Bank Teesside A			2,870	37
Dogger Bank Teesside B			1,525	20
Dudgeon			692	9
East Anglia ONE			713	9
East Anglia Three			1,405	18
Galloper			588	8
Greater Gabbard			698	9

Table 6.9.7: Predicted in-combination displacement mortality for guillemot from the Buchan Ness to Collieston Cliffs SPA				
Project	**Mean-peak population in breeding season**	**Mean-peak population apportioned to SPA in breeding season**	**Mean-peak population in non-breeding season**	**Mean-peak population apportioned to SPA in non-breeding season**
Hornsea Project One			7,318	94
Hornsea Project Two			13,164	168
Humber Gateway			158	2
Inch Cape			3,177	41
Lincs and LID6			931	12
London Array I & II			492	6
Neart na Gaoithe			3,291	42
Race Bank			925	12
Seagreen A			0	0
Seagreen B			0	0
Sheringham Shoal			822	11
Teesside			918	12
Thanet			137	2
Triton Knoll			843	11
Westermost Rough			556	7
Total		475		1,316

Table 6.9.8: Predicted Guillemot Mortality from Buchan Ness to Collieston Coast SPA as a Result of Displacement from In-Combination Displacement Impacts During the Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	1	2	5	10	14	19	24	29	33	38	43	48
20	1	2	5	10	19	29	38	48	57	67	76	86	95
30	1	3	7	14	29	43	57	71	86	100	114	128	143
40	2	4	10	19	38	57	76	95	114	133	152	171	190
50	2	5	12	24	48	71	95	119	143	166	190	214	238
60	3	6	14	29	57	86	114	143	171	200	228	257	285
70	3	7	17	33	67	100	133	166	200	233	266	300	333
80	4	8	19	38	76	114	152	190	228	266	304	342	380
90	4	9	21	43	86	128	171	214	257	300	342	385	428
100	5	10	24	48	95	143	190	238	285	333	380	428	475

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

Table 6.9.9: Predicted Guillemot Mortality from Buchan Ness to Collieston Coast SPA as a Result of Displacement from In-Combination Displacement Impacts during the Non-Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	3	7	13	26	39	53	66	79	92	105	118	132
20	3	5	13	26	53	79	105	132	158	184	211	237	263
30	4	8	20	39	79	118	158	197	237	276	316	355	395
40	5	11	26	53	105	158	211	263	316	369	421	474	527
50	7	13	33	66	132	197	263	329	395	461	527	592	658
60	8	16	39	79	158	237	316	395	474	553	632	711	790
70	9	18	46	92	184	276	369	461	553	645	737	829	921
80	11	21	53	105	211	316	421	527	632	737	842	948	1053
90	12	24	59	118	237	355	474	592	711	829	948	1066	1185
100	13	26	66	132	263	395	527	658	790	921	1053	1185	1316

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

6.9.4 East Caithness Cliffs SPA

Kittiwake

Overview

6.9.4.1 In the breeding season it has been assumed that the Moray West Offshore Wind Farm may act in-combination with both the Moray East and Beatrice offshore wind farms based on the foraging range of kittiwake from the SPA. In the non-breeding seasons, Moray West is assumed to act in-combination with all wind farms located in the post- and pre-breeding BDMPS for kittiwake as described by Furness (2015).

6.9.4.2 The apportioning approach used for the Moray West Offshore Wind Farm in the breeding season is consistent with that applied in the Development alone assessment and Appendix 4.2: Phenology and Apportioning. For Moray East and Beatrice, apportioning values for the breeding season have been obtained from project-specific documentation. For Moray East, a value of 95.1% has been used with this obtained from information submitted as part of post-application consultation. For Beatrice a value of 92.9% has been used with this obtained from the Beatrice Ornithological HRA Technical Report.

6.9.4.3 In the post- and pre-breeding seasons, the approach applied for the Moray West Offshore Wind Farm has been applied for all projects (i.e. using the contribution of the SPA population to the wider regional BDMPS populations).

Displacement

6.9.4.4 Assessment of in-combination displacement impacts on kittiwake has concentrated on impacts from projects within foraging range of East Caithness Cliffs SPA during the breeding season. Impacts from these projects are likely to disproportionately impact kittiwake from the East Caithness Cliffs SPA when compared to other impacts from other projects in the North Sea which are considered more likely to affect birds from other SPAs in close proximity to the respective project. For East Caithness Cliffs SPA, this therefore means that impacts from Moray West in-combination with Moray East and Beatrice are considered.

Breeding season

6.9.4.5 The predicted displacement mortality during the breeding season from each of the projects considered in-combination is presented in Table 6.9.10. During the breeding season in-combination displacement potentially affects 13,206 birds, which leads to mortality of 79 individuals (assuming displacement of 30% and mortality of 2%). From this total mortality, 65 birds are attributable to the kittiwake population at East Caithness Cliffs SPA. The predicted mortality comprises 0.1% of the SPA breeding population (65,000 breeding individuals) and an increase in baseline mortality (9,490 individuals) of 0.68%.

Table 6.9.10: Predicted In-Combination Displacement Mortality for Kittiwake from the East Caithness Cliffs SPA in the breeding season

Offshore Wind Farm	Mean-peak population	Displacement mortality (displacement rate = 30%, mortality rate = 2%)	Displacement mortality apportioned to East Caithness Cliffs SPA
Moray West	6,902	41	29
Moray East	4,082	24	23
Beatrice	2,222	13	12
Total	13,206	79	65

6.9.4.6 If additional mortality of 50 birds per annum is assumed for PVA modelling (the closest modelled output to the predicted in-combination total) then the model predicts a reduction in growth rate of 0.23% (Table 6.9.11). Under this scenario, the predicted median impacted population size after 35-50 years would be approximately 90-93% of that which the model predicts would occur in the in the absence of any additional in-combination impact.

6.9.4.7 The PVA model predicts a positive growth rate for the kittiwake population at East Caithness Cliffs SPA with a resulting end population size higher than that designated at the SPA. However, the population at the SPA has exhibited a declining population trend in recent years with this trend potentially likely to continue regardless of the presence of the Moray West Offshore Wind Farm. Full details of the kittiwake PVA for East Caithness Cliffs SPA is provided in RIAA Appendix 4.5.

Table 6.9.11: PVA Outputs for Kittiwake at East Caithness Cliffs SPA Assuming a Mortality of 50 Birds

Impact Scenario	Years	% Change in Growth Rate	Ratio of Unimpacted to Impacted Growth Rate	Ratio of Unimpacted to Impacted Population Size	Centile for Impacted Population
Unimpacted	-	-	-	1	0.50
Impacted	35	-0.23	0.998	0.93	0.43
	50			0.90	0.41

Non-breeding seasons

6.9.4.8 The predicted displacement mortality during the post- and pre-breeding seasons from each of the projects considered in-combination is presented in Table 6.9.12Table 6.9.10. No assessment in the non-breeding season was conducted for the Beatrice offshore wind farm and population estimates, which would enable displacement mortality to be calculated, are not available. The total in-combination mortality therefore includes Moray West and Moray East only. In the post- and pre-breeding seasons in-combination displacement potentially affects 1,631 and 2,525 birds respectively. This leads to a total mortality of 10 and 15 birds in the post- and pre-breeding seasons (assuming displacement of 30% and mortality of 2%) with one bird attributable to the East Caithness Cliffs kittiwake population in both seasons. The predicted mortality comprises less than 0.01% of the SPA breeding population (65,000 breeding individuals) and an increase in baseline mortality (9,490 individuals) of 0.01% in both seasons.

Table 6.9.12: Predicted In-Combination Displacement Mortality for Kittiwake from the East Caithness Cliffs SPA in the non-breeding seasons

Offshore Wind Farm	Mean-peak population	Displacement mortality (displacement rate = 30%, mortality rate = 2%)	Displacement mortality apportioned to East Caithness Cliffs SPA
Post-breeding			
Moray West	1,470	9	1
Moray East	161	1	0
Beatrice	No assessment conducted		
Total	1,631	10	1
Pre-breeding			

Table 6.9.12: Predicted In-Combination Displacement Mortality for Kittiwake from the East Caithness Cliffs SPA in the non-breeding seasons			
Offshore Wind Farm	**Mean-peak population**	**Displacement mortality (displacement rate = 30%, mortality rate = 2%)**	**Displacement mortality apportioned to East Caithness Cliffs SPA**
Moray West	1,074	6	0
Moray East	1,451	9	1
Beatrice	No assessment conducted		
Total	2,525	15	1

Collision risk

6.9.4.9 During the breeding season, a foraging range approach has been used to identify those plans and projects that may have connectivity with East Caithness Cliffs SPA. Projects that may act in-combination with the Moray West Offshore Wind Farm have been identified using the mean-maximum foraging range of kittiwake (Thaxter *et al.,* 2012). For projects within foraging range, project-specific apportioning values have been used where available. This therefore applies to Moray East and Beatrice with these values obtained from project-specific documentation. In the non-breeding season the 'UK North Sea waters' BDMPS as defined by Furness (2015) has been used to identify those projects that may act in-combination with the Moray West Offshore Wind Farm.

6.9.4.10 Table 6.7.11 presents collision risk estimates sourced for all projects considered in-combination across all biological seasons relevant for kittiwake. Collision risk estimates are presented based on the Basic model of Band (2012). Seasonal collision risk estimates are provided along with seasonal apportioning values and the resulting collision estimates apportioned to the SPA.

6.9.4.11 A total in-combination collision risk mortality of 325 kittiwake is apportioned to the SPA across a full annual cycle. This represents 0.5% of the SPA population (32,500 pairs) and a 3.43% increase in baseline mortality (9,490 individuals).

6.9.4.12 East Caithness Cliffs SPA was designated based on the kittiwake breeding population estimated in 1985-88 (32,500 pairs). This population had increased to 40,140 pairs in 1999 but has since declined to 24,460 pairs in 2015.

6.9.4.13 If additional mortality of 350 birds per annum is assumed for PVA modelling (the closest modelled output to the predicted in-combination total) then the model predicts a reduction in growth rate of 1.6%. Under this scenario, the predicted median impacted population size after 35-50 years would be approximately 46-58% of that which the model predicts would occur in the in the absence of any additional in-combination impact. Should the population. grow at the rate calculated in the PVA model over the next 35 years, then the additional mortality through in combination collisions is not considered to counter a conservation objective to restore the population, as it would still allow the population to grow with minimal delay in reaching the same population level as the un-impacted population. However, in the context of a population trajectory that is currently declining and may continue to decline (or at best be stable) the additional mortality over 35 years causing a reduction in growth rate of 1.58% would have potential to impact the population and make it more difficult to restore the population to a favourable condition (Table 6.9.13). Full details of the PVA undertaken on the kittiwake component of the East Caithness Cliffs SPA is presented in Appendix 4.5.

Table 6.9.13: PVA Outputs for Kittiwake at East Caithness Cliffs SPA Assuming a Mortality of 350 Birds					
Impact Scenario	**Years**	**% Change in Growth Rate**	**Ratio of Unimpacted to Impacted Growth Rate**	**Ratio of Unimpacted to Impacted Population Size**	**Centile for Impacted Population**
Unimpacted	-	-	-	1	0.50
Impacted	35	-1.58	0.985	0.58	0.083
	50			0.46	0.046

Table 6.9.14: Predicted in-combination collision mortality for kittiwake from the East Caithness Cliffs SPA[10]					
Project	**Band model**	**Annual unapportioned collision mortality**	**Seasonal collision mortality apportioned to SPA**		
			Breeding	**Post-breeding**	**Pre-breeding**
Breeding and non-breeding season					
Moray West	Band (2012)	109	56	1	1
Moray East	Band (2012)	86	69	0	1
Beatrice	Band (2012)	45	28	0	1
Non-breeding season					
Aberdeen European Offshore Wind Deployment Centre	Band (2012)	19		0	0
Blyth Demonstration Project	Band (2011)	5		0	0
Dogger Bank Creyke Beck Projects A and B	Band (2012)	719		6	23
Dogger Bank Teesside Projects A and B	Band (2012)	445		5	17
Dudgeon	Band (2000)	0		0	0
East Anglia One	Band (2012)	581		23	11
East Anglia Three	Band (2012)	106		4	2
Galloper	Band *et al*. (2007)	66		2	2
Greater Gabbard	Band (2000)	28		0	1
Hornsea Project One	Band (2012)	123		3	2
Hornsea Project Two	Band (2012)	27		0	0
Humber Gateway	Not available	7		0	0

[10] [10] The collision risk estimates presented in this table have not been corrected for either differences between assessed and as-built turbine scenarios or updated nocturnal activity factors

Hywind	Band (2012)	18		0	0
Inch Cape	Band (2012)	301		13	5
Kentish Flats Extension	Band (2012)	3		0	0
Kincardine	Band (2012)	19		0	0
Lincs	Band (2000)	3		0	0
London Array	Band (2000)	6		0	0
Methil	Band (2011/12)	1		0	0
Neart na Gaoithe	Band (2012)	93		2	2
Race Bank	Band (2000)	31		1	0
Seagreen Alpha	Band (2012)	371		9	9
Seagreen Bravo	Band (2012)	343		7	7
Teesside	Band (2000)	81		1	0
Thanet	Band (2000)	0		0	0
Triton Knoll	Band (2000)	209		6	5
Westermost Rough	Band *et al*. (2007)	0		0	0
Total			153	83	89

Consideration of precaution within the assessment

6.9.4.14 As indicated in Section 6.9 (paragraphs 6.9.2.15 onwards) there is a large degree of precaution incorporated into the in-combination assessment presented here.

6.9.4.15 When applying the turbine scenario correction factors calculated by MacArthur Green (2017) (Table 6.9.4), the total in-combination collision risk estimate reduces by 1.2% (Table 6.9.15). In addition to the reductions in collision risk for the projects included in Table 6.9.15, considerable reductions in the number of collisions will occur at the East Anglia One offshore wind farm (which contributes over 10% of the total in-combination collision risk), which has committed to reductions in both the total capacity of the wind farm and the number of turbines and the Moray East offshore wind farm (which contributes over 17% of the total in-combination collision risk) and projects in the Firth of Forth and Tay (which contribute over 16% of the total in-combination collision risk) which are expected to install a fewer, larger capacity turbines which will likely lead to reductions in the predicted collisions for these projects. Reductions in collision risk are also likely to occur at many other projects at which construction has yet to commence (see paragraph 6.9.2.29), with this likely to have a significant effect on the in-combination total predicted for kittiwake at East Caithness Cliffs SPA.

Table 6.9.15: Changes to Collision Mortality Estimates for Kittiwake Calculated When Applying the Turbine Scenario Correction Factors from MacArthur Green (2017)

Offshore Wind Farm	Post-Breeding Season		Pre-Breeding Season		Annual	
	No Correction	Corrected	No Correction	Corrected	No Correction	Corrected
Galloper	2	1	2	1	4	2
Humber Gateway	0	0	0	0	0	0
Kentish Flats Extension	0	0	0	0	0	0
Lincs	0	0	0	0	0	0
Race Bank	1	1	0	0	1	1
Teesside	1	1	0	0	1	1
Westermost Rough	0	0	0	0	0	0
Totals						
Other projects	80		86		319	
Total	83	82	89	88	325	322
% change	2.0		1.7		1.0	

6.9.4.16 Applying the nocturnal activity correction factors presented in Table 6.9.5 the collision risk estimates presented in Table 6.9.16 have been corrected to account for the over-estimation of nocturnal flight activity. When applying the 'minimum' correction factor the number of breeding season collisions reduces by 4.4%. It should be noted that this is the minimum by which collision risk estimates would reduce as a result of a change in the nocturnal activity factor used for kittiwake and that a realistic change would be higher and potentially closer to the collision risk estimates presented in Table 6.9.15 when applying the 'total' correction factor.

Table 6.9.16: Correction to Collision Mortality Estimates for kittiwake to Take Account of the Over-Estimation of Nocturnal Flight Activity					
Season	**Uncorrected collision risk estimate**	**Corrected collision risk estimate**		**Percentage change**	
		Minimum	**Total**	**Minimum**	**Total**
Post-breeding	83	76	70	8.3	15.9
Pre-breeding	89	82	75	8.2	15.8
Total	325	311	298	4.4	8.4

Conclusion

6.9.4.17 The predicted level of displacement mortality apportioned to the SPA represents an increase of less than 1% of baseline mortality of the SPA population. PVA modelling for the East Caithness Cliffs SPA kittiwake population has been undertaken to identify any potential population level consequences and suggests that the population at the SPA would continue to grow with minimal delay in reaching the same population level as the un-impacted population.

6.9.4.18 Moray West contributes 58 collisions to the in-combination collision total attributable to the kittiwake feature of East Caithness Cliffs SPA. The total in-combination collision risk attributable to East Caithness Cliffs SPA would not prevent allowance of the population to grow with minimal delay in reaching the same population level as the un-impacted population. Although the population is potentially declining, this observation combined with the extensive precaution built into the assessment (built out scenarios, nocturnal activity factors as described above plus other parameters such as avoidance rate and Band model option choice) leads to a conclusion that there is considered to be no adverse effect on the kittiwake feature of the East Caithness Cliffs SPA as a result of in-combination collision risk impacts.

6.9.4.19 This conclusion is also considered applicable should displacement and collision mortality be treated as being mutually exclusive and mortality estimates combined (worst case scenario mortality of 392 birds; 67 birds from displacement and 325 from collision).

Herring gull

Overview

6.9.4.20 In the breeding season it has been assumed that the Moray West Offshore Wind Farm may act in-combination with both the Moray East and Beatrice offshore wind farms based on the foraging range of herring gull from the SPA. In the non-breeding season, Moray West is assumed to act in-combination with all wind farms located in the non-breeding BDMPS for herring gull as described by Furness (2015).

6.9.4.21 The apportioning approach used for the Moray West Offshore Wind Farm in the breeding season is consistent with that applied in the Development alone assessment and Appendix 4.2: Phenology and Apportioning. For Moray East and Beatrice, apportioning values for the breeding season have been obtained from project-specific documentation. For Moray East, a value of 37.5% has been used with this obtained from information submitted as part of post-application consultation. For Beatrice a value of 98.6% has been used with this obtained from the Beatrice Ornithological HRA Technical Report.

6.9.4.22 In the non-breeding season, the approach applied for the Moray West Offshore Wind Farm has been applied for all projects (i.e. using the contribution of the SPA population to the wider regional BDMPS population).

Collision risk

6.9.4.23 Table 6.9.17 presents collision risk estimates sourced for all projects considered in-combination across all biological seasons relevant for herring gull. Collision risk estimates are presented based on the Basic model of Band (2012). Seasonal collision risk estimates are provided along with seasonal apportioning values and the resulting collision estimates apportioned to the SPA.

6.9.4.24 A total in-combination collision risk mortality of 18 herring gull is apportioned to the SPA across a full annual cycle. This represents 0.1% of the SPA population (9,400 pairs) and a 0.59% increase in baseline mortality (3,121 individuals).

Consideration of precaution within the assessment

6.9.4.25 As indicated in Section 6.9 (paragraphs 6.9.2.15 onwards) there is a large degree of precaution incorporated into the in-combination assessment presented here.

6.9.4.26 Applying the turbine scenario correction factors calculated by MacArthur Green (2017) (Table 6.9.4, does not materially alter the number of collisions predicted to be attributable to the East Caithness Cliffs SPA. However, in addition to the reductions in collision risk for the projects included in Table 6.9.3, considerable reductions in the number of collisions will occur at the East Anglia One offshore wind farm, which has committed to reductions in both the total capacity of the wind farm and the number of turbines, and the Moray East wind farm which is expected to install a fewer, larger capacity turbines which will likely lead to a reduction in the predicted collisions for this project. Reductions in collision risk are also likely to occur at many other projects at which construction has yet to commence (see paragraph 6.9.2.29), with this likely to have a significant effect on the in-combination total predicted for herring gull at East Caithness Cliffs SPA.

6.9.4.27 Collision risk estimates predicted for other projects considered in-combination are also likely to reduce when applying the nocturnal activity factors presented in Table 6.9.5. However, when the resulting collision risk estimates are apportioned to the herring gull population at East Caithness Cliffs the reductions calculated do not materially alter the total in-combination collision risk in terms of the assessment presented here.

Conclusion

6.9.4.28 An in-combination mortality of 18 birds has been predicted for the herring gull population at the East Caithness Cliffs SPA. This level of mortality does not lead to an increase in the baseline mortality of the population of above 1%. The Moray West Offshore Wind Farm contributes four collisions to the in-combination collision total attributable to the herring gull feature of East Caithness Cliffs SPA. The total in-combination collision risk attributable to East Caithness Cliffs SPA represents a negligible proportion of the SPA population and less than a 1% increase in the baseline mortality of the SPA population even before taking into account the precaution present in the total in-combination collision risk calculated in Table 6.9.17. There is therefore considered to be no adverse effect on the herring gull feature of the East Caithness Cliffs SPA as a result of in-combination collision risk impacts.

Table 6.9.17: Predicted in-combination collision mortality for herring gull from the East Caithness Cliffs SPA[11]				
Project	**Band model**	**Annual unapportioned collision mortality**	**Seasonal collision mortality apportioned to SPA**	
			Breeding	**Non-breeding**
Breeding and non-breeding season				
Moray West	Band (2012)	13	4	0
Moray East	Band (2012)	58	2	1
Beatrice	Band (2012)	69	8	1
Non-breeding season				
Aberdeen European Offshore Wind Deployment Centre	Band (2012)	5		0
Blyth Demonstration Project	Band *et al*. (2007)	11		0
East Anglia One	Band (2012)	42		1
East Anglia Three	Band (2012)	19		0
Galloper	Band *et al*. (2007)	20		0
Hornsea Project One	Band (2012)	14		0
Humber Gateway	Not available	2		0
Hywind	Band (2011/12)	8		0
Inch Cape	Band (2012)	13		0
Kentish Flats Extension	Band (2012)	2		0
Kincardine	Band (2012)	1		0
Neart na Gaoithe	Band (2012)	32		0

[11] [11] The collision risk estimates presented in this table have not been corrected for either differences between assessed and as-built turbine scenarios or updated nocturnal activity factors

Table 6.9.17: Predicted in-combination collision mortality for herring gull from the East Caithness Cliffs SPA[11]				
Project	**Band model**	**Annual unapportioned collision mortality**	**Seasonal collision mortality apportioned to SPA**	
			Breeding	**Non-breeding**
Seagreen Alpha	Band (2012)	19		0
Seagreen Bravo	Band (2012)	12		0
Teesside	Band (2000)	43		0
Thanet	Band (2000)	9		0
Westermost Rough	Band *et al*. (2007)	0		0
Total			14	5

Guillemot

Overview

6.9.4.29 In the breeding season it has been assumed that the Moray West Offshore Wind Farm may act in-combination with both the Moray East and Beatrice offshore wind farms based on the foraging range of guillemot from the SPA. In the non-breeding season, Moray West is assumed to act in-combination with all wind farms located in the non-breeding BDMPS for guillemot as described by Furness (2015).

6.9.4.30 The apportioning approach used for the Moray West Offshore Wind Farm in the breeding season is consistent with that applied in the Development alone assessment and Appendix 4.2: Phenology and Apportioning. For Moray East and Beatrice, apportioning values for the breeding season have been obtained from project-specific documentation. For Moray East, a value of 93.2% has been used with this obtained from information submitted as part of post-application consultation. For Beatrice a value of 91.6% has been used with this obtained from the Beatrice Ornithological HRA Technical Report.

6.9.4.31 In the non-breeding season, the approach applied for the Moray West Offshore Wind Farm has been applied for all projects.

Displacement

6.9.4.32 The predicted displacement of guillemot from other wind farm projects in-combination with the Moray West Offshore Wind Farm is summarised for the breeding and non-breeding seasons in Table 6.9.20.

Breeding season

6.9.4.33 During the breeding season in-combination displacement potentially affects 32,649 birds (Table 6.9.20), which leads to mortality of 163-196 individuals (assuming displacement of 50-60% and mortality of 1%) (Table 6.9.21). The predicted mortality comprises 0.11-0.14% of the SPA breeding population (142,978 breeding individuals) and an increase in baseline mortality (8,722 individuals) of 1.87-2.25%.

6.9.4.34 East Caithness Cliffs SPA was designated based on the guillemot population estimated in 1985-88 (106,700 individuals). This population had increased to 158,985 individuals in 1999 but has since declined to 149,228 individuals in 2015. However, this population is still above the population originally designated at the SPA

6.9.4.35 If additional mortality of 200 birds per annum is assumed for PVA modelling (the closest modelled output to the predicted in-combination total) then the model predicts a reduction in growth rate of 0.27%. Under this scenario, the predicted median impacted population size after 35-50 years would be approximately 88-91% of that which the model predicts would occur in the in the absence of any additional in-combination impact (Table 6.9.18). Appendix 4.5 presents full PVA results for the breeding guillemot feature of East Caithness Cliffs SPA.

6.9.4.36 The current population at the SPA is higher than the population at designation. If the predicted in-combination mortality were to occur across the lifetime of the Moray West Offshore Wind Farm the resulting end population would still be higher than the population at designation.

Table 6.9.18: PVA Outputs for Guillemot at East Caithness Cliffs SPA Assuming a Mortality of 200 Birds

Impact Scenario	Years	% Change in Growth Rate	Ratio of Unimpacted to Impacted Growth Rate	Ratio of Unimpacted to Impacted Population Size	Centile for Impacted Population
Unimpacted	-	-	-	1	0.50

Table 6.9.18: PVA Outputs for Guillemot at East Caithness Cliffs SPA Assuming a Mortality of 200 Birds					
Impact Scenario	**Years**	**% Change in Growth Rate**	**Ratio of Unimpacted to Impacted Growth Rate**	**Ratio of Unimpacted to Impacted Population Size**	**Centile for Impacted Population**
Impacted	35	-0.27	0.997	0.91	0.25
	50			0.88	0.20

Non-breeding season

6.9.4.37 During the non-breeding season in-combination displacement potentially affects 9,488 birds (Table 6.9.20), which leads to mortality of 47-57 individuals (assuming displacement of 50-60% and mortality of 1%). The predicted mortality comprises 0.03-0.04% of the SPA breeding population (142,978 breeding individuals) and an increase in baseline mortality (8,722 individuals) of 0.54-0.65%.

6.9.4.38 If additional mortality of 100 birds per annum is assumed for PVA modelling (the closest modelled output to the predicted in-combination total) then the model predicts a reduction in growth rate of 0.07%. Under this scenario, the predicted median impacted population size after 35-50 years would be approximately 97-98% of that which the model predicts would occur in the in the absence of any additional in-combination impact (Table 6.9.19). Appendix 4.5 presents full PVA results for the breeding guillemot feature of East Caithness Cliffs SPA.

6.9.4.39 The current population at the SPA is higher than the population at designation. If the predicted in-combination mortality were to occur across the lifetime of The Moray West Offshore Wind Farm the resulting end population is still likely to be higher than the population at designation.

Table 6.9.19: PVA Outputs for Guillemot at East Caithness Cliffs SPA Assuming a Mortality of 50 Birds					
Impact Scenario	**Years**	**% Change in Growth Rate**	**Ratio of Unimpacted to Impacted Growth Rate**	**Ratio of Unimpacted to Impacted Population Size**	**Centile for Impacted Population**
Unimpacted	-	-	-	1	0.50
Impacted	35	-0.07	0.999	0.98	0.42
	50			0.97	0.41

Conclusion

6.9.4.40 The in-combination displacement impact attributable to the East Caithness Cliffs guillemot population is not considered to result in an adverse effect on the integrity of the East Caithness Cliffs SPA. The changes to growth rates and to final population sizes as a result of the total in-combination impact predicted by PVA modelling are not considered to represent significant changes with the final population size of guillemot at the SPA unlikely to fall below the population originally designated at the SPA which is consistent with the maintain conservation objectives for this site. This conclusion is also considered to apply when seasonal displacement impacts are combined, noting that this may over-estimate the total displacement mortality.

6.9.4.41 On this basis, there is no indication that, at the level of mortality predicted to arise from the Moray West Offshore Wind Farm in-combination with other projects, that the population is likely to decline, over a period of 35 years, to an extent that would mean that the breeding guillemot population of the East Caithness Cliffs SPA would fall below the population originally designated.

Table 6.9.20: Predicted In-Combination Displacement Mortality for Guillemot from the East Caithness Cliffs SPA				
Project	**Mean-Peak Population in Breeding Season**	**Mean-Peak Population Apportioned to SPA in Breeding Season**	**Mean-Peak Population in Non-Breeding Season**	**Mean-Peak Population Apportioned to SPA in Non-Breeding Season**
Breeding and Non-Breeding Season				
Moray West	24,426	11,031	38,174	3,519
Moray East	9,820	9,151	1,245	115
Beatrice	13,610	12,466	2,755	254
Non-Breeding Season				
Seagreen A			0	0
Seagreen B			0	0
Inch Cape			3,177	293
Neart na Gaoithe			3,291	303
Aberdeen			225	21
Hywind			0	0
Kincardine			0	0
Blyth Demonstration			1,274	117
Dogger Bank Creyke Beck A			6,724	620
Dogger Bank Creyke Beck B			11,302	1042
Dogger Bank Teesside A			2,870	265
Dogger Bank Teesside D			1,525	141
Dudgeon			692	64
East Anglia ONE			713	66

Table 6.9.20: Predicted In-Combination Displacement Mortality for Guillemot from the East Caithness Cliffs SPA				
Project	**Mean-Peak Population in Breeding Season**	**Mean-Peak Population Apportioned to SPA in Breeding Season**	**Mean-Peak Population in Non-Breeding Season**	**Mean-Peak Population Apportioned to SPA in Non-Breeding Season**
East Anglia Three			1,405	130
Galloper			588	54
Greater Gabbard			698	64
Hornsea Project One			7,318	675
Hornsea Project Two			13,164	1214
Humber Gateway			158	15
Lincs and LID6			931	86
London Array I & II			492	45
Race Bank			925	85
Sheringham Shoal			822	76
Teesside			918	85
Thanet			137	13
Triton Knoll			843	78
Westermost Rough			556	51
Total		32,649		9,488

Table 6.9.21: Predicted Guillemot Mortality from East Caithness Cliffs SPA as a Result of Displacement from In-Combination Displacement Impacts During the Breeding Season													
Displaced (%)	**Mortality Rate (%)**												
	1	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	33	65	163	326	653	979	1306	1632	1959	2285	2612	2938	3265
20	65	131	326	653	1306	1959	2612	3265	3918	4571	5224	5877	6530
30	98	196	490	979	1959	2938	3918	4897	5877	6856	7836	8815	9795
40	131	261	653	1306	2612	3918	5224	6530	7836	9142	10448	11754	13060
50	163	326	816	1632	3265	4897	6530	8162	9795	11427	13060	14692	16325
60	196	392	979	1959	3918	5877	7836	9795	11754	13713	15672	17630	19589
70	229	457	1143	2285	4571	6856	9142	11427	13713	15998	18283	20569	22854
80	261	522	1306	2612	5224	7836	10448	13060	15672	18283	20895	23507	26119
90	294	588	1469	2938	5877	8815	11754	14692	17630	20569	23507	26446	29384
100	326	653	1632	3265	6530	9795	13060	16325	19589	22854	26119	29384	32649
	< 1% background mortality				> 1% background mortality/< 1% SPA population						> 1% SPA population		

Table 6.9.22: Predicted Guillemot Mortality from East Caithness Cliffs SPA as a Result of Displacement from In-Combination Displacement Impacts During the Non-Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	9	19	47	95	190	285	380	474	569	664	759	854	949
20	19	38	95	190	380	569	759	949	1139	1328	1518	1708	1898
30	28	57	142	285	569	854	1139	1423	1708	1993	2277	2562	2846
40	38	76	190	380	759	1139	1518	1898	2277	2657	3036	3416	3795
50	47	95	237	474	949	1423	1898	2372	2846	3321	3795	4270	4744
60	57	114	285	569	1139	1708	2277	2846	3416	3985	4554	5124	5693
70	66	133	332	664	1328	1993	2657	3321	3985	4649	5313	5978	6642
80	76	152	380	759	1518	2277	3036	3795	4554	5313	6073	6832	7591
90	85	171	427	854	1708	2562	3416	4270	5124	5978	6832	7686	8539
100	95	190	474	949	1898	2846	3795	4744	5693	6642	7591	8539	9488

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

Razorbill

Overview

6.9.4.42 In the breeding season it has been assumed that the Moray West Offshore Wind Farm may act in-combination with both the Moray East and Beatrice offshore wind farms based on the foraging range of razorbill from the SPA. In the non-breeding seasons, Moray West is assumed to act in-combination with all wind farms located in the post-, non- and pre-breeding BDMPS for razorbill as described by Furness (2015).

6.9.4.43 The apportioning approach used for the Moray West Offshore Wind Farm in the breeding season is consistent with that applied in the Development alone assessment and Appendix 4.2: Phenology and Apportioning. For Moray East and Beatrice, apportioning values for the breeding season have been obtained from project-specific documentation. For Moray East, a value of 98.1% has been used with this obtained from information submitted as part of post-application consultation. For Beatrice a value of 98.0% has been used with this obtained from the Beatrice Ornithological HRA Technical Report.

6.9.4.44 In the post-, non- and pre-breeding seasons, the approach applied for the Moray West Offshore Wind Farm has been applied for all projects (i.e. using the contribution of the SPA population to the wider regional BDMPS population).

Displacement

6.9.4.45 The predicted displacement of razorbill from other wind farm projects in-combination with the Moray West Offshore Wind Farm is summarised for the breeding post-, non- and pre-breeding seasons in Table 6.9.24.

Breeding season

6.9.4.46 During the breeding season in-combination displacement potentially affects 4,583 birds (Table 6.9.24), which leads to mortality of 18-28 birds (assuming displacement of 40-60% and mortality of 1%). The predicted mortality comprises 0.09-0.13% of the SPA breeding population (21,172 breeding individuals) and an increase in baseline mortality (2,223 individuals) of 0.82-1.24%.

6.9.4.47 East Caithness Cliffs SPA was designated based on the razorbill population estimated in 1985-88 (15,800 individuals). This population had increased to 17,830 individuals in 1999 with the most recent population estimated at 30,042 individuals in 2015.

6.9.4.48 If additional mortality of 50 birds per annum is assumed for PVA modelling (the closest modelled output to the predicted in-combination total) then the model predicts a reduction in growth rate of 0.31%. Under this scenario, the predicted median impacted population size after 35-50 years would be approximately 86-90% of that which the model predicts would occur in the in the absence of any additional in-combination impact (Table 6.9.23). Appendix 4.5 presents full PVA results for the breeding razorbill feature of East Caithness Cliffs SPA.

6.9.4.49 The SPA population has exhibited a positive growth rate in recent years, with the current SPA population nearly double the designated population, suggesting that the colony may have the potential for continued growth.

Table 6.9.23: PVA Outputs for Razorbill at East Caithness Cliffs SPA Assuming a Mortality of 50 Birds

Impact Scenario	Years	% Change in Growth Rate	Ratio of Unimpacted to Impacted Growth Rate	Ratio of Unimpacted to Impacted Population Size	Centile for Impacted Population
Unimpacted	-	-	-	1	0.50
Impacted	35	-0.31	0.997	0.90	0.41

Table 6.9.23: PVA Outputs for Razorbill at East Caithness Cliffs SPA Assuming a Mortality of 50 Birds					
Impact Scenario	**Years**	**% Change in Growth Rate**	**Ratio of Unimpacted to Impacted Growth Rate**	**Ratio of Unimpacted to Impacted Population Size**	**Centile for Impacted Population**
	50			0.86	0.38

Post-breeding season

6.9.4.50 During the post-breeding season in-combination displacement potentially affects 1,463 birds (Table 6.9.24), which leads to mortality of 6-9 birds (assuming displacement of 40-60% and mortality of 1%) (Table 6.9.26). The predicted mortality comprises 0.03-0.04% of the SPA breeding population (21,172 breeding individuals) and an increase in baseline mortality (2,223 individuals) of 0.26-0.39%.

Non-breeding season

6.9.4.51 During the non-breeding season in-combination displacement potentially affects 493 birds (Table 6.9.24), which leads to mortality of 2-3 birds (assuming displacement of 40-60% and mortality of 1%) Table 6.9.27). The predicted mortality comprises 0.01% of the SPA breeding population (21,172 breeding individuals) and an increase in baseline mortality (2,223 individuals) of 0.09-0.13%.

6.9.4.52 The Moray West Offshore Wind Farm contributes only 1.3% of the total in-combination impact with the majority contributed by projects located in the Dogger Bank Zone. It is therefore considered that the Moray West Offshore Wind Farm does not materially alter the current level of in-combination mortality predicted in the non-breeding season.

Pre-breeding season

6.9.4.53 During the pre-breeding season in-combination displacement potentially affects 1,072 birds (Table 6.9.24), which leads to mortality of 4-6 birds (assuming displacement of 40-60% and mortality of 1%) (Table 6.9.28). The predicted mortality comprises 0.02-0.03% of the SPA breeding population (21,172 breeding individuals) and an increase in baseline mortality (2,223 individuals) of 0.19-0.29%.

Conclusion

6.9.4.54 The in-combination displacement impact attributable to the East Caithness Cliffs razorbill population is not considered to result in an adverse effect on the integrity of the East Caithness Cliffs SPA. The changes to growth rates and to final population sizes as a result of the total in-combination impact predicted by PVA modelling are not considered to represent significant changes with the final population size of guillemot at the SPA unlikely to fall below the population originally designated at the SPA. In addition, the population at the SPA has exhibited a positive growth rate since designation, with the SPA currently supporting double the number of razorbill than estimated at designation. This conclusion is also considered to apply when seasonal displacement impacts are combined, noting that this may over-estimate the total displacement mortality.

Table 6.9.24: Predicted In-Combination Displacement Mortality for Razorbill from the East Caithness Cliffs SPA								
Project	**Mean-Peak Populations**				**Mean-Peak Populations Apportioned to SPA**			
	Breeding	**Post-Breeding**	**Non-Breeding**	**Pre-Breeding**	**Breeding**	**Post-Breeding**	**Non-Breeding**	**Pre-Breeding**
Breeding and Non-Breeding Season								
Moray West	2,808	3,544	184	3,585	1,351	150	6	151
Moray East	2,423	1,103	30	168	2,377	47	1	7
Beatrice	873	833	555	833	855	35	19	35
Non-Breeding Season								
Seagreen A		0	0	0		0	0	0
Seagreen B		0	0	0		0	0	0
Inch Cape		2,870	651	0		121	22	0
Neart na Gaoithe		5,492	508	0		232	17	0
Aberdeen		64	7	26		3	0	1
Hywind		0	0	0		0	0	0
Kincardine		0	0	0		0	0	0
Blyth Demonstration		61	61	91		3	2	4
Dogger Bank Creyke Beck A		2,090	1,728	4,149		88	59	175
Dogger Bank Creyke Beck B		2,729	2,143	5,119		115	74	216
Dogger Bank Teesside A		449	959	1,919		19	33	81

Table 6.9.24: Predicted In-Combination Displacement Mortality for Razorbill from the East Caithness Cliffs SPA								
Project	**Mean-Peak Populations**				**Mean-Peak Populations Apportioned to SPA**			
	Breeding	**Post-Breeding**	**Non-Breeding**	**Pre-Breeding**	**Breeding**	**Post-Breeding**	**Non-Breeding**	**Pre-Breeding**
Dogger Bank Teesside B		832	1,426	2,953		35	49	125
Dudgeon		341	745	346		14	26	15
East Anglia ONE		39	155	336		2	5	14
East Anglia Three		820	1,206	1,547		35	41	65
Galloper		65	106	394		3	4	17
Greater Gabbard		0	387	84		0	13	4
Hornsea Project One		7,132	1,518	1,803		301	52	76
Hornsea Project Two		4,221	720	1,668		178	25	70
Humber Gateway		13	13	20		1	0	1
Lincs and LID6		22	22	34		1	1	1
London Array I & II		3	3	8		0	0	0
Race Bank		7	7	16		0	0	1
Sheringham Shoal		1,343	211	30		57	7	1
Teesside		57	2	20		2	0	1
Thanet		0	14	21		0	0	1
Triton Knoll		380	855	117		16	29	5
Westermost Rough		121	152	91		5	5	4
Total					4,583	1,463	493	1,072

Table 6.9.25: Predicted Razorbill Mortality from East Caithness Cliffs SPA as a Result of Displacement from In-Combination Displacement Impacts During the Breeding Season													
Displaced (%)	**Mortality Rate (%)**												
	1	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	5	9	23	46	92	138	183	229	275	321	367	413	458
20	9	18	46	92	183	275	367	458	550	642	733	825	917
30	14	28	69	138	275	413	550	688	825	963	1100	1238	1375
40	18	37	92	183	367	550	733	917	1100	1283	1467	1650	1833
50	23	46	115	229	458	688	917	1146	1375	1604	1833	2063	2292
60	28	55	138	275	550	825	1100	1375	1650	1925	2200	2475	2750
70	32	64	160	321	642	963	1283	1604	1925	2246	2567	2888	3208
80	37	73	183	367	733	1100	1467	1833	2200	2567	2933	3300	3667
90	41	83	206	413	825	1238	1650	2063	2475	2888	3300	3713	4125
100	46	92	229	458	917	1375	1833	2292	2750	3208	3667	4125	4583
	< 1% background mortality				> 1% background mortality/< 1% SPA population						> 1% SPA population		

Table 6.9.26: Predicted Razorbill Mortality from East Caithness Cliffs SPA as a Result of Displacement from In-Combination Displacement Impacts During the Post-Breeding Season

Displaced (%)	Mortality rate (%)												
	1	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	1	3	7	15	29	44	59	73	88	102	117	132	146
20	3	6	15	29	59	88	117	146	176	205	234	263	293
30	4	9	22	44	88	132	176	219	263	307	351	395	439
40	6	12	29	59	117	176	234	293	351	410	468	527	585
50	7	15	37	73	146	219	293	366	439	512	585	658	731
60	9	18	44	88	176	263	351	439	527	614	702	790	878
70	10	20	51	102	205	307	410	512	614	717	819	922	1024
80	12	23	59	117	234	351	468	585	702	819	936	1053	1170
90	13	26	66	132	263	395	527	658	790	922	1053	1185	1316
100	15	29	73	146	293	439	585	731	878	1024	1170	1316	1463

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

Table 6.9.27: Predicted Razorbill Mortality from East Caithness Cliffs SPA as a Result of Displacement from In-Combination Displacement Impacts During the Non-Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	0	1	2	5	10	15	20	25	30	34	39	44	49
20	1	2	5	10	20	30	39	49	59	69	79	89	99
30	1	3	7	15	30	44	59	74	89	103	118	133	148
40	2	4	10	20	39	59	79	99	118	138	158	177	197
50	2	5	12	25	49	74	99	123	148	172	197	222	246
60	3	6	15	30	59	89	118	148	177	207	237	266	296
70	3	7	17	34	69	103	138	172	207	241	276	310	345
80	4	8	20	39	79	118	158	197	237	276	315	355	394
90	4	9	22	44	89	133	177	222	266	310	355	399	444
100	5	10	25	49	99	148	197	246	296	345	394	444	493

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

Table 6.9.28: Predicted Razorbill Mortality from East Caithness Cliffs SPA as a Result of Displacement from In-Combination Displacement Impacts During the Pre-Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	1	2	5	11	21	32	43	54	64	75	86	96	107
20	2	4	11	21	43	64	86	107	129	150	171	193	214
30	3	6	16	32	64	96	129	161	193	225	257	289	322
40	4	9	21	43	86	129	171	214	257	300	343	386	429
50	5	11	27	54	107	161	214	268	322	375	429	482	536
60	6	13	32	64	129	193	257	322	386	450	514	579	643
70	8	15	38	75	150	225	300	375	450	525	600	675	750
80	9	17	43	86	171	257	343	429	514	600	686	772	857
90	10	19	48	96	193	289	386	482	579	675	772	868	965
100	11	21	54	107	214	322	429	536	643	750	857	965	1072

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

6.9.5 North Caithness Cliffs SPA

Kittiwake

Overview

6.9.5.1 In the breeding season it has been assumed that the Moray West Offshore Wind Farm may act in-combination with both the Moray East and Beatrice offshore wind farms based on the foraging range of kittiwake from the SPA. In the non-breeding seasons, Moray West is assumed to act in-combination with all wind farms located in the post- and pre-breeding BDMPS for kittiwake as described by Furness (2015).

6.9.5.2 The apportioning approach used for the Moray West Offshore Wind Farm in the breeding season is consistent with that applied in the Development alone assessment and Appendix 4.2: Phenology and Apportioning. For Moray East and Beatrice, apportioning values for the breeding season have been obtained from project-specific documentation. For Moray East, a value of 3.4% has been used with this obtained from information submitted as part of post-application consultation. For Beatrice a value of 3.3% has been used with this obtained from the Beatrice Ornithological HRA Technical Report.

6.9.5.3 In the post- and pre-breeding seasons, the approach applied for the Moray West Offshore Wind Farm (see paragraph 6.8.4.7) has been applied for all projects (i.e. using the contribution of the SPA population to the wider regional BDMPS population).

Displacement

6.9.5.4 Assessment of in-combination displacement impacts on kittiwake has concentrated on impacts from projects within foraging range of North Caithness Cliffs SPA during the breeding season. Impacts from these projects are likely to disproportionately impact kittiwake from the North Caithness Cliffs when compared to other impacts from other projects in the North Sea which are considered more likely to affect birds from other SPAs in close proximity to the respective project. For North Caithness Cliffs SPA, this therefore means that impacts from Moray West in-combination with Moray East and Beatrice are considered.

Breeding season

6.9.5.5 The predicted displacement mortality during the breeding season from each of the projects considered in-combination is presented in Table 6.9.29. During the breeding season in-combination displacement potentially affects 13,206 birds, which leads to a total mortality of 79 individuals (assuming displacement of 30% and mortality of 2%). From this total mortality, two birds are attributable to the kittiwake population at North Caithness Cliffs SPA. The predicted mortality comprises 0.01% of the SPA breeding population (26,200 breeding individuals) and an increase in baseline mortality (9,490 individuals) of 0.06%.

Table 6.9.29: Predicted In-Combination Displacement Mortality for Kittiwake from the North Caithness Cliffs SPA in the breeding season

Offshore Wind Farm	Mean-peak population	Displacement mortality (displacement rate = 30%, mortality rate = 2%)	Displacement mortality apportioned to North Caithness Cliffs SPA
Moray West	6,902	41	1
Moray East	4,082	24	1
Beatrice	2,222	13	0
Total	13,206	79	2

Non-breeding seasons

6.9.5.6 The predicted displacement mortality during the post- and pre-breeding seasons from each of the projects considered in-combination is presented in Table 6.9.30Table 6.9.10. No assessment in the non-breeding seasons was conducted for Beatrice offshore Wind Farm and population estimates, which would enable displacement mortality to be calculated, are not available. The total in-combination mortality therefore includes Moray West and Moray East only. In the post- and pre-breeding seasons in-combination displacement potentially affects 1,631 and 2.525 birds respectively. This leads to a total mortality of 10 and 15 birds in the post- and pre-breeding seasons (assuming displacement of 30% and mortality of 2%) with less than one bird attributable to the North Caithness Cliffs SPA kittiwake population in both seasons. The predicted mortality therefore comprises a negligible proportion of the SPA population (26,200 individuals) and a negligible increase in the baseline mortality (3,825 individuals) of that population.

Table 6.9.30: Predicted In-Combination Displacement Mortality for Kittiwake from the East Caithness Cliffs SPA in the non-breeding seasons

Offshore Wind Farm	Mean-peak population	Displacement mortality (displacement rate = 30%, mortality rate = 2%)	Displacement mortality apportioned to East Caithness Cliffs SPA
Post-breeding			
Moray West	1,470	9	0
Moray East	161	1	0
Beatrice	No assessment conducted		
Total	1,631	10	0
Pre-breeding			
Moray West	1,074	6	0
Moray East	1,451	9	0
Beatrice	No assessment conducted		
Total	2,525	15	0

Collision risk

6.9.5.7 Identification of projects that may act in-combination with the Moray West Offshore Wind Farm on the kittiwake feature of the North Caithness Cliffs SPA has followed the approach described in paragraph 6.9.4.9.

6.9.5.8 Table 6.9.32 presents collision risk estimates sourced for all projects considered in-combination across all biological seasons relevant for kittiwake. Collision risk estimates are presented based on the Basic model of Band (2012). Seasonal collision risk estimates are provided along with seasonal apportioning values and the resulting collision estimates apportioned to the SPA.

6.9.5.9 A total in-combination collision risk mortality of 49 kittiwake is apportioned to the SPA across a full annual cycle. This represents 0.19% of the SPA population (13,100 pairs) and a 1.28% increase in baseline mortality (3,825 individuals).

6.9.5.10 North Caithness Cliffs SPA was designated based on the kittiwake breeding population estimated in 1985-88 (13,100 pairs). This population had decreased to 10,147 pairs in 1999 with a further decrease into 2015 (3,267 pairs).

6.9.5.11 If additional mortality of 50 birds per annum is assumed for PVA modelling (the closest modelled output to the predicted in-combination total) then the model predicts a reduction in growth rate of 0.99%. Under this scenario, the predicted median impacted population size after 35-50 years would be approximately 62-71% of that which the model predicts would occur in the in the absence of any additional in-combination impact (Table 6.9.31). Appendix 4.5 presents full PVA results for the breeding kittiwake feature of North Caithness Cliffs SPA.

Table 6.9.31: PVA Outputs for Kittiwake at North Caithness Cliffs SPA Assuming a Mortality of 50 Birds

Impact Scenario	Years	% Change in Growth Rate	Ratio of Unimpacted to Impacted Growth Rate	Ratio of Unimpacted to Impacted Population Size	Centile for Impacted Population
Unimpacted	-	-	-	1	0.50
Impacted	35	-0.99	0.99	0.71	0.20
	50			0.62	0.15

Table 6.9.32: Predicted in-combination collision mortality for kittiwake from the North Caithness Cliffs SPA[12]					
Project	**Band Model**	**Annual unapportioned collision risk**	**Seasonal collision risk apportioned to SPA**		
			Breeding	**Post-Breeding**	**Pre-Breeding**
Breeding and Non-Breeding Season					
Moray West	Band (2012)	109	2	0	0
Moray East	Band (2012)	86	2	0	0
Beatrice	Band (2012)	45	1	0	0
Non-Breeding Season					
Aberdeen European Offshore Wind Deployment Centre	Band (2012)	19		0	0
Blyth Demonstration Project	Band (2011)	5		0	0
Dogger Bank Creyke Beck Projects A and B	Band (2012)	719		2	6
Dogger Bank Teesside Projects A and B	Band (2012)	445		1	4
Dudgeon	Band (2000)	0		0	0
East Anglia One	Band (2012)	581		6	3
East Anglia Three	Band (2012)	106		1	1
Galloper	Band *et al*. (2007)	66		0	1
Greater Gabbard	Band (2000)	28		0	0
Hornsea Project One	Band (2012)	123		1	0
Hornsea Project Two	Band (2012)	27		0	0
Humber Gateway	Not available	7		0	0

[12] [12] The collision risk estimates presented in this table have not been corrected for either differences between assessed and as-built turbine scenarios or updated nocturnal activity factors

Hywind	Band (2012)	18		0	0
Inch Cape	Band (2012)	301		3	1
Kentish Flats Extension	Band (2012)	3		0	0
Kincardine	Band (2012)	19		0	0
Lincs	Band (2000)	3		0	0
London Array	Band (2000)	6		0	0
Methil	Band (2011/12)	1		0	0
Neart na Gaoithe	Band (2012)	93		1	1
Race Bank	Band (2000)	31		0	0
Seagreen Alpha	Band (2012)	371		2	2
Seagreen Bravo	Band (2012)	343		2	2
Teesside	Band (2000)	81		0	0
Thanet	Band (2000)	0		0	0
Triton Knoll	Band (2000)	209		1	1
Westermost Rough	Band *et al*. (2007)	0		0	0
Total			6	21	22

Consideration of precaution within the assessment

6.9.5.12 When applying the turbine scenario correction factors calculated by MacArthur Green (2017) (Table 6.9.4), the total in-combination collision risk estimate apportioned to North Caithness Cliffs SPA reduces to a limited extent (similar to that reported for East Caithness Cliffs SPA) (see Table 6.9.15). However, considerable reductions in the number of collisions will occur at the East Anglia One offshore wind farm (which contributes over 17% of the in-combination collision risk total), which has committed to reductions in both the total capacity of the wind farm and the number of turbines and the Moray East offshore wind farm (which contributes over 5% of the total in-combination collision risk) and projects in the Firth of Forth and Tay (which contribute over 26% of the total in-combination collision risk) which are expected to install a fewer, larger capacity turbines which will likely lead to reductions in the predicted collisions for these projects. Reductions in collision risk are also likely to occur at many other projects at which construction has yet to commence (see paragraph 6.9.2.29) with this likely to have a significant effect on the in-combination total predicted for herring gull at East Caithness Cliffs SPA.

6.9.5.13 Applying the nocturnal activity correction factors presented in Table 6.9.5 the collision risk estimates presented in Table 6.9.32 have been corrected to account for the over-estimation of nocturnal flight activity (Table 6.9.33). When applying the 'minimum' correction factor the number of overall season collisions reduces by 7.3%. It should be noted that this is the minimum by which collision risk estimates would reduce as a result of a change in the nocturnal activity factor used for kittiwake and that a realistic change would be higher and potentially closer to the collision risk estimates presented in Table 6.9.33 when applying the 'total' correction factor.

Table 6.9.33: Correction to Collision Risk Estimates for Kittiwake to Take Account of the Over-Estimation of Nocturnal Flight Activity

Season	Uncorrected Collision Risk Estimate	Corrected Collision Risk Estimate		Percentage Change	
		Minimum	Total	Minimum	Total
Post-breeding	21	19	18	8.3	15.9
Pre-breeding	22	21	19	8.2	15.8
Total	49	45	42	7.3	14.0

Conclusion

6.9.5.14 The kittiwake colony at North Caithness Cliffs SPA is relatively small and declining and therefore any mortality apportioned to it has the potential to have comparatively larger impacts as indicted by PVA results. The level of predicted in combination collisions apportioned to the SPA are however small, with Moray West Offshore Wind Farm contributing a negligible proportion (just 2 birds per annum). This may be argued to be an imperceptible level of effect or when considered amongst the levels of uncertainty and precaution discussed in this HRA Report, to have the potential to be effectively zero.

6.9.5.15 On this basis, the in-combination displacement and collision impact attributable to the North Caithness Cliffs kittiwake population is not considered to result in an adverse effect on the integrity of the North Caithness Cliffs SPA.

Guillemot

Overview

6.9.5.16 In the breeding season it has been assumed that the Moray West Offshore Wind Farm may act in-combination with both the Moray East and Beatrice offshore wind farms based on the foraging range of guillemot from the SPA. In the non-breeding season, Moray West is assumed to act in-combination with all wind farms located in the non-breeding BDMPS for guillemot as described by Furness (2015).

6.9.5.17 The apportioning approach used for the Moray West Offshore Wind Farm in the breeding season is consistent with that applied in the Development alone assessment and Appendix 4.2: Phenology and Apportioning. For Moray East and Beatrice, apportioning values for the breeding season have been obtained from project-specific documentation. For Moray East, a value of 5.8% has been used with this obtained from information submitted as part of post-application consultation. For Beatrice a value of 5.7% has been used with this obtained from the Beatrice Ornithological HRA Technical Report.

6.9.5.18 In the non-breeding season, the approach applied for the Moray West Offshore Wind Farm has been applied for all projects (i.e. using the contribution of the SPA population to the wider regional BDMPS population).

Displacement

6.9.5.19 The predicted displacement of guillemot from other wind farm projects in-combination with the Moray West Offshore Wind Farm is summarised for the breeding and non-breeding seasons in Table 6.9.35.

Breeding season

6.9.5.20 During the breeding season in-combination displacement potentially affects 2,034 birds (Table 6.9.356.30), which leads to mortality of 10-12 individuals (assuming displacement of 50-60% and mortality of 1%) (Table 6.9.36). The predicted mortality comprises 0.02% of the SPA breeding population (51,322 breeding individuals) and an increase in baseline mortality (3,131 individuals) of 0.32-0.39%.

Non-breeding season

6.9.5.21 During the non-breeding season in-combination displacement potentially affects 4,187 birds (Table 6.9.35), which leads to mortality of 21-25 individuals (assuming displacement of 50-60% and mortality of 1%) (Table 6.9.37). The predicted mortality comprises 0.04-0.05% of the SPA breeding population (51,322 breeding individuals) and an increase in baseline mortality (3,131 individuals) of 0.67-0.80%.

6.9.5.22 If additional mortality of 50 birds per annum is assumed for PVA modelling (the closest modelled output to the predicted in-combination total) then the model predicts a reduction in growth rate of 0.26%. Under this scenario, the predicted median impacted population size after 35-50 years would be approximately 88-91% of that which the model predicts would occur in the in the absence of any additional in-combination impact (Table 6.9.34). Appendix 4.5 provides full details of PVA of the guillemot feature of North Caithness Cliffs SPA.

6.9.5.23 North Caithness Cliffs SPA was designated based on the guillemot population estimated in 1985-88 (38,300 individuals). This population had increased to 70,154 individuals in 1999 but has subsequently decreased to 38,863 individuals (2015).

Table 6.9.34: PVA Outputs for Guillemot at North Caithness Cliffs SPA Assuming a Mortality of 50 Birds					
Impact Scenario	**Years**	**% Change in Growth Rate**	**Ratio of Unimpacted to Impacted Growth Rate**	**Ratio of Unimpacted to Impacted Population Size**	**Centile for Impacted Population**
Unimpacted	-	-	-	1	0.50
Impacted	35	0.26	0.997	0.91	0.25
	50			0.88	0.21

Conclusion

6.9.5.24 The in-combination displacement impact attributable to the North Caithness Cliffs guillemot population is not considered to result in an adverse effect on the integrity of the East Caithness Cliffs SPA. The changes to growth rates and to final population sizes as a result of the total in-combination impact predicted by PVA modelling are not considered to represent significant changes with the final population size of guillemot at the SPA. Between 1985-88 and 1999 the SPA population showed a considerable increase. However, by 2015 the population had returned to that estimated when the SPA was originally designated. It is therefore unclear as to the current population trend at the SPA, although it is considered likely that the SPA population is either currently stable or potentially decreasing. If the population is currently stable then it is considered unlikely that the predicted level of in-combination mortality will result in the population reducing to a level that would affect the integrity of the SPA. If the population is currently decreasing then the predicted level of in-combination mortality is unlikely to significantly alter the current level of decrease with PVA outputs suggesting limited reductions in both growth rate and final population size.

6.9.5.25 These conclusions are also considered to apply when seasonal displacement impacts are combined, noting that this may over-estimate the total displacement mortality.

6.9.5.26 On this basis, there is no indication that, at the level of mortality predicted to arise from the Moray West Offshore Wind Farm in-combination with other projects, that the population is likely to decline, over a period of 35 years, to an extent that would mean that the breeding guillemot population of the North Caithness Cliffs SPA would fall below the population originally designated.

Table 6.9.35: Predicted In-Combination Displacement Mortality for Guillemot from the North Caithness Cliffs SPA				
Project	**Mean-Peak Population in Breeding Season**	**Mean-Peak Population Apportioned to SPA in Breeding Season**	**Mean-Peak Population in Non-Breeding Season**	**Mean-Peak Population Apportioned to SPA in Non-Breeding Season**
Breeding and Non-Breeding Season				
Moray West	24,426	691	38,174	1,553
Moray East	9,820	568	1,245	51
Beatrice	13,610	776	2,755	112
Non-Breeding Season				
Aberdeen			225	9
Blyth Demonstration			1,274	52
Dogger Bank Creyke Beck A			6,724	274
Dogger Bank Creyke Beck B			11,302	460
Dogger Bank Teesside A			2,870	117
Dogger Bank Teesside D			1,525	62
Dudgeon			692	28
East Anglia ONE			713	29
East Anglia Three			1,405	57
Galloper			588	24
Greater Gabbard			698	28
Hornsea Project One			7,318	298
Hornsea Project Two			13,164	536
Humber Gateway			158	6

Table 6.9.35: Predicted In-Combination Displacement Mortality for Guillemot from the North Caithness Cliffs SPA				
Project	**Mean-Peak Population in Breeding Season**	**Mean-Peak Population Apportioned to SPA in Breeding Season**	**Mean-Peak Population in Non-Breeding Season**	**Mean-Peak Population Apportioned to SPA in Non-Breeding Season**
Hywind			0	0
Inch Cape			3,177	129
Kincardine			0	0
Lincs and LID6			931	38
London Array I & II			492	20
Neart na Gaoithe			3,291	134
Race Bank			925	38
Seagreen A			0	0
Seagreen B			0	0
Sheringham Shoal			822	33
Teesside			918	37
Thanet			137	6
Triton Knoll			843	34
Westermost Rough			556	23
Total		2,034		4,187

Table 6.9.36: Predicted Guillemot Mortality from North Caithness Coast SPA as a Result of Displacement from In-Combination Displacement Impacts During the Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	2	4	10	20	41	61	81	102	122	142	163	183	203
20	4	8	20	41	81	122	163	203	244	285	325	366	407
30	6	12	31	61	122	183	244	305	366	427	488	549	610
40	8	16	41	81	163	244	325	407	488	570	651	732	814
50	10	20	51	102	203	305	407	509	610	712	814	915	1017
60	12	24	61	122	244	366	488	610	732	854	976	1098	1221
70	14	28	71	142	285	427	570	712	854	997	1139	1282	1424
80	16	33	81	163	325	488	651	814	976	1139	1302	1465	1627
90	18	37	92	183	366	549	732	915	1098	1282	1465	1648	1831
100	20	41	102	203	407	610	814	1017	1221	1424	1627	1831	2034

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

Table 6.9.37: Predicted Guillemot Mortality from North Caithness Coast SPA as a Result of Displacement from In-Combination Displacement Impacts During the Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	4	8	21	42	84	126	167	209	251	293	335	377	419
20	8	17	42	84	167	251	335	419	502	586	670	754	837
30	13	25	63	126	251	377	502	628	754	879	1005	1131	1256
40	17	33	84	167	335	502	670	837	1005	1172	1340	1507	1675
50	21	42	105	209	419	628	837	1047	1256	1466	1675	1884	2094
60	25	50	126	251	502	754	1005	1256	1507	1759	2010	2261	2512
70	29	59	147	293	586	879	1172	1466	1759	2052	2345	2638	2931
80	33	67	167	335	670	1005	1340	1675	2010	2345	2680	3015	3350
90	38	75	188	377	754	1131	1507	1884	2261	2638	3015	3392	3769
100	42	84	209	419	837	1256	1675	2094	2512	2931	3350	3769	4187

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

Razorbill

Overview

6.9.5.27 In the breeding season it has been assumed that the Moray West Offshore Wind Farm may act in-combination with both the Moray East and Beatrice offshore wind farms based on the foraging range of razorbill from the SPA. In the non-breeding seasons, Moray West is assumed to act in-combination with all wind farms located in the post-, non- and pre-breeding BDMPS for razorbill as described by Furness (2015).

6.9.5.28 The apportioning approach used for the Moray West Offshore Wind Farm in the breeding season is consistent with that applied in the Development alone assessment as described in Appendix 4.2: Phenology and Apportioning. For Moray East and Beatrice, apportioning values for the breeding season have been obtained from project-specific documentation. For Moray East, a value of 1.9% has been used with this obtained from information submitted as part of post-application consultation. For Beatrice a value of 2.0% has been used with this obtained from the Beatrice Ornithological HRA Technical Report.

6.9.5.29 In the post-, non- and pre-breeding seasons, the approach applied for the Moray West Offshore Wind Farm) has been applied for all projects (i.e. using the contribution of the SPA population to the wider regional BDMPS population).

Displacement

6.9.5.30 The predicted displacement of razorbill from other wind farm projects in-combination with Moray West is summarised for the breeding post-, non- and pre-breeding seasons in Table 6.9.38.

Breeding season

6.9.5.31 During the breeding season in-combination displacement potentially affects 95 birds (Table 6.9.38), which leads to mortality of 0-1 birds (assuming displacement of 40-60% and mortality of 1%) (Table 6.9.39). The predicted mortality comprises 0.01% of the SPA breeding population (5,360 breeding individuals) and an increase in baseline mortality (563 individuals) of 0.07-0.10%. The in-combination impact in the breeding season therefore represents a negligible proportion of the SPA population and a negligible increase in baseline mortality.

Post-breeding season

6.9.5.32 During the post-breeding season in-combination displacement potentially affects 189 birds (Table 6.9.38), which leads to mortality of one bird (assuming displacement of 40-60% and mortality of 1%) (Table 6.9.40). The predicted mortality comprises 0.01-0.02% of the SPA breeding population (5,360 breeding individuals) and an increase in baseline mortality (563 individuals) of 0.13-0.20%. The in-combination impact in the post-breeding season therefore represents a negligible proportion of the SPA population and a negligible increase in baseline mortality.

Non-breeding season

6.9.5.33 During the non-breeding season in-combination displacement potentially affects 67 birds (Table 6.9.38), which leads to mortality of less than one bird (assuming displacement of 40-60% and mortality of 1%) (Table 6.9.41). The predicted mortality therefore comprises a negligible proportion of the SPA breeding population (5,360 breeding individuals) and a negligible increase in baseline mortality (563 individuals).

6.9.5.34 Moray West contributes only 1.3% of the total in-combination impact with the majority contributed by projects located in the Dogger Bank Zone. It is therefore considered that Moray West does not materially alter the current level of in-combination mortality predicted in the non-breeding season.

Pre-breeding season

6.9.5.35 During the pre-breeding season in-combination displacement potentially affects 138 birds (Table 6.9.38), which leads to mortality of one bird (assuming displacement of 40-60% and mortality of 1%) (Table 6.9.42). The predicted mortality comprises 0.01-0.02% of the SPA breeding population (5,360 breeding individuals) and an increase in baseline mortality (563 individuals) of 0.10-0.15%. The in-combination impact in the pre-breeding season therefore represents a negligible proportion of the SPA population and a negligible increase in baseline mortality.

Conclusion

6.9.5.36 North Caithness Cliffs SPA was designated based on the razorbill population estimated in 1985-88 (4,000 individuals). This population had decreased to 2,466 individuals in 1999-2001 but has subsequently increased to 3,507 individuals (2015).

6.9.5.37 The predicted in-combination mortality of razorbill in all season represents a negligible proportion of the SPA population and a negligible increase in the baseline mortality of the population. Therefore it is considered that there is no adverse effect on the razorbill population of the North Caithness Cliffs SPA as a result of displacement impacts associated with Moray West.

Table 6.9.38: Predicted In-Combination Displacement Mortality for Razorbill from the North Caithness Cliffs SPA								
Project	**Mean-Peak Populations**				**Mean-Peak Populations Apportioned to SPA**			
	Breeding	**Post-Breeding**	**Non-Breeding**	**Pre-Breeding**	**Breeding**	**Post-Breeding**	**Non-Breeding**	**Pre-Breeding**
Breeding and Non-Breeding Season								
Moray West	2,808	3,544	184	3,585	31	19	1	20
Moray East	2,423	1,103	30	168	46	6	0	1
Beatrice	873	833	555	833	17	5	3	5
Non-Breeding Season								
Aberdeen		64	7	26		0	0	0
Blyth Demonstration		61	61	91		0	0	0
Dogger Bank Creyke Beck A		2,090	1,728	4,149		11	8	23
Dogger Bank Creyke Beck B		2,729	2,143	5,119		15	10	28
Dogger Bank Teesside A		449	959	1,919		2	4	10
Dogger Bank Teesside B		832	1,426	2,953		5	7	16
Dudgeon		341	745	346		2	3	2
East Anglia ONE		39	155	336		0	1	2
East Anglia Three		820	1,206	1,547		4	6	8
Galloper		65	106	394		0	0	2
Greater Gabbard		0	387	84		0	2	0
Hornsea Project One		7,132	1,518	1,803		39	7	10
Hornsea Project Two		4,221	720	1,668		23	3	9

Table 6.9.38: Predicted In-Combination Displacement Mortality for Razorbill from the North Caithness Cliffs SPA								
Project	**Mean-Peak Populations**				**Mean-Peak Populations Apportioned to SPA**			
	Breeding	**Post-Breeding**	**Non-Breeding**	**Pre-Breeding**	**Breeding**	**Post-Breeding**	**Non-Breeding**	**Pre-Breeding**
Humber Gateway		13	13	20		0	0	0
Hywind		0	0	0		0	0	0
Inch Cape		2,870	651	0		16	3	0
Kincardine		0	0	0		0	0	0
Lincs and LID6		22	22	34		0	0	0
London Array I & II		3	3	8		0	0	0
Neart na Gaoithe		5,492	508	0		30	2	0
Race Bank		7	7	16		0	0	0
Seagreen A		0	0	0		0	0	0
Seagreen B		0	0	0		0	0	0
Sheringham Shoal		1,343	211	30		7	1	0
Teesside		57	2	20		0	0	0
Thanet		0	14	21		0	0	0
Triton Knoll		380	855	117		2	4	1
Westermost Rough		121	152	91		1	1	0
Total					95	189	67	138

Table 6.9.39: Predicted Razorbill Mortality from North Caithness Cliffs SPA as a Result of Displacement from In-Combination Displacement Impacts During the Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	1	2	3	4	5	6	7	8	9	10
20	0	0	1	2	4	6	8	10	11	13	15	17	19
30	0	1	1	3	6	9	11	14	17	20	23	26	29
40	0	1	2	4	8	11	15	19	23	27	30	34	38
50	0	1	2	5	10	14	19	24	29	33	38	43	48
60	1	1	3	6	11	17	23	29	34	40	46	51	57
70	1	1	3	7	13	20	27	33	40	47	53	60	67
80	1	2	4	8	15	23	30	38	46	53	61	68	76
90	1	2	4	9	17	26	34	43	51	60	68	77	86
100	1	2	5	10	19	29	38	48	57	67	76	86	95

	< 1% background mortality		> 1% background mortality/< 1% SPA population		> 1% SPA population

Table 6.9.40: Predicted Razorbill Mortality from North Caithness Cliffs SPA as a Result of Displacement from In-Combination Displacement Impacts During the Post-Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	1	2	4	6	8	9	11	13	15	17	19
20	0	1	2	4	8	11	15	19	23	26	30	34	38
30	1	1	3	6	11	17	23	28	34	40	45	51	57
40	1	2	4	8	15	23	30	38	45	53	60	68	76
50	1	2	5	9	19	28	38	47	57	66	76	85	94
60	1	2	6	11	23	34	45	57	68	79	91	102	113
70	1	3	7	13	26	40	53	66	79	93	106	119	132
80	2	3	8	15	30	45	60	76	91	106	121	136	151
90	2	3	9	17	34	51	68	85	102	119	136	153	170
100	2	4	9	19	38	57	76	94	113	132	151	170	189

	< 1% background mortality		> 1% background mortality/< 1% SPA population		> 1% SPA population

Table 6.9.41: Predicted Razorbill Mortality from North Caithness Cliffs SPA as a Result of Displacement from In-Combination Displacement Impacts During the Non-Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	1	1	2	3	3	4	5	5	6	7
20	0	0	1	1	3	4	5	7	8	9	11	12	13
30	0	0	1	2	4	6	8	10	12	14	16	18	20
40	0	1	1	3	5	8	11	13	16	19	21	24	27
50	0	1	2	3	7	10	13	17	20	23	27	30	34
60	0	1	2	4	8	12	16	20	24	28	32	36	40
70	0	1	2	5	9	14	19	23	28	33	38	42	47
80	1	1	3	5	11	16	21	27	32	38	43	48	54
90	1	1	3	6	12	18	24	30	36	42	48	54	60
100	1	1	3	7	13	20	27	34	40	47	54	60	67

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

Table 6.9.42: Predicted Razorbill Mortality from North Caithness Cliffs SPA as a Result of Displacement From In-Combination Displacement Impacts During the Pre-Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	1	1	3	4	6	7	8	10	11	12	14
20	0	1	1	3	6	8	11	14	17	19	22	25	28
30	0	1	2	4	8	12	17	21	25	29	33	37	42
40	1	1	3	6	11	17	22	28	33	39	44	50	55
50	1	1	3	7	14	21	28	35	42	48	55	62	69
60	1	2	4	8	17	25	33	42	50	58	66	75	83
70	1	2	5	10	19	29	39	48	58	68	78	87	97
80	1	2	6	11	22	33	44	55	66	78	89	100	111
90	1	2	6	12	25	37	50	62	75	87	100	112	125
100	1	3	7	14	28	42	55	69	83	97	111	125	138

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

Puffin

Overview

6.9.5.38 In the breeding season it has been assumed that the Moray West Offshore Wind Farm may act in-combination with both the Moray East and Beatrice offshore wind farms based on the foraging range of puffin from the SPA.

6.9.5.39 The apportioning approach used for the Moray West Offshore Wind farm in the breeding season is consistent with that applied in the Development alone assessment as described in Appendix 4.2: Phenology and Apportioning. For Moray East and Beatrice, apportioning values for the breeding season have been obtained from project-specific documentation. For Moray East, a value of 77.5% has been used with this obtained from information submitted as part of post-application consultation. For Beatrice a value of 34.6% has been used with this obtained from the Beatrice Ornithological HRA Technical Report.

6.9.5.40 In the non-breeding season, the approach applied for the Moray West Offshore Wind Farm has been applied for all projects (i.e. using the contribution of the SPA population to the wider regional BDMPS population).

Displacement

6.9.5.41 The predicted displacement of puffin from other wind farm projects in-combination with the Moray West Offshore Wind Farm is summarised for the breeding and non-breeding seasons in Table 6.9.43.

Breeding season

6.9.5.42 During the breeding season in-combination displacement potentially affects 3,319 birds (Table 6.9.43), which leads to mortality of 33-40 individuals (assuming displacement of 50-60% and mortality of 2%) (Table 6.9.44). The predicted mortality comprises 0.95-1.14% of the SPA breeding population (3,500 breeding individuals) and an increase in baseline mortality (329 individuals) of 10.1-12.1%.

6.9.5.43 The Moray West Offshore Wind Farm contributes only 4.96% of the total in-combination impact with the majority (65%) contributed by Moray East. It is therefore considered that the Moray West Offshore Wind Farm does not materially alter the current level of in-combination mortality predicted in the breeding season.

Non-breeding season

6.9.5.44 During the non-breeding season in-combination displacement potentially affects 19 birds (Table 6.9.43), which leads to mortality of less than one bird (assuming displacement of 50-60% and mortality of 2%). The predicted mortality therefore comprises a negligible proportion of the SPA breeding population 3,500 breeding individuals) and a negligible increase in baseline mortality (329 individuals).

Conclusion

6.9.5.45 The Moray West Offshore Wind Farm is not considered to materially alter the current level of in-combination mortality, contributing only one bird to the overall in-combination total. The Moray West Offshore Wind Farm will therefore not alter the likelihood of an adverse effect on the SPA arising from the current level of in-combination mortality.

Table 6.9.43: Predicted In-Combination Displacement Mortality for Puffin from the North Caithness Cliffs SPA				
Project	**Mean-Peak Population in Breeding Season**	**Mean-Peak Population Apportioned to SPA in Breeding Season**	**Mean-Peak Population in non-Breeding Season**	**Mean-Peak Population Apportioned to SPA in Non-Breeding Season**
Breeding and Non-Breeding Season				
Moray West	1115	165	12	5
Moray East	2795	2165	174	0
Beatrice	2858	989	2435	3
Non-Breeding Season				
Aberdeen			44	0
Blyth Demonstration			64	0
Dogger Bank Creyke Beck A			292	0
Dogger Bank Creyke Beck B			733	1
Dogger Bank Teesside A			271	0
Dogger Bank Teesside D			0	0
Dudgeon			3	0
East Anglia ONE			32	0
East Anglia Three			74	0
Galloper			1	0
Greater Gabbard			1	0
Hornsea Project One			1257	2
Hornsea Project Two			2039	3
Humber Gateway			6	0

Table 6.9.43: Predicted In-Combination Displacement Mortality for Puffin from the North Caithness Cliffs SPA				
Project	**Mean-Peak Population in Breeding Season**	**Mean-Peak Population Apportioned to SPA in Breeding Season**	**Mean-Peak Population in non-Breeding Season**	**Mean-Peak Population Apportioned to SPA in Non-Breeding Season**
Hywind			0	0
Inch Cape			2688	3
Kincardine			0	0
Lincs and LID6			5	0
London Array I & II			1	0
Neart na Gaoithe			913	1
Race Bank			9	0
Seagreen A			0	0
Seagreen B			0	0
Sheringham Shoal			25	0
Teesside			9	0
Thanet			0	0
Triton Knoll			65	0
Westermost Rough			20	0
Total		3319		19

Table 6.9.44: Predicted Puffin Mortality from North Caithness Cliffs SPA as a Result of In-Combination Displacement Impacts During the Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	3	7	17	33	66	100	133	166	199	232	266	299	332
20	7	13	33	66	133	199	266	332	398	465	531	597	664
30	10	20	50	100	199	299	398	498	597	697	797	896	996
40	13	27	66	133	266	398	531	664	797	929	1062	1195	1328
50	17	33	83	166	332	498	664	830	996	1162	1328	1494	1660
60	20	40	100	199	398	597	797	996	1195	1394	1593	1792	1991
70	23	46	116	232	465	697	929	1162	1394	1626	1859	2091	2323
80	27	53	133	266	531	797	1062	1328	1593	1859	2124	2390	2655
90	30	60	149	299	597	896	1195	1494	1792	2091	2390	2688	2987
100	33	66	166	332	664	996	1328	1660	1991	2323	2655	2987	3319

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

6.9.6 Troup, Pennan and Lion's Heads SPA

Kittiwake

Overview

6.9.6.1 In the breeding season it has been assumed that Moray West may act in-combination with the Moray East, Beatrice, Kincardine and Hywind offshore wind farms based on the foraging range of kittiwake from the SPA. In the non-breeding seasons, Moray West is assumed to act in-combination with all wind farms located in the post- and pre-breeding BDMPS for kittiwake as described by Furness (2015).

6.9.6.2 The apportioning approach used for Moray West in the breeding season is consistent with that applied in the project alone assessment as described in Annex 4.2. For all projects, apportioning values for the breeding season have been obtained from project-specific documentation. For Moray East, a value of 3.4% has been used with this obtained from information submitted as part of post-application consultation. For Beatrice a value of 3.3% has been used with this obtained from the Beatrice Ornithological HRA Technical Report. The HRA for Hywind apportioned 56.3% of the total collision risk estimate to the breeding colony at Troup, Pennan and Lion's Head SPA while an apportioning value of 2.0% was applied at Kincardine.

6.9.6.3 In the post- and pre-breeding seasons, the approach applied for Moray West (see paragraph 6.8.4.7) has been applied for all projects (i.e. using the contribution of the SPA population to the wider regional BDMPS population).

Displacement

6.9.6.4 Assessment of in-combination displacement impacts on kittiwake has concentrated on impacts from projects within foraging range of Troup, Pennan and Lion's Heads SPA during the breeding season. Impacts from these projects are likely to disproportionately impact kittiwake from the Troup, Pennan and Lion's Heads SPA when compared to other impacts from other projects in the North Sea which are considered more likely to affect birds from other SPAs in close proximity to the respective project. For Troup, Pennan and Lion's Heads SPA, this therefore means that impacts from Moray West in-combination with Moray East, Beatrice, Hywind and Kincardine are considered.

Breeding season

6.9.6.5 The predicted displacement mortality during the breeding season from each of the projects considered in-combination is presented in Table 6.9.45. During the breeding season in-combination displacement potentially affects 13,622 birds, which leads to a total mortality of 82 individuals (assuming displacement of 30% and mortality of 2%). From this total mortality, four birds are attributable to the kittiwake population at Troup, Pennan and Lion's Heads SPA. The predicted mortality comprises 0.01% of the SPA breeding population (63,200 breeding individuals) and an increase in baseline mortality (9,227 individuals) of 0.04%.

Table 6.9.45: Predicted In-Combination Displacement Mortality for Kittiwake from the North Caithness Cliffs SPA in the breeding season

Offshore Wind Farm	Mean-peak population	Displacement mortality (displacement rate = 30%, mortality rate = 2%)	Displacement mortality apportioned to North Caithness Cliffs SPA
Moray West	6,902	41	1
Moray East	4,082	24	1
Beatrice	2,222	13	0
Hywind	187	1	1
Kincardine	229	1	0
Total	13,622	82	4

Non-breeding seasons

6.9.6.6 The predicted displacement mortality during the post- and pre-breeding seasons from each of the projects considered in-combination is presented in Table 6.9.30Table 6.9.10. No assessment in the non-breeding seasons was conducted for the Beatrice or Kincardine offshore wind farms and population estimates, which would enable displacement mortality to be calculated, are not available. Additionally, a combined non-breeding assessment was conducted for the Hywind offshore wind farm comprising a total population of six birds. If this population were subjected to displacement analysis and apportioning the resulting displacement mortality attributable to Troup, Pennan and Lion's Heads SPA would be less than one bird and therefore Hywind has been discounted from the in-combination assessment. The total in-combination mortality therefore includes Moray West and Moray East only.

6.9.6.7 In the post- and pre-breeding seasons in-combination displacement potentially affects 1,631 and 2.525 birds respectively. This leads to a total mortality of 10 and 15 birds in the post- and pre-breeding seasons (assuming displacement of 30% and mortality of 2%) with less than one bird attributable to the Troup, Pennan and Lion's Heads SPA kittiwake population in both seasons. The predicted mortality therefore comprises a negligible proportion of the SPA

population (63,200 individuals) and a negligible increase in the baseline mortality (9,227 individuals) of that population.

Table 6.9.46: Predicted In-Combination Displacement Mortality for Kittiwake from the East Caithness Cliffs SPA in the non-breeding seasons

Offshore Wind Farm	Mean-peak population	Displacement mortality (displacement rate = 30%, mortality rate = 2%)	Displacement mortality apportioned to East Caithness Cliffs SPA
Post-breeding			
Moray West	1,470	9	0
Moray East	161	1	0
Total	1,631	10	0
Pre-breeding			
Moray West	1,074	6	0
Moray East	1,451	9	0
Total	2,525	15	0

Collision risk

6.9.6.8 Identification of projects that may act in-combination with Moray West on the kittiwake feature of the Troup, Pennan and Lion's Heads SPA has followed the approach described in paragraph 6.9.4.9.

6.9.6.9 Table 6.9.47 presents collision risk estimates sourced for all projects considered in-combination across all biological seasons relevant for kittiwake. Collision risk estimates are presented based on the Basic model of Band (2012). Seasonal collision risk estimates are provided along with seasonal apportioning values and the resulting collision estimates apportioned to the SPA.

6.9.6.10 A total in-combination collision risk mortality of 79 kittiwake is apportioned to the SPA across a full annual cycle. This represents 0.13% of the SPA population (31,600 pairs) and a 0.86% increase in baseline mortality (9,227 individuals).

Table 6.9.47: Predicted In-Combination Collision Mortality for Kittiwake from the Troup, Pennan and Lion's Heads SPA[13]					
Project	**Band Model**	**Annual unapportioned collision mortality**	**Seasonal collision mortality apportioned to SPA**		
			Breeding	**Post-Breeding**	**Pre-Breeding**
Breeding and non-breeding season					
Moray West	Band (2012)	109	5	1	0
Moray East	Band (2012)	86	0	0	0
Beatrice	Band (2012)	45	1	0	0
Non-breeding season					
Aberdeen European Offshore Wind Deployment Centre	Band (2012)	19		0	0
Blyth Demonstration Project	Band (2011)	5		0	0
Dogger Bank Creyke Beck Projects A and B	Band (2012)	719		8	8
Dogger Bank Teesside Projects A and B	Band (2012)	445		6	6
Dudgeon	Band (2000)	0		0	0
East Anglia One	Band (2012)	581		9	4
East Anglia Three	Band (2012)	106		1	1
Galloper	Band *et al*. (2007)	66		1	1
Greater Gabbard	Band (2000)	28		0	0
Hornsea Project One	Band (2012)	123		1	1
Hornsea Project Two	Band (2012)	27		0	0
Humber Gateway	Not available	7		0	0

[13] [13] The collision risk estimates presented in this table have not been corrected for either differences between assessed and as-built turbine scenarios or updated nocturnal activity factors

Hywind	Band (2012)	18	9	0	0
Inch Cape	Band (2012)	301		2	2
Kentish Flats Extension	Band (2012)	3		0	0
Kincardine	Band (2012)	19	0	0	0
Lincs	Band (2000)	3		0	0
London Array	Band (2000)	6		0	0
Methil	Band (2011/12)	1		0	0
Neart na Gaoithe	Band (2012)	93		1	1
Race Bank	Band (2000)	31		0	0
Seagreen Alpha	Band (2012)	371		3	3
Seagreen Bravo	Band (2012)	343		2	2
Teesside	Band (2000)	81		0	0
Thanet	Band (2000)	0		0	0
Triton Knoll	Band (2000)	209		2	2
Westermost Rough	Band *et al*. (2007)	0		0	0
Total			16	31	33

Consideration of precaution within the assessment

6.9.6.11 When applying the turbine scenario correction factors calculated by MacArthur Green (2017) (Table 6.9.3), the total in-combination collision risk estimate reduces by a similar percentage to that calculated for the total in-combination collision risk for East Caithness Cliffs SPA (paragraph 6.9.4.14). This reduction however does not materially alter the number of collisions predicted to be attributable to the Troup, Pennan and Lion's Heads SPA. However, in addition to the reductions in collision risk for the projects included in Table 6.9.47 considerable reductions in the number of collisions will occur at the East Anglia One offshore wind farm which contributes nearly 16% of the total in-combination collision risk), which has committed to reductions in both the total capacity of the wind farm and the number of turbines, and projects in the Firth of Forth and Tay (which contribute over 24% of the total in-combination collision risk) which are expected to install a fewer, larger capacity turbines which will likely lead to reductions in the predicted collisions for these projects. Reductions in collision risk are also likely to occur at many other projects at which construction has yet to commence (see paragraph 6.9.2.29), with this likely to have a significant effect on the in-combination total predicted for herring gull at East Caithness Cliffs SPA.

6.9.6.12 Applying the nocturnal activity correction factors presented in Table 6.9.5 the collision risk estimates presented in Table 6.9.47 have been corrected to account for the over-estimation of nocturnal flight activity (Table 6.9.48). When applying the 'minimum' correction factor the number of breeding season collisions reduces by 19.9%. It should be noted that this is the minimum by which collision risk estimates would reduce as a result of a change in the nocturnal activity factor used for kittiwake and that a realistic change would be higher and potentially closer to the collision risk estimates presented in Table 6.9.48 when applying the 'total' correction factor.

Table 6.9.48: Correction to Collision Risk Estimates for Kittiwake to Take Account of the Over-Estimation of Nocturnal Flight Activity

Season	Uncorrected Collision Risk Estimate	Corrected Collision Risk Estimate		Percentage Change	
		Minimum	Total	Minimum	Total
Post-breeding	31	28	26	8.3	15.9
Pre-breeding	33	30	28	8.2	15.8
Total	79	74	69	6.6	12.8

Conclusion

6.9.6.13 Troup, Pennan and Lion's Heads SPA was designated based on the kittiwake breeding population estimated in 1995 (31,600 pairs). This population decreased to 7,180 pairs in 2015 but has since shown signs of a slight recovery with 10,503 pairs estimated in 2017.

6.9.6.14 The level of in-combination displacement and collision mortality is not considered to represent an impact that would result in an impact that would adversely affect the integrity of the kittiwake feature of Troup, Pennan and Lion's Heads SPA.

Herring gull

Overview

6.9.6.15 In the breeding season it has been assumed that the Moray West Offshore Wind Farm may act in-combination with the Moray East, Beatrice, Kincardine and Hywind offshore wind farms based on the foraging range of herring gull from the SPA. In the non-breeding season, Moray West is assumed to act in-combination with all wind farms located in the non-breeding BDMPS fir herring gull as described by Furness (2015).

6.9.6.16 The apportioning approach used for the Moray West Offshore Wind Farm in the breeding season is consistent with that applied in the Development alone assessment as described in paragraphs 6.8.3.6 to 6.8.3.9 and Appendix 4.2: Phenology and Apportioning.

6.9.6.17 For other projects, information on the apportioning approach applied has been obtained from project-specific documentation. The apportioning approaches applied at Moray East, Beatrice and Kincardine did not attribute any impacts predicted in the breeding season to breeding birds from Troup, Pennan and Lion's Heads SPA, with this approach followed in this assessment. For Hywind, an apportioning value of 73% has been used with this obtained from the Hywind HRA.

6.9.6.18 In the non-breeding season, the approach applied for the Moray West Offshore Wind Farm (see paragraph 6.8.3.9) has been applied for all projects.

Collision risk

6.9.6.19 Identification of projects that may act in-combination with the Moray West Offshore Wind Farm on the herring gull feature of the Troup, Pennan and Lion's Heads SPA has followed the approach described in paragraph 6.9.3.6.

6.9.6.20 Table 6.9.49 presents collision risk estimates sourced for all projects considered in-combination across all biological seasons relevant for herring gull. Collision risk estimates are presented based on the Basic model of Band (2012). Seasonal collision risk estimates are provided along with seasonal apportioning values and the resulting collision estimates apportioned to the SPA.

6.9.6.21 A total in-combination collision risk mortality of three herring gull is apportioned to the SPA across a full annual cycle. This represents 0.03% of the SPA population (4,200 pairs) and a 0.2% increase in baseline mortality (1,394 individuals).

Conclusion

6.9.6.22 An in-combination mortality of six birds has been predicted for the herring gull population at the Troup, Pennan and Lion's Heads SPA. This level of mortality does not lead to an increase in the baseline mortality of the population of above 1%. In addition, the Moray West Offshore Wind Farm contributes less than one collision to the in-combination collision total and therefore does not materially alter the current level of in-combination mortality. As only a negligible proportion of the SPA population affected and the negligible increase in the baseline mortality of the SPA population as a result of the predicted in-combination mortality, there is considered to be no adverse effect on the herring gull feature of the Troup, Pennan and Lion's Heads SPA as a result of in-combination collision risk impacts.

Table 6.9.49: Predicted In-Combination Collision Mortality for Herring Gull from the Troup, Pennan and Lion's Heads SPA[14]				
Project	**Band Model**	**Annual unapportioned collision mortaility**	**Seasonal collision mortality apportioned to SPA**	
			Breeding	**Non-Breeding**
Breeding and Non-Breeding Season				
Moray West	Band (2012)	12	0	0
Moray East	Band (2012)	58	0	0
Beatrice	Band (2012)	69	0	1
Non-Breeding Season				
Aberdeen European Offshore Wind Deployment Centre	Band (2012)	5		0
Blyth Demonstration Project	Band *et al*. (2007)	11		0
East Anglia One	Band (2012)	57		0
East Anglia Three	Band (2012)	19		0
Galloper	Band *et al*. (2007)	20		0
Hornsea Project One	Band (2012)	14		0
Humber Gateway	Not available	2		0
Hywind	Band (2011/12)	8	0	0
Inch Cape	Band (2012)	13		0
Kentish Flats Extension	Band (2012)	2		0
Kincardine	Band (2012)	1	0	0
Neart na Gaoithe	Band (2012)	32		0

[14] [14] The collision risk estimates presented in this table have not been corrected for either differences between assessed and as-built turbine scenarios or updated nocturnal activity factors

Table 6.9.49: Predicted In-Combination Collision Mortality for Herring Gull from the Troup, Pennan and Lion's Heads SPA[14]				
Project	**Band Model**	**Annual unapportioned collision mortaility**	**Seasonal collision mortality apportioned to SPA**	
			Breeding	**Non-Breeding**
Seagreen Alpha	Band (2012)	19		0
Seagreen Bravo	Band (2012)	12		0
Teesside	Band (2000)	43		0
Thanet	Band (2000)	9		0
Westermost Rough	Band *et al*. (2007)	0		0
Total			1	2

Guillemot

Overview

6.9.6.23 In the breeding season it has been assumed that the Moray West Offshore Wind Farm may act in-combination with the Moray East, Beatrice, Kincardine and Hywind offshore wind farms based on the foraging range of guillemot from the SPA. In the non-breeding season, Moray West is assumed to act in-combination with all wind farms located in the non-breeding BDMPS for guillemot as described by Furness (2015).

6.9.6.24 The apportioning approach used for the Moray West Offshore Wind Farm in the breeding season is consistent with that applied in the Development alone assessment as described in paragraph 6.8.3.3 and Appendix 4.2: Phenology and Apportioning. For other projects, information on the apportioning approach applied in the breeding season has been obtained from project-specific documentation. For Moray East the apportioning approach applied assumed that no birds present Moray East originated from the Troup, Pennan and Lion's Heads SPA breeding colony and as such no impacts were apportioned to the SPA. For Beatrice and apportioning value of 1.6% was applied with this obtained from the Beatrice Ornithological HRA Technical Report. The HRA for Hywind applied an apportioning value of 57.2% with assessments at Kincardine using an apportioning value of 10%.

6.9.6.25 In the non-breeding season, the approach applied for the Moray West Offshore Wind Farm has been applied for all projects (i.e. using the contribution of the SPA population to the wider regional BDMPS population).

Displacement

6.9.6.26 The predicted displacement of guillemot from other wind farm projects in-combination with the Moray West Offshore Wind Farm is summarised for the breeding and non-breeding seasons in Table 6.9.50.

Breeding season

6.9.6.27 During the breeding season in-combination displacement potentially affects 1,077 birds (Table 6.9.50), which leads to mortality of 5-6 individuals (assuming displacement of 50-60% and mortality of 1%) (Table 6.9.51). The predicted mortality comprises 0.01% of the SPA breeding population (59,764 breeding individuals) and an increase in baseline mortality (3,646 individuals) of 0.15-0.18%.

Non-breeding season

6.9.6.28 During the non-breeding season in-combination displacement potentially affects 974 birds (Table 6.9.50), which leads to mortality of 5-6 individuals (assuming displacement of 50-60% and mortality of 1%) (Table 6.9.52). The predicted mortality comprises 0.01% of the SPA breeding population (59,764 breeding individuals) and an increase in baseline mortality (3,646 individuals) of 0.13-0.16%.

Conclusion

6.9.6.29 The predicted in-combination mortality of guillemot in the breeding season represents a negligible proportion of the SPA population and a negligible increase in the baseline mortality of the population.

6.9.6.30 In the non-breeding season, the predicted in-combination mortality also represents a negligible proportion of the SPA population and less than a 1% increase in baseline mortality of that population. Therefore it is considered that there is no adverse effect on the guillemot population of the Troup, Pennan and Lion's Heads SPA as a result of displacement impacts associated with Moray West.

Table 6.9.50: Predicted In-Combination Displacement Mortality for Guillemot from the Troup, Pennan and Lion's Heads SPA				
Project	**Mean-Peak Population in Breeding Season**	**Mean-Peak Population Apportioned to SPA in Breeding Season**	**Mean-Peak Population in Non-Breeding Season**	**Mean-Peak Population Apportioned to SPA in Non-Breeding Season**
Breeding and Non-Breeding Season				
Moray West	24,426	743	38,174	361
Moray East	9,820	0	1,245	12
Beatrice	13,610	218	2,755	26
Hywind	511	106	0	0
Kincardine	632	10	0	0
Non-Breeding Season				
Aberdeen			225	2
Blyth Demonstration			1,274	12
Dogger Bank Creyke Beck A			6,724	64
Dogger Bank Creyke Beck B			11,302	107
Dogger Bank Teesside A			2,870	27
Dogger Bank Teesside D			1,525	14
Dudgeon			692	7
East Anglia ONE			713	7
East Anglia Three			1,405	13
Galloper			588	6
Greater Gabbard			698	7
Hornsea Project One			7,318	69

Table 6.9.50: Predicted In-Combination Displacement Mortality for Guillemot from the Troup, Pennan and Lion's Heads SPA				
Project	**Mean-Peak Population in Breeding Season**	**Mean-Peak Population Apportioned to SPA in Breeding Season**	**Mean-Peak Population in Non-Breeding Season**	**Mean-Peak Population Apportioned to SPA in Non-Breeding Season**
Hornsea Project Two			13,164	125
Humber Gateway			158	1
Inch Cape			3,177	30
Lincs and LID6			931	9
London Array I & II			492	5
Neart na Gaoithe			3,291	31
Race Bank			925	9
Seagreen A			0	0
Seagreen B			0	0
Sheringham Shoal			822	8
Teesside			918	9
Thanet			137	1
Triton Knoll			843	8
Westermost Rough			556	5
Total		1,077		974

Table 6.9.51: Predicted Guillemot Mortality from Troup, Pennan and Lion's Heads SPA as a Result of Displacement from In-Combination Displacement Impacts during the Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	2	5	11	22	32	43	54	65	75	86	97	108
20	2	4	11	22	43	65	86	108	129	151	172	194	215
30	3	6	16	32	65	97	129	162	194	226	259	291	323
40	4	9	22	43	86	129	172	215	259	302	345	388	431
50	5	11	27	54	108	162	215	269	323	377	431	485	539
60	6	13	32	65	129	194	259	323	388	453	517	582	646
70	8	15	38	75	151	226	302	377	453	528	603	679	754
80	9	17	43	86	172	259	345	431	517	603	690	776	862
90	10	19	48	97	194	291	388	485	582	679	776	873	970
100	11	22	54	108	215	323	431	539	646	754	862	970	1077

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

Table 6.9.52: Predicted Guillemot Mortality from Troup, Pennan and Lion's Heads SPA as a Result of Displacement from In-Combination Displacement Impacts during the Non-Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	2	5	10	19	29	39	49	58	68	78	88	97
20	2	4	10	19	39	58	78	97	117	136	156	175	195
30	3	6	15	29	58	88	117	146	175	205	234	263	292
40	4	8	19	39	78	117	156	195	234	273	312	351	390
50	5	10	24	49	97	146	195	244	292	341	390	439	487
60	6	12	29	58	117	175	234	292	351	409	468	526	585
70	7	14	34	68	136	205	273	341	409	477	546	614	682
80	8	16	39	78	156	234	312	390	468	546	624	702	780
90	9	18	44	88	175	263	351	439	526	614	702	789	877
100	10	19	49	97	195	292	390	487	585	682	780	877	974

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

Razorbill

Overview

6.9.6.31 In the breeding season it has been assumed that the Moray West Offshore Wind Farm may act in-combination with the Moray East, Beatrice, Kincardine and Hywind offshore wind farms based on the foraging range of razorbill from the SPA. In the non-breeding seasons, Moray West is assumed to act in-combination with all wind farms located in the post-, non- and pre-breeding BDMPS for razorbill as described by Furness (2015).

6.9.6.32 The apportioning approach used for the Moray West Offshore Wind Farm in the breeding season is consistent with that applied in the Development alone assessment as described Appendix 4.2: Phenology and Apportioning. For other projects, information on the apportioning approach applied in the breeding season has been obtained from project-specific documentation. For Moray East, Beatrice and Kincardine the apportioning approaches applied assumed that no birds present at each project originated from the Troup, Pennan and Lion's Heads SPA breeding colony and as such no impacts were apportioned to the SPA. The HRA for Hywind applied an apportioning value of 19.4%.

6.9.6.33 In the post-, non- and pre-breeding seasons, the approach applied for the Moray West Offshore Wind Farm has been applied for all projects (i.e. using the contribution of the SPA population to the wider regional BDMPS population).

Displacement

6.9.6.34 The predicted displacement of razorbill from other wind farm projects in-combination with the Moray West Offshore Wind Farm is summarised for the breeding post-, non- and pre-breeding seasons in Table 6.9.53.

Breeding season

6.9.6.35 During the breeding season in-combination displacement potentially affects 100 birds (Table 6.9.53), which leads to mortality of 0-1 birds (assuming displacement of 40-60% and mortality of 1%) (Table 6.9.54). The predicted mortality comprises 0.01% of the SPA breeding population (6,432 breeding individuals) and an increase in baseline mortality (675 individuals) of 0.06-0.09%.

6.9.6.36 The total in-combination displacement mortality in the breeding season represents a negligible proportion of the SPA population and a negligible increase in the baseline mortality of the population.

Post-breeding season

6.9.6.37 During the post-breeding season in-combination displacement potentially affects 204 birds (Table 6.9.53), which leads to mortality of one bird (assuming displacement of 40-60% and mortality of 1%) (Table 6.9.55). The predicted mortality comprises 0.01-0.02% of the SPA breeding population (6,432 breeding individuals) and an increase in baseline mortality (675 individuals) of 0.12-0.18%.

6.9.6.38 The total in-combination displacement mortality in the post-breeding season represents a negligible proportion of the SPA population and a negligible increase in the baseline mortality of the population.

Non-breeding season

6.9.6.39 During the non-breeding season in-combination displacement potentially affects 69 birds (Table 6.9.53), which leads to mortality of less than one bird (assuming displacement of 40-60% and mortality of 1%) (Table 6.9.56). The predicted mortality therefore comprises a negligible proportion of the SPA breeding population (6,432 breeding individuals) and a negligible increase in baseline mortality (675 individuals).

6.9.6.40 Moray West contributes only 1.3% of the total in-combination impact with the majority contributed by projects located in the Dogger Bank Zone. It is therefore considered that Moray West does not materially alter the current level of in-combination mortality predicted in the non-breeding season.

Pre-breeding season

6.9.6.41 During the pre-breeding season in-combination displacement potentially affects 149 birds (Table 6.9.53), which leads to mortality of one bird (assuming displacement of 40-60% and mortality of 1%) (Table 6.9.570). The predicted mortality comprises 0.01% of the SPA breeding population (6,432 breeding individuals) and an increase in baseline mortality (675 individuals) of 0.09-0.13%.

6.9.6.42 The total in-combination displacement mortality in the breeding season represents a negligible proportion of the SPA population and a negligible increase in the baseline mortality of the population.

Conclusion

6.9.6.43 The predicted in-combination mortality of razorbill in all season represents a negligible proportion of the SPA population and a negligible increase in the baseline mortality of the population. Therefore it is considered that there is no adverse effect on the guillemot population of the Troup, Pennan and Lion's Heads SPA as a result of displacement impacts associated with Moray West.

Table 6.9.53: Predicted In-Combination Displacement Mortality for Razorbill from the Troup, Pennan and Lion's Heads SPA								
Project	**Mean-Peak Populations**				**Mean-Peak Populations Apportioned to SPA**			
	Breeding	**Post-Breeding**	**Non-Breeding**	**Pre-Breeding**	**Breeding**	**Post-Breeding**	**Non-Breeding**	**Pre-Breeding**
Breeding and Non-Breeding Season								
Moray West	2,808	3,544	184	3,585	86	21	1	21
Moray East	2,423	1,103	30	168	0	6	0	1
Beatrice	873	833	555	833	0	5	3	5
Non-Breeding Season								
Seagreen A		0	0	0		0	0	0
Seagreen B		0	0	0		0	0	0
Inch Cape		2,870	651	0		17	3	0
Neart na Gaoithe		5,492	508	0		32	2	0
Aberdeen		64	7	26		0	0	0
Hywind	69	0	0	0	13	0	0	0
Kincardine	22	0	0	0	0	0	0	0
Blyth Demonstration		61	61	91		0	0	1
Dogger Bank Creyke Beck A		2,090	1,728	4,149		12	8	24
Dogger Bank Creyke Beck B		2,729	2,143	5,119		16	10	30
Dogger Bank Teesside A		449	959	1,919		3	5	11
Dogger Bank Teesside B		832	1,426	2,953		5	7	17
Dudgeon		341	745	346		2	4	2

Table 6.9.53: Predicted In-Combination Displacement Mortality for Razorbill from the Troup, Pennan and Lion's Heads SPA								
Project	**Mean-Peak Populations**				**Mean-Peak Populations Apportioned to SPA**			
	Breeding	**Post-Breeding**	**Non-Breeding**	**Pre-Breeding**	**Breeding**	**Post-Breeding**	**Non-Breeding**	**Pre-Breeding**
East Anglia ONE		39	155	336		0	1	2
East Anglia Three		820	1,206	1,547		5	6	9
Galloper		65	106	394		0	1	2
Greater Gabbard		0	387	84		0	2	0
Hornsea Project One		7,132	1,518	1,803		42	7	11
Hornsea Project Two		4,221	720	1,668		25	3	10
Humber Gateway		13	13	20		0	0	0
Lincs and LID6		22	22	34		0	0	0
London Array I & II		3	3	8		0	0	0
Race Bank		7	7	16		0	0	0
Sheringham Shoal		1,343	211	30		8	1	0
Teesside		57	2	20		0	0	0
Thanet		0	14	21		0	0	0
Triton Knoll		380	855	117		2	4	1
Westermost Rough		121	152	91		1	1	1
Total					100	204	69	149

Table 6.9.54: Predicted Razorbill Mortality from Troup, Pennan and Lion's Heads SPA as a Result of Displacement from In-Combination Displacement Impacts During the Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	1	2	3	4	5	6	7	8	9	10
20	0	0	1	2	4	6	8	10	12	14	16	18	20
30	0	1	1	3	6	9	12	15	18	21	24	27	30
40	0	1	2	4	8	12	16	20	24	28	32	36	40
50	0	1	2	5	10	15	20	25	30	35	40	45	50
60	1	1	3	6	12	18	24	30	36	42	48	54	60
70	1	1	3	7	14	21	28	35	42	49	56	63	70
80	1	2	4	8	16	24	32	40	48	56	64	72	80
90	1	2	4	9	18	27	36	45	54	63	72	81	90
100	1	2	5	10	20	30	40	50	60	70	80	90	100

	< 1% background mortality		> 1% background mortality/< 1% SPA population		> 1% SPA population

Table 6.9.55: Predicted Razorbill Mortality from Troup, Pennan and Lion's Heads SPA as a Result of Displacement from In-Combination Displacement Impacts during the Post-Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	1	2	4	6	8	10	12	14	16	18	20
20	0	1	2	4	8	12	16	20	24	29	33	37	41
30	1	1	3	6	12	18	24	31	37	43	49	55	61
40	1	2	4	8	16	24	33	41	49	57	65	73	82
50	1	2	5	10	20	31	41	51	61	71	82	92	102
60	1	2	6	12	24	37	49	61	73	86	98	110	122
70	1	3	7	14	29	43	57	71	86	100	114	128	143
80	2	3	8	16	33	49	65	82	98	114	131	147	163
90	2	4	9	18	37	55	73	92	110	128	147	165	184
100	2	4	10	20	41	61	82	102	122	143	163	184	204

	< 1% background mortality		> 1% background mortality/< 1% SPA population		> 1% SPA population

Table 6.9.56: Predicted Razorbill Mortality from Troup, Pennan and Lion's Heads SPA as a Result of Displacement from In-Combination Displacement Impacts during the Non-Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	1	1	2	3	3	4	5	5	6	7
20	0	0	1	1	3	4	5	7	8	10	11	12	14
30	0	0	1	2	4	6	8	10	12	14	16	19	21
40	0	1	1	3	5	8	11	14	16	19	22	25	27
50	0	1	2	3	7	10	14	17	21	24	27	31	34
60	0	1	2	4	8	12	16	21	25	29	33	37	41
70	0	1	2	5	10	14	19	24	29	34	38	43	48
80	1	1	3	5	11	16	22	27	33	38	44	49	55
90	1	1	3	6	12	19	25	31	37	43	49	56	62
100	1	1	3	7	14	21	27	34	41	48	55	62	69

	< 1% background mortality		> 1% background mortality/< 1% SPA population		> 1% SPA population

Table 6.9.57: Predicted Razorbill Mortality from Troup, Pennan and Lion's Heads SPA as a Result of Displacement from In-Combination Displacement Impacts during the Pre-Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	1	1	3	4	6	7	9	10	12	13	15
20	0	1	1	3	6	9	12	15	18	21	24	27	30
30	0	1	2	4	9	13	18	22	27	31	36	40	45
40	1	1	3	6	12	18	24	30	36	42	48	54	60
50	1	1	4	7	15	22	30	37	45	52	60	67	75
60	1	2	4	9	18	27	36	45	54	63	72	81	90
70	1	2	5	10	21	31	42	52	63	73	84	94	105
80	1	2	6	12	24	36	48	60	72	84	96	108	120
90	1	3	7	13	27	40	54	67	81	94	108	121	135
100	1	3	7	15	30	45	60	75	90	105	120	135	149

	< 1% background mortality		> 1% background mortality/< 1% SPA population		> 1% SPA population

6.10 Summary

6.10.1.1 The screening process indicated that LSE on the interest features of the East Caithness Cliffs SPA, North Caithness Cliffs SPA, Troup and Lion's Head SPA, Buchan Ness to Collieston Coast SPA and Moray Firth pSPA could not be discounted and so a systematic assessment of the potential for an adverse effect on the integrity of this site has been undertaken.

6.10.1.2 The assessment has considered the potential impacts of Moray West Offshore Wind Farm during construction, operation and maintenance and decommissioning, alone and in-combination with other relevant plans and projects with respect to the site's Conservation Objectives.

6.10.1.3 With respect to all SPAs and the pSPA, there is no indication that the construction, operation and maintenance or decommissioning will lead to a significant change in the extent and distribution of the habitats of any of the qualifying features for those sites.

6.10.1.4 There is no indication that the structure and function of the habitats of the qualifying features will be significantly altered, nor the supporting processes on which those habitats rely. In each case the distribution of qualifying features within each site will also be maintained.

6.10.1.5 With respect to the population of each of the qualifying features, the likely mortality arising from the construction and operation of Moray West alone and in-combination with other plans and projects (other offshore wind farms in this case) has been predicted with no conclusions of adverse effect on site integrity reached.

7 Assessment of Adverse Effects Upon Site Integrity – Marine Mammals

7.1 Introduction

7.1.1.1 This assessment of adverse effect on site integrity has been undertaken in accordance with EU and national guidance (EC, 2001; SNH, 2010; EU, 2011) and will ensure that Moray West is compliant with the UK and Scottish Government's international commitments to conserve biodiversity as implemented by national planning and wildlife protection legislation and national planning policies.

7.1.1.2 The Moray West Offshore Wind Farm HRA Screening Report (Moray West, 2017) identified two SACs where marine mammals are a qualifying features where there was a likely significant effect (LSE) (Table 7.1.1; Figure 6.1.1).

Table 7.1.1: European Sites and Features for which LSE have been Identified

European Site	Feature
Dornoch Firth and Morrich More SAC	Harbour seal
Moray Firth SAC	Bottlenose dolphin

7.1.1.3 The conservation objectives for these sites are given below, followed by a description of the baseline environment relevant to each site and feature.

7.2 Conservation Objectives

7.2.1 Dornoch Firth and Morrich More SAC

The conservation objectives of the Dornoch Firth and Morrich More SAC are given below:

To avoid deterioration of the habitats of the qualifying species (Harbour 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 features; 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 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

7.2.2 Moray Firth SAC

The conservation objectives of the Moray Firth SAC are given below:

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 for each of the qualifying features; 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 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

7.3 Baseline Characterisation

7.3.1.1 For both sites designated for marine mammal features, the designated sites represent only a small proportion of area used by bottlenose dolphins and harbour seals within the wider management unit areas. As such, and as agreed by Scottish Ministers and SNH in the Scoping Opinion, the population of the Moray Firth Seal Management Area is taken as being equivalent to the SAC population for harbour seals. Similarly, the coastal east Scotland management unit population is taken as equivalent for the Moray Firth SAC bottlenose dolphin population. As such the baseline characterisation for both bottlenose dolphins and harbour seals is taken to be the same as presented in the Offshore EIA Report (Chapter 9: Marine Mammals) and detailed in Appendix 9.1: Marine Mammal Baseline. The following summarises the key data sources examined to establish the baseline for each of these populations.

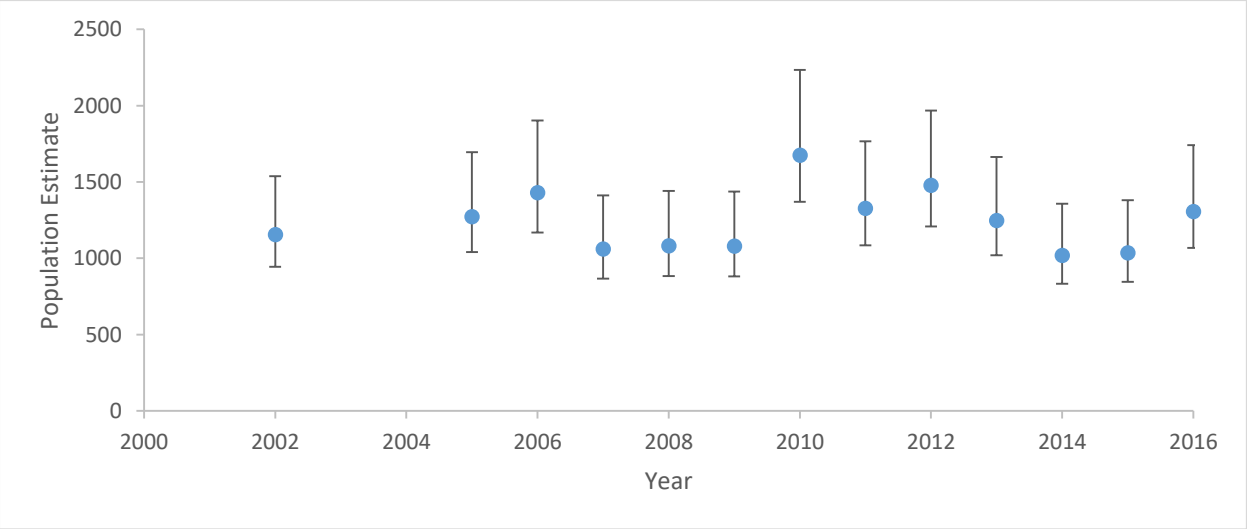
7.3.2 Dornoch and Morrich More SAC: Harbour Seal

7.3.2.1 The Dornoch and Morrich More SAC supports a significant proportion of the inner Moray Firth population of the harbour seal. The seals, which utilise sand-bars and shores at the mouth of the estuary as haul-out and breeding sites, are the most northerly population to utilise sandbanks.

Haul-Out Counts

7.3.2.2 The most recent harbour seal August moult count for Moray Firth Seal management area was 940 in 2016 (SCOS 2017). Applying a correction to account for the number of seal at sea during the time of the counts, scales this to a population estimate of 1,306 harbour seals (95% CI: 1,068 to 1741) which accounts for approximately 3.1% of the total population in Great Britain.

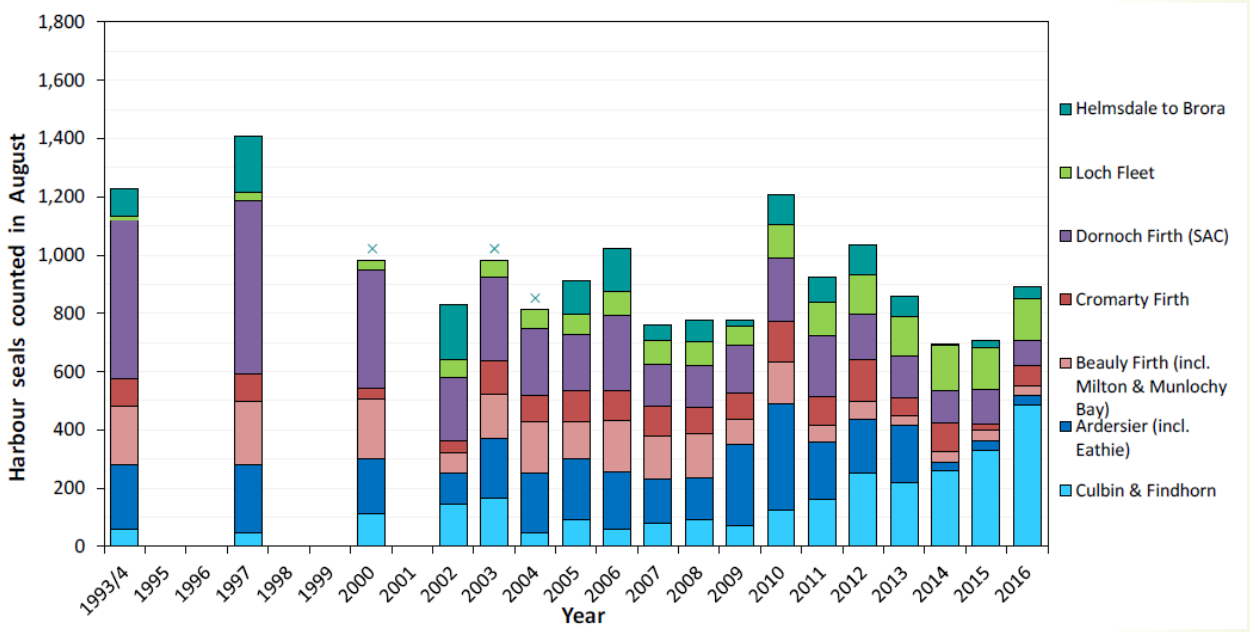
7.3.2.3 Overall, across the time series of data between 2002 and 2016, it appears that the population in the Moray Firth MU is reasonably stable, though with inter-annual variation (Graph 7.4.1). The population appeared to be declining between 2012 and 2015 (from 1,476 in 2012 to 1,018 in 2014 and 1,035 in 2015); however, the 2016 estimate of 1,306 animals was higher than that obtained in 2014 and 2015 and is more in line with the previous estimate in 2012.



Graph 7.3.1 Moray Firth MU harbour seal population estimates (raw counts scaled to account for the proportion at sea) between 2002 and 2016. Error bars show the 95% CIs. Data obtained from SCOS (2017)

7.3.2.4 A breakdown of the counts in the different areas surveyed within the Moray Firth are available up to 2016, as presented in Graph 7.4.2. The haul-out data for the annually surveyed sites show that the Loch Fleet counts have increased from 59 animals in 2002 to 145 animals in 2016 (average p.a. increase of 8.35%). If the 2016 count of 145 is scaled to include the proportion of seals in the water at the time of the count, the abundance of harbour seals in Loch Fleet during the 2016 August moult is estimated as 201 animals (95% CI 165 to 269). Unlike the Loch Fleet site, the annual moult count within the Dornoch Firth and Morrich More SAC has fluctuated annually from 220 in 2002 to a maximum of 290 in 2003 and a minimum of 85 in 2016. Over the period between 2002 and 2016 the counts show an average per annum 0.48% decline in counts. If the 2016 count of 85 is scaled to include the proportion of seals in the water at the time of the count, the abundance of harbour seals in the Dornoch Firth and Morrich More SAC during the 2016 August moult is estimated as 118 animals (95% CI 97 to 157).

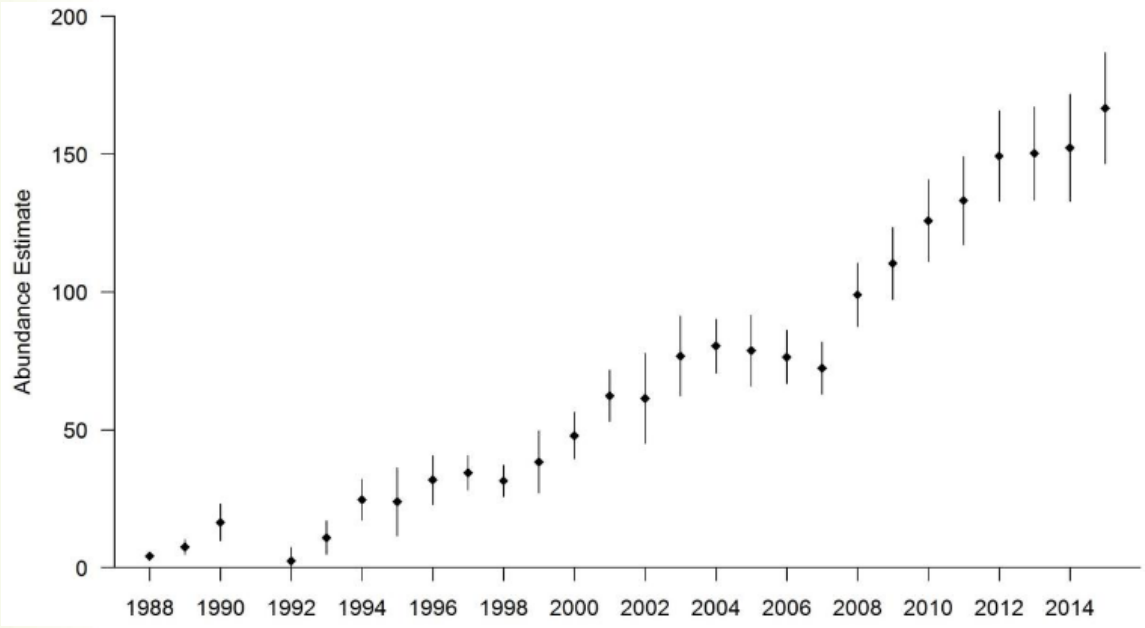
7.3.2.5 Other haul-out sites in the Moray Firth that are surveyed annually during the moult count include Culbin & Findhorn which has shown a large increase in counts from 49 in 2004 to 484 in 2016. All other annually monitored sites (Helmsdale to Brora, Cromarty Firth, Beauly Firth and Ardersier) have shown large fluctuations in annual moult counts. The count data have shown a change in areas of usage within the Moray Firth over time, from most counts being located within the Dornoch Firth and Morrich Moore SAC in the 1990s to most seals being counted in Culbin and Findhorn in more recent years (Graph 7.4.2).



Graph 7.3.2 Harbour seal counts at haul-out sites in the Moray Firth between 1993 and 2016 (SCOS 2017). x: Helmsdale to Brora not surveyed in 2000, 2003 or 2004

University of Aberdeen Harbour Seal Haul-Out Surveys

7.3.2.6 The Loch Fleet National Nature Reserve is the nearest major harbour seal breeding site to the Moray West site. The estimated abundance of harbour seals at the Loch Fleet National Nature Reserve has increased since the mid 1990's and reached its highest estimate in 2015 of 167 seals (95% CI: 146 to 187; estimated by adjusting counts made during the pupping season) (Graham *et al*. 2016) (Graph 7.4.3).



Graph 7.3.3 Estimated number of seals using Loch Fleet from 1988 to 2015 with 95% confidence intervals (Graham *et al*. 2016)

7.3.2.7 Other haul-out sites along the coast north of the Dornoch Firth and Morrich More SAC have been monitored monthly as part of the BOWL strategic pre-construction MMMP in 2014 and 2015, including Lothmore, Lothbeg, Sputie Burn and Dunrobin (in addition to the Loch Fleet surveys). These data show that Loch Fleet supports considerably more seals than the other surveyed sites (mean count up to 129 in 2014), however there are also a number of harbour seals that haul-out at Sputie Burn year round (mean count up to 39 in 2014).

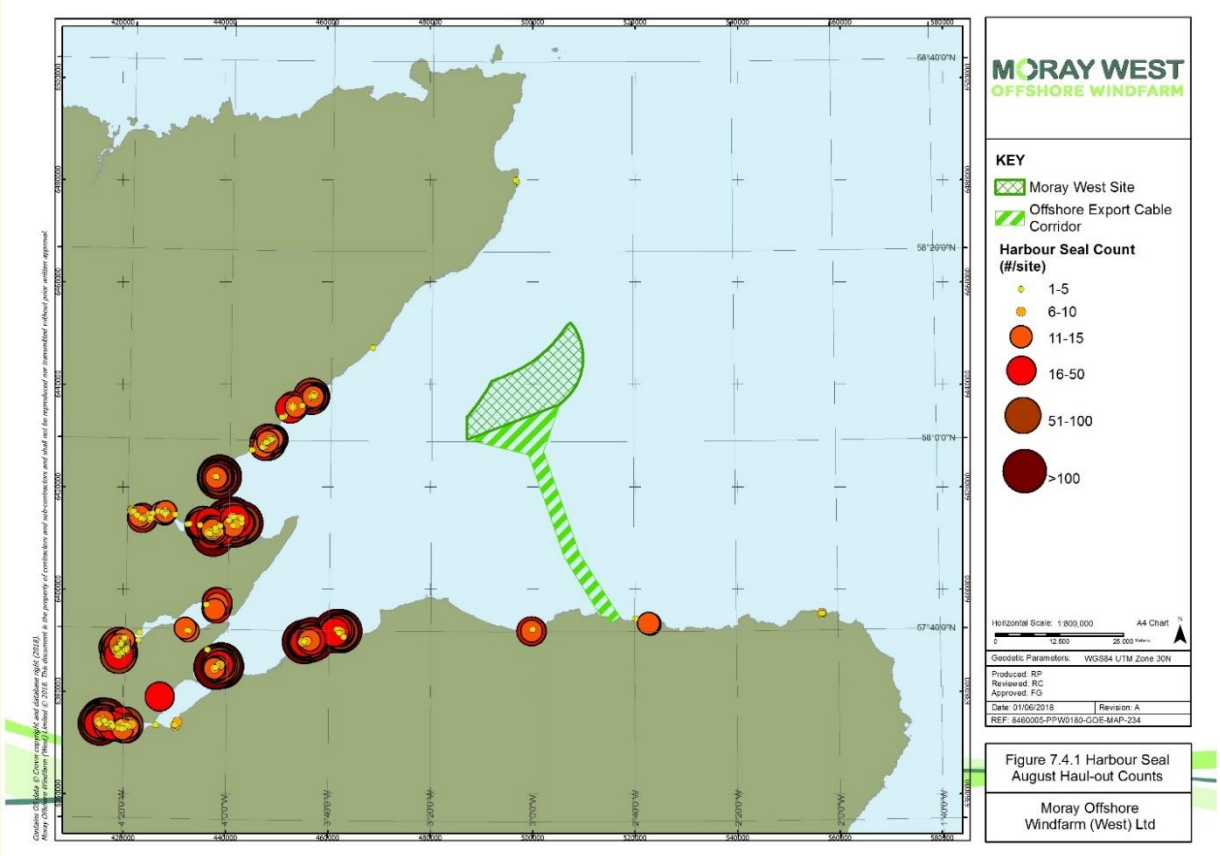


Figure 7.3.1 Harbour seal haul-out counts during the SMRU August moult count between 1997 and 2016.

Telemetry Data – Seal Movements and Distribution

7.3.2.8 A total of 37 adult harbour seals were tagged in the Moray Firth between 2004 and 2015, with tag durations lasting between 20 and 185 days (mean 115 days). Of these, 12 seals recorded tag locations within the Moray West Site, however, these only comprised a low proportion of their total tag locations (maximum 4.14%) (Figure 7.4.2). The more recent telemetry data (2014 and 2015 deployments) show much less usage of the Moray West, Moray East and BOWL wind farm development sites than previous tag deployments (Figure 7.3.2). While this may simply be due to individual variations in range and movement patterns, there is the potential that these data could reflect a change in harbour seal usage of this area in recent years.

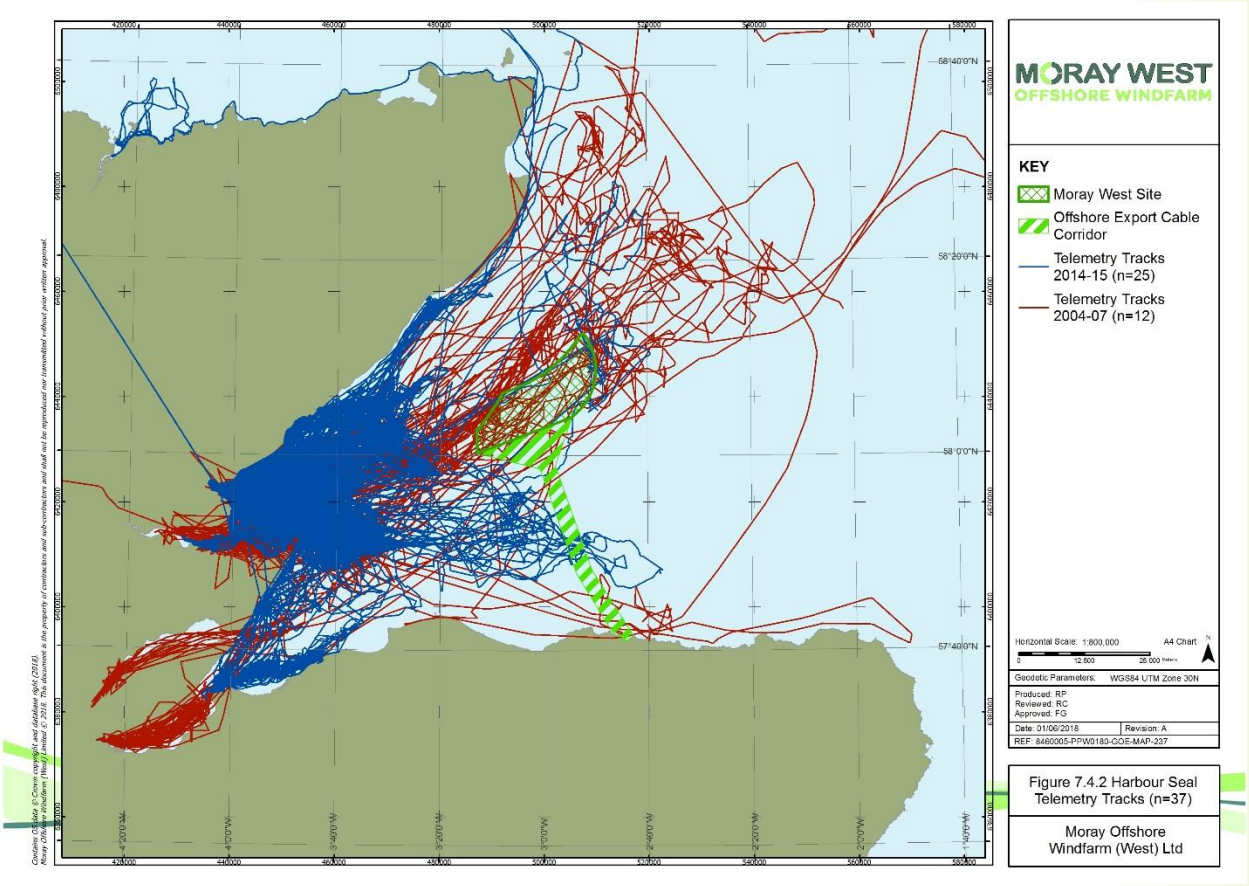


Figure 7.3.2 Harbour seal telemetry tracks for deployments between 2004-2007 and 2014-2015.

At-Sea Usage

7.3.2.9 Both the previous (2004-2007) and the most recent telemetry data (2014-2015, which showed much less usage of the Moray West, Moray East and BOWL wind farm development sites than previous tag deployments) were modelled using a GAMM to predict harbour seal at-sea usage in the Moray Firth. The resulting harbour seal at-sea usage map (Bailey 2017) shows that harbour seals are not predicted to be evenly distributed within the Moray Firth (Figure 7.3.3). There are hotspots of higher predicted densities in the inner Moray Firth, with highest densities around the Dornoch Firth and Morrich More SAC. The grid cell with the maximum density within the Moray West Site has an estimated at-sea density of 3.97 seals/cell which, assuming uniform distribution within a grid cell, equates to 0.16 seals/km^2.

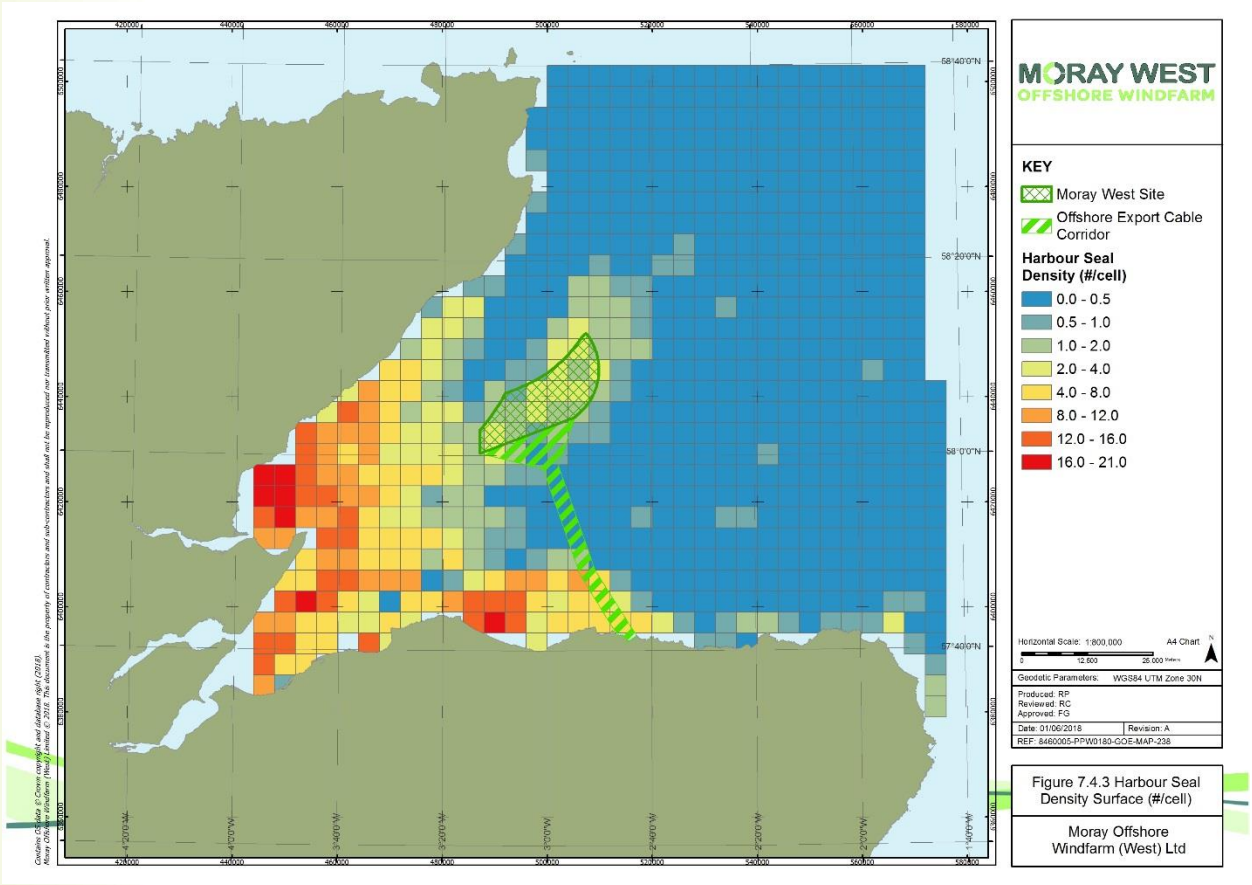


Figure 7.3.3 Harbour seal at-sea usage showing the predicted number of animals in each 4x4 km grid cell (Bailey 2017).

Harbour Seal Baseline Conclusion

7.3.2.10 Despite the fact that in the UK, harbour seals are considered to have an "Unfavourable Inadequate Conservation Status", the harbour seal population in the Moray Firth has remained relatively stable since 2002, though there is inter-annual variation in population estimates. The current Moray Firth population size estimate is 1,304 harbour seals which accounts for approximately 3% of the total UK population. The most recent telemetry data show less usage of the Moray West, Moray East and BOWL wind farm development sites than previous tag deployments. The at-sea usage map confirms that harbour seals are not evenly distributed throughout the Moray Firth, and that they occur at highest densities around the Dornoch Firth and Morrich More SAC.

7.3.3 Moray Firth SAC: Bottlenose Dolphin

7.3.3.1 The Moray Firth population of bottlenose dolphins is the only known remaining resident population in the North Sea and it was for this reason that the Moray Firth SAC was established to protect this population. The conservation objectives of the Moray Firth SAC are to avoid the deterioration of the bottlenose dolphin habitat, to achieve a favourable conservation status and to ensure the population size and distribution of the bottlenose dolphins is maintained in the long-term.

Photo-ID

7.3.3.2 The most recent population estimate of bottlenose dolphin abundance for the Coastal East Scotland MU population is 195 individuals (95% HPDI: 164 to 224), based on photo-ID counts in 2015 (Graham *et al*. 2016). This population has increased from an estimated 101 individuals

(95% HPDI: 70 to 129) in 1990. Between 1990 and 2015 the number of individuals using the SAC has remained stable at 98 individuals (95% CI: 83 to 116). Whilst the population size has increased, the relative proportion of the population that uses the SAC has declined (Graham *et al*. 2016). Whilst the Moray Firth is clearly an important area for this population, they are not restricted to the either the Moray Firth SAC or the wider Moray Firth. Instead, these animals are highly mobile, and have a large range that extends from within the Moray Firth SAC, east along the outer Moray Firth coastline and south to the Firth of Forth (Cheney *et al*. 2013).

Acoustic Surveys

7.3.3.3 The CPOD studies in 2009, 2010 and 2011 showed that dolphins were detected regularly in the inner Moray Firth and along the southern Moray Firth coast; with a detections also recorded in the more offshore locations within the Moray Firth, including at CPOD sites within the Moray East and West development areas (Thompson *et al*. 2010, Thompson *et al*. 2011, Moray East ES 2012, Thompson *et al*. 2014). Using sightings data and a classification tree it was concluded that the dolphin detections at CPOD locations within the Moray West Site were more likely to be other dolphin species such as common or white-beaked dolphins and not bottlenose dolphins. This was further confirmed with the acoustic data collected by the EARs in 2010 which demonstrated that the detections across the Moray East and West sites were either other dolphin species or false detections.

7.3.3.4 The results of the classification tree analysis and the habitat modelling provided the probability of bottlenose dolphins occurring in grid cells across the Moray Firth. This habitat model showed that the probability of detecting a bottlenose dolphin in any given hour was up to 0.117 (11.7%) in any one grid cell, and that bottlenose dolphins were more likely to be detected in coastal waters, especially along the southern coast of the Moray Firth, compared to offshore waters (Thompson *et al*. 2014).

Long Term CPOD Sites and the BOWL MMMP

7.3.3.5 The results from the Passive Acoustic Monitoring (PAM) data collected at the four long-term monitoring sites in the Moray Firth have shown that the percentage of dolphin positive days and the median detection positive hours was highest at all sites between May and August (Table 7.4.1). Both the percentage dolphin positive days and the median dolphin positive hours showed that the sites located in the inner Moray Firth SAC (Sutors of Cromarty and Chanonry) had higher dolphin detection rates than the sites located along the outer southern coast of the Moray Firth (Lossiemouth and Spey Bay).

Table 7.3.1: Percentage of Dolphin Positive Days and Median Dolphin Positive Hours by Month Across the Four Long-Term CPOD Monitoring Sites in the Moray Firth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
% Dolphin Positive Days												
Chanonry	53.8	47	43	89	92.1	98.7	98.7	99	96	79.7	80.2	68.4
Lossiemouth	46	55	64	77	81.2	85.2	75.8	81	71	42.9	61.6	59.4
Spey Bay	19.4	27	40	72	90.9	94.6	89.9	84	83	62.3	55.1	52.4
Sutors	79.6	80	65	92	100	100	99.3	99	93	95.9	99.1	93.3
Median Dolphin Positive Hours												
Chanonry	1	0	0	3	4	5	7	7	5	3	3	2
Lossiemouth	0	1	1	2	2	2	2	2	1	0	1	1
Spey Bay	0	0	0	2	4	4	3.5	3	2	1	1	1
Sutors	2	1	1	5	11	10	9	8	4	7	6	5

ECOMMAS Surveys

7.3.3.6 Of the five ECOMMAS PAM site groups in the Moray Firth, Cromarty had the highest proportion of dolphin positive days with site Cromarty 05 having between 89 and 96% of the survey days with dolphin detections (Table 7.4.2 and Figure 7.3.4). There was also a consistent pattern of declines in the proportion of dolphin positive days with increasing distance from the coast at all site groups except Fraserburgh and Spey Bay.

Table 7.3.2: Proportion of Survey Days in which Dolphins were Detected (Dolphin Positive Days) at Each of the 15 ECOMMAS CPOD Sites in the Moray Firth Between 2013 and 2016. No Data is Denoted By '-'

Site	2013	2014	2015	2016
Cromarty 05	0.89	-	0.95	0.96
Cromarty 10	0.32	0.43	0.37	0.36
Cromarty 15	0.02	0.00	0.04	0.01
Fraserburgh 05	0.13	0.30	0.11	0.06
Fraserburgh 10	-	-	0.00	0.00
Fraserburgh 15	-	0.04	0.08	0.10
Helmsdale 05	0.05	0.12	0.14	0.15
Helmsdale 10	0.00	-	0.02	0.04
Helmsdale 15	0.01	0.01	0.00	0.03
Latheron 05	0.19	0.02	0.20	0.27
Latheron 10	0.03	-	0.04	0.14
Latheron 15	0.04	-	0.01	0.05
Spey Bay 05	0.22	0.21	0.14	0.11
Spey Bay 10	0.00	-	0.00	0.00
Spey Bay 15	-	0.01	0.03	0.02

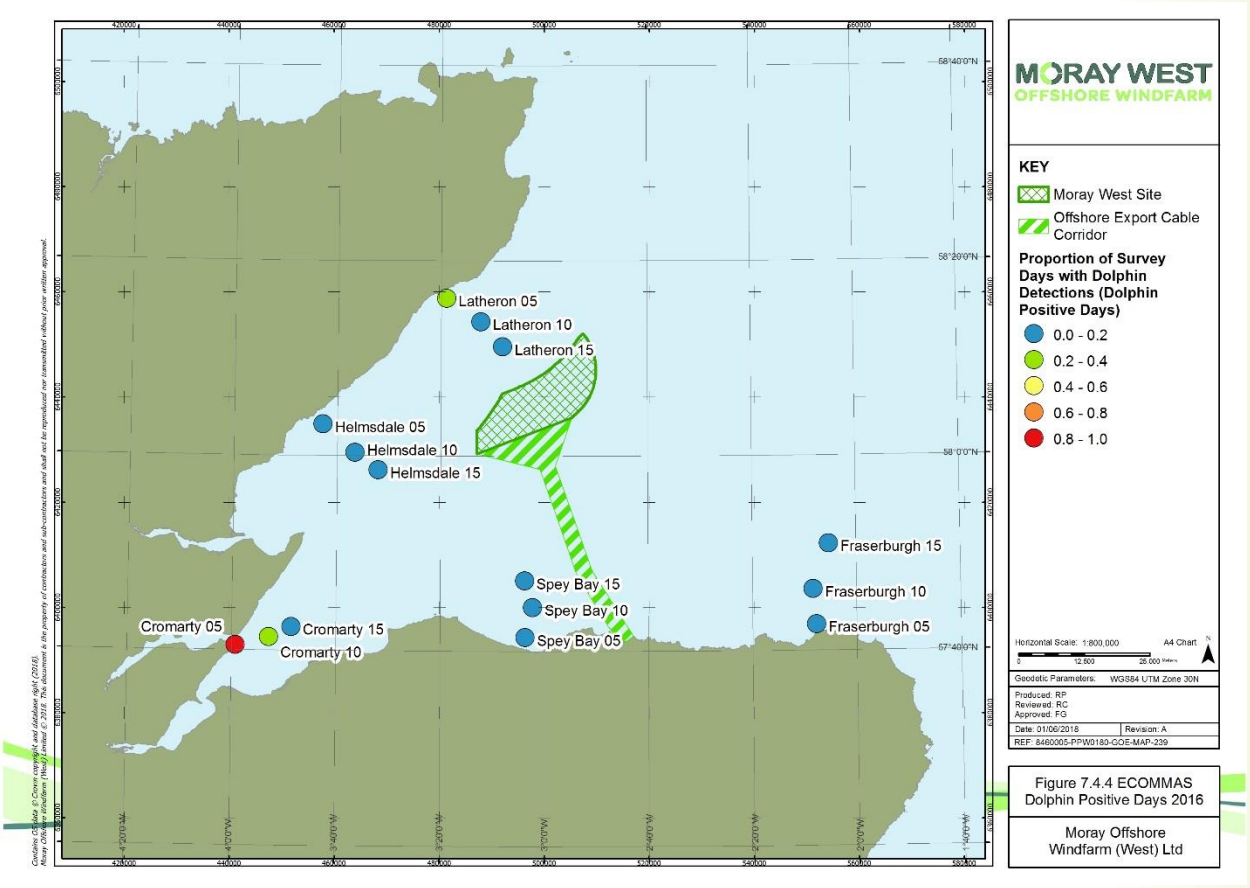
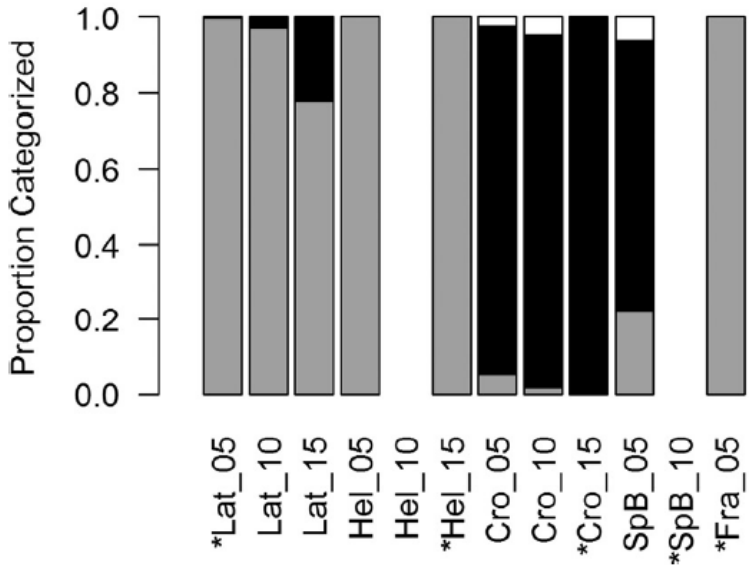


Figure 7.3.4 Proportion of dolphin positive days at each of the 15 ECOMMAS CPOD sites in the Moray Firth in 2016.

7.3.3.7 These data have been further analysed to separate the CPOD "dolphin" detection data into two groups: broad-band echolocation clicks (made by bottlenose and common dolphins) and frequency banded echolocation clicks (made by Risso's and white-beaked dolphins) (Palmer *et al*. 2017). The analysis of the CPOD data from the ECOMMAS surveys have shown that at the northern Moray Firth sites at Helmsdale and Latheron, the detections have mostly been frequency banded echolocation clicks (Graph 7.3.4) and so are likely to be either Risso's or white-beaked dolphins. At Cromarty, the detections were identified as predominantly broad-band echolocation clicks (Graph 7.3.4) and are most likely to be bottlenose dolphins. Along the southern coast of the Moray Firth, the Spey Bay detections were mainly broad-band (Graph 7.3.4) and so are attributed to either bottlenose or common dolphins and at Fraserburgh the detections were all frequency banded (Graph 7.3.4) and so were attributed to Risso's or white-beaked dolphins.



Graph 7.3.4 The proportion of click trains recorded at ECOMMAS PAM sites within the Moray Firth classified as broadband (black), frequency banded (grey) or unknown (white) by the combination of the Generalised Additive model (GAM) click-train classification and the encounter likelihood ratio (Palmer *et al*. 2017). Asterisks indicate joint C-POD/SM2M deployment locations from which training data were derived and where CPODs were displaced no data are presented.

7.3.3.8 The analysis of the ECOMMAS CPOD data by Palmer *et al*. (2017) highlights that the predicted probability of dolphin occurrence previously estimated in Thompson *et al*. (2014) was likely to have overestimated the probability of bottlenose dolphin occurrence along the northern coast of the Moray Firth. In order to provide a more realistic density surface for bottlenose dolphins in the Moray Firth, the dolphins in the grid cells located along the coast north of, and surrounding, Helmsdale and Latheron were re-distributed to other grid cells within the Moray Firth, based on the proportion of the total each cell contained (Figure 7.3.5). In addition to this, the number of dolphins present in each grid cell has been adjusted in order to reflect the fact that only approximately half the population is likely to be present in the Moray Firth at any one time (and available to be impacted), with the remaining population distributed further south along the east coast as far as the Firth of Forth (Cheney *et al*. 2013, Graham *et al*. 2016).

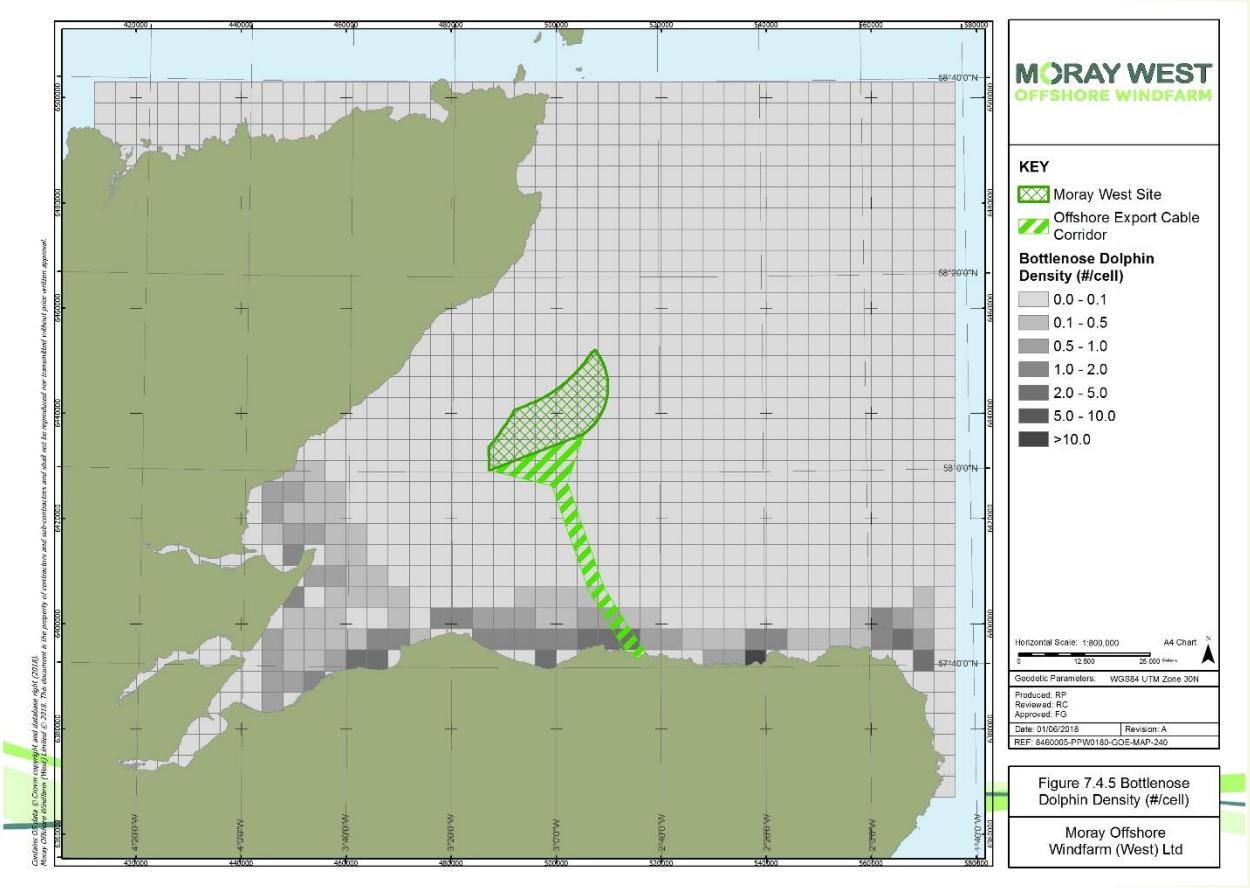


Figure 7.3.5 Revised spatial variation in bottlenose dolphin occurrence across the Moray Firth (revised in light of ECOMMAS data presented in Palmer *et al.,* 2017). Predictions for each cell represent the number bottlenose dolphins occurring in each 4x4 km cell.

Bottlenose Dolphin Baseline Conclusion

7.3.3.9 The Coastal East Scotland MU population of bottlenose dolphins has been increasing since 1990 and the current population estimate is 195 animals. This population extends between the Moray Firth and south along the east coast of Scotland to the Firth of Forth. The use of the Moray Firth SAC by this population varies from year to year, and in 2015 approximately half of the population used the SAC (Graham *et al*. 2016). The population is considered to be healthy and has a "Favourable Conservation Status". The ECOMMAS acoustic surveys have determined that bottlenose dolphins are less likely to be present along the northern coast of the Moray at Helmsdale and Latheron, but are found mainly along the southern coast of the Moray Firth. The impact assessment will be based on the revised grid cell specific density estimates presented in Figure 7.3.5.

7.4 Description of Potential Impacts

7.4.1.1 Impact identified as requiring assessment in the RIAA in Chapter 4 (Table 4.5.3) are summarised below.

Table 7.4.1: Potential Impacts from Moray West on Marine Mammal Site Features

Project Phase	Impact	Description
Construction	Underwater noise – piling	The impact of underwater noise from piling activities on marine mammals in terms of both physical and auditory injury and disturbance.

Table 7.4.1: Potential Impacts from Moray West on Marine Mammal Site Features		
Project Phase	**Impact**	**Description**
	Underwater noise from construction / decommissioning activities (excluding piling)	The impact of underwater noise from other construction activities such as increased vessel activity on marine mammals in terms of both physical and auditory injury and disturbance.
	Risk of collision with vessels	Potential for physical trauma from collision with vessels involved in construction (and decommissioning) activities.
Operation and maintenance	Risk of collision with vessels	Potential for physical trauma from collision with vessels involved in operation and maintenance activities.
Decommissioning	Effects are assumed to be similar to those predicted during the construction phase.	

7.4.1.2 A description of these impacts is provided below.

7.4.2 Piling Noise

7.4.2.1 It is well documented that the noise generated by pile driving can cause a range of effects on marine mammals. Noise modelling was undertaken to allow the quantification of the numbers of individuals potentially affected by noise levels high enough to cause physical and auditory injury and disturbance. Noise modelling outputs were used to predict the ranges to which individuals might be at risk of physical and auditory injury from the noise generated by pile driving, as well as the numbers of individuals potentially experiencing disturbance (with the potential to lead to behavioural effects such as displacement and reduction in foraging). The noise modelling is presented in detail in Appendix 9.2 of the EIA Report (Moray West, 2018) and the methodology applied to the assessment, including details of the thresholds used is described in detail in Chapter 9 of the EIA report (Moray West, 2018).

7.4.2.2 In summary, thresholds derived from the National Marine Fisheries Service (2016) guidance on predicting auditory injury were used to determine the risk of Permanent Threshold Shift (PTS).

7.4.2.3 Dose response curves were used to predict the proportion of animals responding at a range of noise levels to assess the potential impact of disturbance. The dose response curve used for the assessment of bottlenose dolphins was derived from data on the responses of harbour porpoises to pile driving at the Beatrice Offshore Wind Farm (Graham *et al*., 2017). In the absence of empirical data on bottlenose dolphin response to pile driving noise, this approach is considered precautionary. The dose response curve used for the assessment of impact to harbour seals was derived from data on the responses of seals to pile driving at the Lincs Offshore Wind Farm (Russell *et al*., 2016). The detailed results of the assessment are presented in Chapter 9 of the EIA report (Moray West, 2018) and those results relevant to the assessment of impacts on the bottlenose dolphin and harbour seal populations associated with the protected sites are summarised in Sections 7.5 and 7.6 below.

7.4.3 Non-Piling Driving Impacts: Vessel Noise and Collision Risk and Noise from Other Construction Activities

7.4.3.1 In addition to underwater noise from pile-driving during the installation of WTG and offshore substation foundations, there is also potential for marine mammals to be affected by underwater noise generated from other construction and decommissioning activities such as vessel activity, seabed preparation for installation of gravity base structure foundations (e.g. dredging), underwater cutting and other activities in relation to cable installation (such as

trenching,). Although the majority of the activity will take place offshore at the turbine array area, there will also be activity in the coastal area and near shore on the southern Moray Firth in relation to the offshore cable installation and landfall activities at Sandend Bay.

7.4.3.2 Increased vessel traffic has the potential to result in disturbance of marine mammals. The project maximum design scenario assumes a total of two installation vessels (JUVs or HLVs) on site at the same time and that each of these vessels may be accompanied by several other support vessels, tugs, and / or transport barges.

7.4.3.3 The magnitude and characteristics of vessel noise varies depending on ship type, ship size, mode of propulsion, operational factors and speed. Vessels of varying size produce different frequencies, generally becoming lower frequency with increasing size. The predominant sound frequencies associated with large vessels are below several hundred Hz. Thomsen *et al*., (2006) used species hearing detection thresholds to conclude that noise from larger vessels around 0.25 kHz will be detected by harbour seals at ranges of 20 km and are expected to detect two kHz ship noise at approximately three km. Most noise from construction / maintenance vessels is exhibited at these ranges (Richardson 1995). The distance at which animals may react is difficult to predict. Behavioural responses can vary a great deal depending on context and data specific to harbour porpoises and seals are sparse. According to Thomsen *et al*., (2006) seals might be expected to respond to vessels of this type at approximately 400 m.

7.4.3.4 Pirotta *et al*., (2015) demonstrated that the response of bottlenose dolphins in the Moray Firth was related to the number of boats present but did not vary significantly with the levels of overall noise. While this result does provide evidence that a perception of risk can be related to the presence of boats, silent and stationary boats did not elicit a response. It is therefore difficult to disentangle the effect of presence of boats with the noise they emit, although it is expected that observed responses are at least in part due to noise disturbance and in part due to perceived risks of collision.

7.4.3.5 There is very little published information on the responses of seals at sea to vessels. Jones *et al*., (2017) presents an analysis of the predicted co-occurrence of ships and seals at sea which demonstrates that UK wide there is a large degree of predicted co-occurrence between ships and seals at sea, particularly within 50 km of the coast close to seal haul-outs. There is no evidence relating decreasing seal populations with high levels of co-occurrence between ships and animals and areas where seal populations are increasing (e.g. south east England) and where ship co-occurrences are highest, are experiencing the highest levels of growth (Jones *et al*., 2017).

7.4.3.6 During construction of the wind farm, another potential source of impact from increased vessel activity is physical trauma from collision with a boat or ship (disturbance as a result of vessel noise has already been assessed). These injuries include blunt trauma to the body or injuries consistent with propeller strikes.

7.4.3.7 However, there is currently a lack of information on the frequency of occurrence of boat collisions as a source of marine mammal mortality. There is little evidence from strandings data in the UK that injury from vessel collisions is an important source of mortality. There were 52 stranded bottlenose dolphins reported round the UK between 2005 and 2010, 18 of which were studied at post mortem and none of which were confirmed as having died as a result of physical trauma related to vessel collisions (Deaville and Jepson 2011). There is currently no information on the incidence of vessel collisions with harbour seals.

7.4.4 Risk of Collision with Vessels (Construction and Operations and Maintenance Vessels)

7.4.4.1 During construction of the wind farm, another potential source of impact from increased vessel activity is physical trauma from collision with a boat or ship (disturbance as a result of vessel noise has already been assessed). These injuries include blunt trauma to the body or injuries consistent with propeller strikes. The risk of collision of marine mammals with vessels would be

directly influenced by the type of vessel and the speed with which it is travelling (Laist *et al.,* 2001) and indirectly by ambient noise levels underwater and the behaviour the marine mammal is engaged in.

7.5 Assessment of Adverse Effects – Project Alone

7.5.1 Harbour Seal: Piling Noise

7.5.1.1 The predicted ranges for lethal or physical injury from a single strike was <50 m for all marine mammal species. With the adoption of a Piling Strategy which includes an MMMP which will ensure that marine mammals are outside of this range before piling begins there is negligible risk of lethal or physical injury to any marine mammal.

7.5.1.2 The predicted range of auditory injury in the form of Permanent Threshold Shift (PTS) (using both SPL_{zp} and SEL_{cum} metrics) was <50 m for the maximum hammer energy for both monopiles and pin piles. This suggests that alongside the adoption of appropriate mitigation (e.g. the use of an ADD prior to a soft start) to ensure that marine mammals are outside of this range before piling starts, the risk of PTS to any harbour seal is negligible.

7.5.1.3 According to the noise modelling detailed in Appendix 9.2 of the offshore EIA Report, in combination with the dose response curve used in the assessment derived from the seal responses detailed in (Russell *et al.*, 2016), the range at which harbour seals are predicted to experience disturbance is limited to between 5 and 6 km.

7.5.1.4 The number of animals predicted to be disturbed under each scenario are 12 seals for the 5,000 kJ monopile installation and 7 seals for the 3,000 kJ pin pile installation. These represent a maximum of 0.2% and 0.1% of the harbour seal reference population (Moray Firth Seal Management Area) respectively (Table 7.5.1).

Table 7.5.1: Number of Harbour Seals Disturbed by Monopile (5,000 kJ) and Pin-Pile (3,000 kJ) Foundation Installation at Location 1

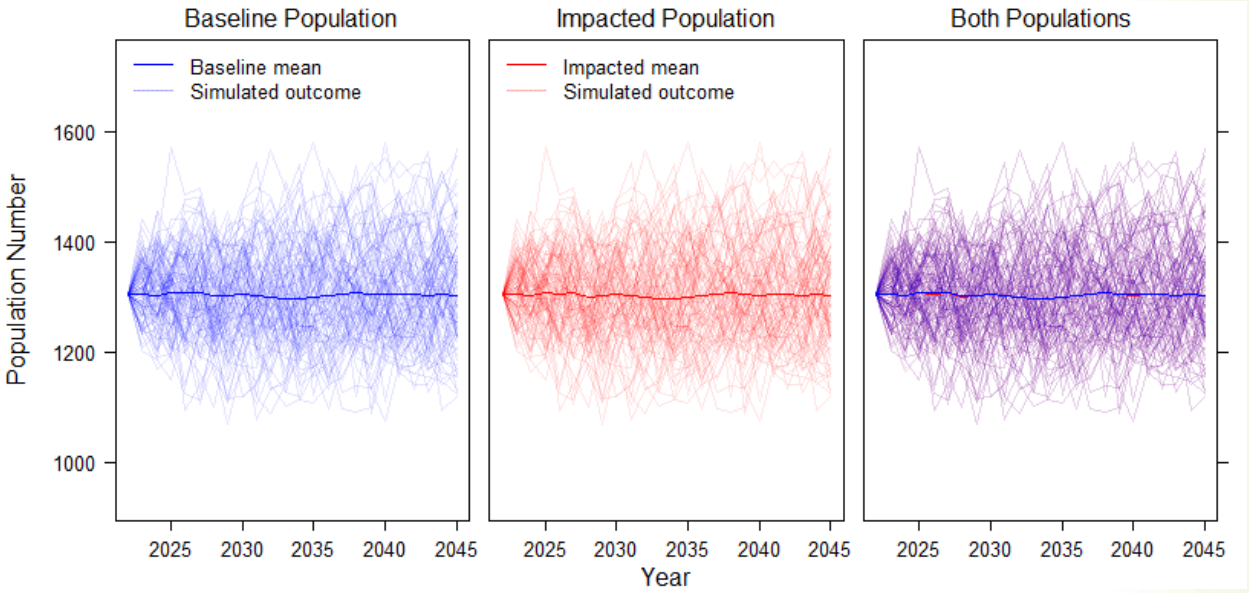
Foundation Type	Hammer Energy (kJ)	# Seals Impacted	% Population
Monopile	5,000	11.7	0.2 %
Pin pile	3,000	6.4	0.1%

7.5.1.5 The number of animals predicted to be disturbed by concurrent piling are given in Table 7.5.2. As a result of multiple operations installing two monopiles using 5,000 kJ hammer energy the number of animals predicted to be disturbed is 20 harbour seals. This represents a maximum of 0.4% of the harbour seal reference population (Moray Firth Seal Management Area) (Table 7.5.2).

Table 7.5.2: Number of Harbour Seals Predicted to Experience Behavioural Disturbance as a Result of the Concurrent Installation of Monopiles and Pin-Piles at Location 1 and 3

Foundation Type	Hammer Energy (kJ)	# Seals Impacted	% Population
Monopile Locations 1 & 3	5,000	19.6	0.40%
Monopile Locations 1 & 3	3,500	13.1	0.25%
Pin pile Locations 1 & 3	3,000	11.0	0.20%

7.5.1.6 Population modelling using the iPCoD framework demonstrated that there was no risk of a population level effect from this level of disturbance. Impacted simulations were virtually identical to baseline simulated populations with no difference in final population sizes when the population trajectory was simulated over a 25 year period. There was very little difference between foundation types and sequential vs concurrent scenarios. Graph 7.5.1 presents the simulated population trajectories from both baseline and impacted populations. Although there is considerable uncertainty in the future trajectory of both populations, there is no significant difference between impacted and baseline trajectories.



Graph 7.5.1 Simulated harbour seal population sizes for both the baseline and the impacted populations after single piling of monopiles at 5,000 kJ

7.5.1.7 In summary, the iPCoD modelling has indicated that this level of disturbance occurring over a maximum period of two breeding seasons will not result in any population level effects. In addition, with the adoption of a MMMP which will ensure that marine mammals are outside of the range of potential injury risk at the onset of piling, there is negligible risk of lethal or physical injury to any marine mammal.

7.5.1.8 Therefore there is considered to be no indication of an adverse effect on the integrity of the harbour seal feature of the Dornoch and Morrich More SAC as a result of pile driving noise.

7.5.2 Harbour Seal: Non-Piling Related Impacts

7.5.2.1 In addition to underwater noise from pile-driving during the installation of foundations, there is also potential for harbour seals to be affected by underwater noise generated from other construction activities such as vessel activity, seabed preparation for installation of gravity base structure foundations (e.g. dredging) and other activities in relation to cable installation (such as trenching).

7.5.2.2 Disturbance from vessel noise is only likely to occur where increased noise from vessel movements associated with the construction, operation and decommissioning of Moray West is greater than the background ambient noise. The current maximum design scenario assumes a total of two installation vessels (JUVs or HLVs) on site at the same time during construction and that each of these vessels may be accompanied by several other support vessels, tugs, and / or transport barges. During operation vessel activity will be lower than during construction but there will be a number of vessel visits per year to allow for scheduled and unscheduled maintenance. During the period of piling operations, it is therefore considered unlikely that vessel noise will impact marine mammal receptors at level additional to the piling activity itself. In fact, it is difficult to separate out the effect of vessel presence and activity from the effect of

pile driving in isolation, since the data collected to date on the response of animals to pile driving, will have included a degree of vessel activity in combination with the piling, therefore it could be considered that the typical vessel activity related to pile driving, may be already assessed to some extent under the pile driving related disturbance assessment. Individuals have more potential to be impacted by increased vessel movements during periods when piling is not taking place. The piling modelling assessment presented above assumes that individuals are disturbed on each day of piling, regardless of the duration of piling, plus a residual day of disturbance – this inclusion of residual disturbance and the assumption of all day disturbance, even when piling may only take a few hours, may account for the additional disturbance from vessels over and above piling related disturbance.

7.5.2.3 Harbour seals are expected to detect 2 kHz ship noise at approximately three km and 0.25 kHz at ranges of 20 km. These frequencies were chosen because most noise from construction / maintenance vessels is exhibited at these ranges (Richardson 1995). The distance at which animals may react is difficult to predict. Behavioural responses can vary a great deal depending on context and data specific to harbour porpoises and seals are sparse. According to Thomsen *et al.,* (2006) both porpoises and seals might be expected to respond to vessels of this type at approximately 400 m. There is very little published information on the responses of seals at sea to vessels. Jones *et al.,* (2017) presents an analysis of the predicted co-occurrence of ships and seals at sea which demonstrates that UK wide there is a large degree of predicted co-occurrence between ships and seals at sea, particularly within 50 km of the coast close to seal haul-outs. There is no evidence relating decreasing seal populations with high levels of co-occurrence between ships and animals and areas where seal populations are increasing (e.g. south east England) and where ship co-occurrences are highest, are experiencing the highest levels of growth (Jones *et al.,* 2017).

7.5.2.4 There is little evidence from marine mammal strandings in the UK that injury from vessel collisions is an important source of mortality (CSIP 2015).

7.5.2.5 As stated in Chapter 4: Description of Development, it is expected that up to two installation vessels (JUVs or HLVs) would be involved in foundation and WTG installation at any one time. Each of these vessels may be accompanied by several other support vessels, tugs, and/or transport barges. This does not represent a significant increase in vessel activity in the Moray West Site, where baseline summer vessel transits is on average 15 vessels per day and in winter is on average eight vessels per day.

7.5.2.6 Seals are relatively small and highly mobile, and are expected to detect vessels in close proximity and largely avoid collision.

7.5.2.7 Predictability of vessel movement by marine mammals is known to be a key aspect in minimising the potential risks imposed by vessel traffic (Nowacek *et al.,* 2001; Lusseau, 2003; 2006). The vessel management plan developed for the project will ensure that vessel traffic moves along predictable routes.

7.5.2.8 It is not expected that the level of vessel activity during construction would cause an increase in the risk of mortality from collisions. The adoption of a vessel management plan during construction that includes preferred transit routes and guidance for vessel operations in the vicinity of marine mammals and around seal haul-outs will minimise the potential for any impact.

7.5.2.9 The levels of increase in vessel activity will not represent a significant increase above baseline levels of ship activity in the Moray Firth and is not expected to increase the potential for disturbance or collision above that already experienced in the region. It is not expected that the level of vessel activity during operation would cause an increase in the risk of mortality from collisions, nor will it add significantly to levels of noise disturbance.

7.5.2.10 In the Moray Firth, sandeels dominate harbour seal diet in all seasons, and in the summer, where sandeel contribution to the diet was lowest, flatfish were important prey (Wilson and Hammond 2015). The fish and shellfish chapter of the EIA report concluded that there would be no significant impacts to any fish species that may be considered important prey for harbour seals. Furthermore, the assessment detailed in Section 8 below indicates that there will be no Adverse Effect on Integrity of the Moray Firth SAC with respect to the subtidal sandbank habitats comprising sandy sediments that support sandeels.

7.5.2.11 Suspended sediments could temporarily impair the foraging ability of marine mammals, although harbour seals have been demonstrated to be able to find food using their vibrissae (Hanke *et al.,* 2013) , so would be less affected by reductions in visibility. As highly mobile species, they are able to move away from areas of higher concentrations and return once the disturbance has ceased.

7.5.3 Assessment of the Potential for an Adverse Effect on the Dornoch and Morrich More SAC

7.5.3.1 The focus of the conservation objectives for the Dornoch and Morrich More SAC is to maintain the harbour seal population as a viable component of the site, to maintain the distribution, extent and functioning of the habitats supporting the species and to avoid significant disturbance to harbour seals.

7.5.3.2 The above objectives relate to the potential for the following impacts, which if they were to occur would compromise the harbour seal population as a viable component of the site:

- Killing or injuring a significant number of harbour seals;
- Disturbing a significant number of harbour seals;
- Exclusion over a significant portion(s) of the site; and
- Significant damage to relevant habitats leading to a reduction in the ability to support the harbour seal population (e.g. destruction to haul out sites or reduction in prey base).

7.5.3.3 The ranges for auditory injury presented above and the assessment of the potential for direct mortality through vessel collision indicate that there is no risk to the survival or viability of the species as a result of death or injury. Therefore there will be no Adverse Effect on Integrity in relation to the site's conservation objectives in relation to any injury or mortality.

7.5.3.4 In the context of a mobile species qualifying feature of a designated site, the effect of disturbance is the effective loss of available habitat, leading to costs to individual fitness which may be as a result of reduced foraging opportunities or the reduction in the ability to rest or display other behaviours essential to the health and reproduction potential of individuals. The assessment of disturbance in relation to underwater noise from construction activities and increased vessel use has indicated that the areas over which harbour seals may be disturbed are relatively small, and effects will be limited in duration. The numbers of individuals affected will be low. Population modelling has shown that this will have no impact on the future trajectory of the Moray Firth bottlenose population and therefore there will be no Adverse Effect on Integrity in relation to the site's conservation objectives in relation to any disturbance effect.

7.5.3.5 In the context of the harbour seal population associated with the Dornoch and Morrich More SAC, the 'structure, function and supporting processes' of habitats supporting the species relates to the availability and density of harbour seal prey within the foraging areas used by the seal population as well as the availability of suitable haul out sites. As discussed above, there is no significant effect predicted for any of the harbour seal prey species and all potentially disturbing activities are considerable distances from the haul out sites used by harbour seals. There is therefore no Adverse Effect on Site Integrity predicted in relation to habitat supporting the harbour seal population.

7.5.4 Bottlenose Dolphin: Piling Noise

7.5.4.1 The predicted ranges for lethal or physical injury from a single strike was <50 m for all marine mammal species. With the adoption of a MMMP which will ensure that marine mammals are outside of this range before piling begins there is negligible risk of lethal or physical injury to any marine mammal. The predicted range of PTS (using both SPL_{zp} and SEL_{cum}) was <50 m for the maximum hammer energy for both monopiles and pin piles. This suggests that alongside the adoption of appropriate mitigation to ensure that all marine mammals are outside of this range (e.g. the use of an ADD prior to a soft start) the risk of PTS to any bottlenose dolphin is negligible.

7.5.4.2 A total of 14 dolphins are predicted to be disturbed when piling is occurring at 5,000 kJ for monopile installation (worst case maximum hammer energy) (Table 7.5.3). For the 'most likely' maximum hammer energy of 3,500 kJ for monopiles, this number reduces to 12. These represent 6.96% and 5.9% of the bottlenose dolphin reference population (East Coast MU) respectively. The equivalent number for the worst case maximum hammer energy for pin pile installation is 10 dolphins, representing 5.1% of the population. The magnitude of the effect is therefore considered low in terms of the duration of the effect (a maximum of two breeding cycles).

Table 7.5.3: Number of Dolphins Potentially Disturbed by Monopile (5,000 kJ) and Pin-Pile (3,000 kJ) Foundation Installation at Location 1 Using the Harbour Porpoise Dose-Response Curve. Results are Shown Including and Excluding the Animals Present Within the Contours Between 120 and 130 dB.

Foundation Type	Hammer Energy (kJ)	120 – 170 dB		130 – 170 dB	
		# Dolphins Impacted	% Population	# Dolphins Impacted	% Population
Monopile	5,000	13.6	6.96%	13.2	6.76%
	3,500	11.5	5.90%	11.0	5.65%
	3,000	10.0	5.10%	9.4	4.84%
	2,500	8.8	4.51%	8.2	4.22%
	2,000	7.7	3.96%	7.1	3.65%
	1,000	4.9	2.52%	3.9	2.01%
Pin-pile	3,000	10.0	5.10%	9.4	4.84%

7.5.4.3 The number of animals predicted to be disturbed by concurrent piling are given in Table 7.5.4. A total of 15 dolphins (7.5% of the MU) are predicted to be disturbed when piling occurs at 5,000 kJ for two concurrent monopile installations (worst case maximum hammer energy).

Table 7.5.4: Number of Bottlenose Dolphins Predicted to Experience Behavioural Disturbance as a Result of the Concurrent Installation of Monopiles and Pin-Piles at Location 1 and 3

Foundation Type	Hammer Energy (kJ)	120 - 180		130 - 180	
		# Dolphins Impacted	% Population	# Dolphins Impacted	% Population
Monopile Locations 1 & 3	5,000	14.6	7.5%	14.2	7.3%
Monopile Locations 1 & 3	3,500	12.6	6.5%	12.2	6.2%

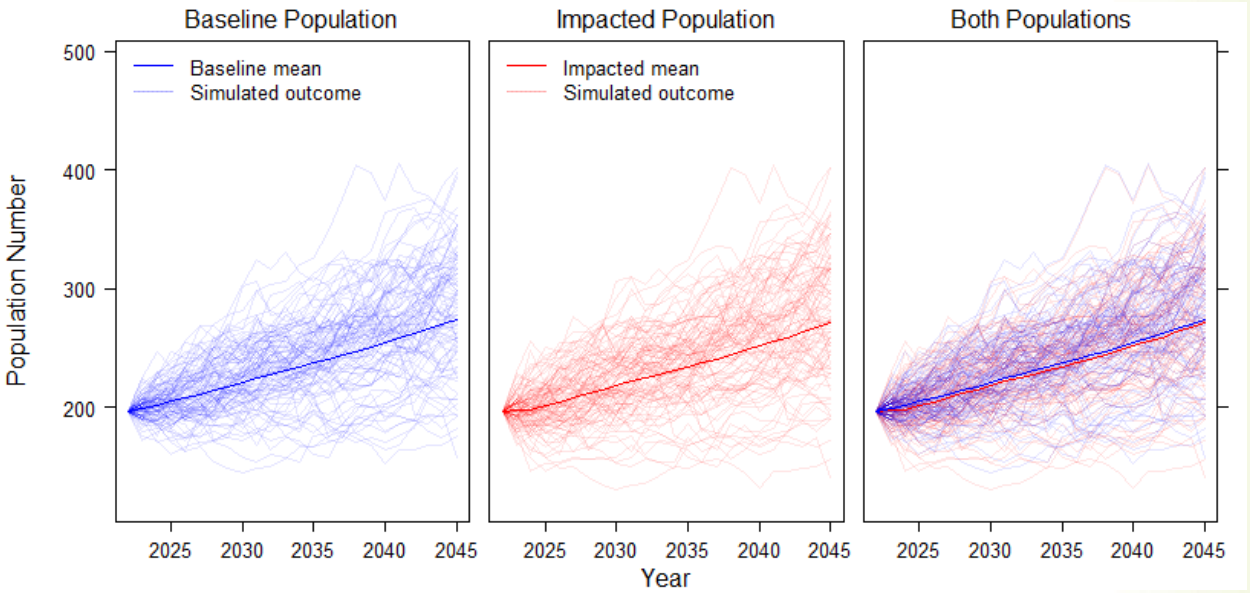
Table 7.5.4: Number of Bottlenose Dolphins Predicted to Experience Behavioural Disturbance as a Result of the Concurrent Installation of Monopiles and Pin-Piles at Location 1 and 3					
Foundation Type	**Hammer Energy (kJ)**	**120 - 180**		**130 - 180**	
		# Dolphins Impacted	**% Population**	**# Dolphins Impacted**	**% Population**
Pin-pile Locations 1 & 3	3,000	11.9	6.1%	11.4	5.8%

7.5.4.4 Although the number of dolphins predicted to be affected by disturbance is higher for concurrent piling, compared to single piling, the overall duration of the disturbance will be shorter if multiple vessels are operating. For the monopile scenarios, the concurrent scenarios resulted in an overall lower level of impact compared to the single piling scenarios. The differences were very small between the monopile single scenario and both single and concurrent pin-pile scenarios. Table 7.5.5 presents an overview of the results from all the bottlenose dolphin iPCoD simulations. Graph 7.5.2 presents the simulated population trajectory for the single pin-pile scenario and demonstrates that there is an initial drop in the population growth rate as a result of the predicted impact, but that the impacted population trajectory recovers and growth rate returns to equal that of the baseline population over the remainder of the simulations.

Table 7.5.5: Results of the iPCoD Modelling for Bottlenose Dolphins Under 6 Scenarios: Single Vessel Installation of Monopiles (5,000 kJ), Concurrent Installation of Monopiles (5,000 kJ), Single Vessel Installation of Monopiles (3,500 kJ), Concurrent Installation of Monopiles (3,500 kJ), Single Vessel Installation of Pin-Piles (3,000 kJ) and Concurrent Installation of Pin-Piles (3,000 kJ). Red Text Denotes which of the 6 Scenarios had the Worst Case Result for Each Output Metric							
Result Parameter		**MP 5000 Single**	**MP 5000 Concurrent**	**MP 3500 Single**	**MP 3500 Concurrent**	**PP_3000 _Single**	**PP_3000_C oncurrent**
Median Population Size Year 24	**Baseline**	274	273	272	274	272	277
	Impacted	270	272	268	274	268	272
	Difference in Median Popn size	4	1	4	0	4	5
	Impacted as % of baseline	98.5%	99.6%	98.5%	100.0%	98.5%	98.2%
Additional Risk of a 1% Decline	**Yr 1**	0.078	0.077	0.045	0.072	0.065	0.092
	Yr 6	0.045	0.032	0.047	0.025	0.053	0.03
	Yr 12	0.015	0.017	0.013	0.008	0.018	0.006
	Yr 18	0.005	0.008	0.007	0.003	0.003	0.003
	Yr 24	0	0.001	0.003	0.002	0.002	0
Ratio of the impacted to un-impacted population size across all 1000	**Yr 1 Min**	0.8652	0.8925	0.8687	0.8804	0.8523	0.8706
	Yr 6 Min	0.8596	0.8295	0.8272	0.8627	0.8447	0.8496
	Yr 12 Min	0.8346	0.8118	0.8283	0.8571	0.8276	0.8182
	Yr 18 Min	0.8352	0.8077	0.8182	0.8657	0.8333	0.8174
	Yr 24 Min	0.8345	0.8182	0.8344	0.8693	0.8333	0.7941

Table 7.5.5: Results of the iPCoD Modelling for Bottlenose Dolphins Under 6 Scenarios: Single Vessel Installation of Monopiles (5,000 kJ), Concurrent Installation of Monopiles (5,000 kJ), Single Vessel Installation of Monopiles (3,500 kJ), Concurrent Installation of Monopiles (3,500 kJ), Single Vessel Installation of Pin-Piles (3,000 kJ) and Concurrent Installation of Pin-Piles (3,000 kJ). Red Text Denotes which of the 6 Scenarios had the Worst Case Result for Each Output Metric

Result Parameter		MP 5000 Single	MP 5000 Concurrent	MP 3500 Single	MP 3500 Concurrent	PP_3000 _Single	PP_3000_C oncurrent
paired simulations	Yr 1 Median	1	1	1	0.9905	1	1
	Yr 6 Median	0.9914	0.9916	0.9915	0.9921	0.9904	0.9911
	Yr 12 Median	1	1	1	1	0.9912	0.9926
	Yr 18 Median	1	1	1	1	0.9928	1
	Yr 24 Median	1	1	1	1	0.9946	1
	Yr 1 Mean	0.9913	0.991	0.9922	0.9919	0.9929	0.9917
	Yr 6 Mean	0.9873	0.9915	0.9875	0.9924	0.9863	0.9881
	Yr 12 Mean	0.9879	0.9917	0.9885	0.9928	0.9869	0.989
	Yr 18 Mean	0.9878	0.9916	0.9885	0.9932	0.9869	0.9885
	Yr 24 Mean	0.9874	0.9917	0.9888	0.9932	0.9869	0.9889
Ratio of impacted to un-impacted annual growth rate	Yr 1 Min	0.8918	0.91	0.8632	0.8996	0.8533	0.8703
	Yr 6 Min	0.9596	0.9692	0.9703	0.9587	0.9444	0.9673
	Yr 12 Min	0.9747	0.9764	0.9788	0.9835	0.9806	0.9804
	Yr 18 Min	0.9819	0.9801	0.978	0.9839	0.9766	0.9796
	Yr 24 Min	0.9816	0.9722	0.9818	0.9735	0.9691	0.9727
	Yr 1 Median	0.9914	0.9995	0.9913	0.9998	0.99	0.993
	Yr 6 Median	1	1	1	1	1	1
	Yr 12 Median	1	1	1	1	1	1
	Yr 18 Median	1	1	1	1	1	1
	Yr 24 Median	1	1	1	1	1	1
	Yr 1 Mean	0.9905	0.9967	0.9899	0.9972	0.9857	0.9923
	Yr 6 Mean	0.9988	0.9995	0.9987	0.9995	0.9989	0.9989
	Yr 12 Mean	0.9997	0.9998	0.9996	1	0.9998	0.9997
	Yr 18 Mean	0.9999	1	1	1	0.9999	1
	Yr 24 Mean	1	1	1	0.9999	0.9999	0.9997
Centile for un-impacted population which matches the 50th centile for the impacted population	Yr 1	36	36	44	40	42	35
	Yr 6	45	46	44	45	42	43
	Yr 12	44	49	48	48	45	47
	Yr 18	46	47	48	47	48	47
	Yr 24	47	49	47	50	47	46



Graph 7.5.2 Simulated bottlenose dolphin population trajectories for both the baseline and the impacted populations for the single piling scenario for pinpiles at 3,000 kJ.

7.5.4.5 In summary, the iPCoD modelling has indicated that the predicted level of disturbance occurring over a maximum period of two breeding seasons will not result in a significant long term change in the population growth rate and no long term change in the population trajectory. Therefore there is considered to be no indication of an adverse effect on the integrity of the bottlenose dolphin feature of the Moray Firth SAC as a result of pile driving noise.

7.5.5 Bottlenose Dolphin: Non-Piling Related Impacts

7.5.5.1 In addition to underwater noise from pile-driving during the installation of foundations, there is also potential for bottlenose dolphins to be affected by underwater noise generated from other construction activities such as vessel activity, seabed preparation for installation of gravity base structure foundations (e.g. dredging) and other activities in relation to cable installation (such as trenching).

7.5.5.2 Disturbance from vessel noise is only likely to occur where increased noise from vessel movements associated with the construction, operation and decommissioning of Moray West is greater than the background ambient noise. The current maximum design scenario assumes a total of two installation vessels (JUVs or HLVs) on site at the same time during construction and that each of these vessels may be accompanied by several other support vessels, tugs, and / or transport barges. During operation vessel activity will be lower than during construction but there will be a number of vessel visits per year to allow for scheduled and unscheduled maintenance. During the period of piling operations, it is therefore considered unlikely that vessel noise in the vicinity of the piling activity will impact marine mammal receptors additional to the piling activity itself. As described above, it is difficult to separate out the effect of vessel presence and activity during construction from the effect of pile driving in isolation and the piling modelling assessment presented above may already take a large degree of vessel disturbance into account.

7.5.5.3 Behavioural responses can vary a great deal depending on context. Although bottlenose dolphins have been shown to change behaviour in response to vessel presence (Pirotta *et al.,* 2013), there is evidence that coastal bottlenose dolphins in the Moray Firth can compensate for any behavioural response to disturbance by commercial vessels: up to a six-fold increase in vessel traffic modelled in the Moray Firth did not affect changes in behavioural time budgets, spatial distribution, motivations and social structure (New *et al.,* 2013) suggesting that despite

large increases in the potential for disturbance, dolphins could avoid contact with vessels and retreat to undisturbed areas.

7.5.5.4 The predicted levels of increase in vessel activity resulting from the Moray West project alone will not represent a significant increase above baseline levels of ship activity in the Moray Firth and is not expected to increase the potential for disturbance above that already experienced in the region. It is not expected that the level of vessel activity during operation would cause an increase in the risk of mortality from collisions, nor will it add significantly to levels of noise disturbance. The adoption of a vessel management plan during operation and maintenance that includes preferred transit routes and guidance for vessel operation in the vicinity of bottlenose dolphins will minimise the potential for any impact.

7.5.5.5 Bottlenose dolphins eat a wide variety of fish, squid and crustaceans. In Scottish waters, cod, saithe and whiting were found to be the most common prey items in stomach contents of stranded and bycaught bottlenose dolphins (Santos *et al.,* 2001). The fish and shellfish chapter of the EIA report (Chapter 8: Fish & Shellfish Ecology) concluded that there would be no significant impacts to any fish species that may be considered important prey for bottlenose dolphins.

7.5.5.6 Suspended sediments could temporarily impair the foraging ability of marine mammals, although cetaceans largely rely upon echolocation for foraging, so would be less affected by reductions in visibility. As highly mobile species, they are able to move away from areas of higher concentrations and return once the disturbance has ceased.

7.5.6 Assessment of the Potential for an Adverse Effect on the Moray Firth SAC

7.5.6.1 The focus of the conservation objectives for the Moray Firth SAC is to maintain the bottlenose dolphin population as a viable component of the site, to maintain the distribution, extent and functioning of the habitats supporting the species and to avoid significant disturbance to bottlenose dolphins.

7.5.6.2 The above objectives relate to the potential for the following impacts:

- Killing or injuring a significant number of bottlenose dolphins;
- Disturbance to a significant number of bottlenose dolphins;
- Exclusion or disturbance preventing their use of a significant portion(s) of the site; and
- Significant damage to relevant habitats leading to a reduction in the ability to support the population (e.g. reduction in prey availability).

7.5.6.3 The ranges for auditory injury presented above and the assessment of the potential for direct mortality through vessel collision indicate that there is no risk to the survival or viability of the species as a result of death or injury. Therefore there will be no Adverse Effect on Integrity in relation to the site's conservation objectives in relation to any injury or mortality caused by the project.

7.5.6.4 In the context of a mobile species qualifying feature of a designated site, the effect of disturbance is the effective loss of available habitat, leading to costs to individual fitness which may be as a result of reduced foraging opportunities or the reduction in the ability to rest or display other behaviours (including social interaction) essential to the health and reproductive potential of individuals. The assessment of disturbance in relation to underwater noise from construction activities and increased vessel use has indicated that the areas over which dolphins may be disturbed are relatively small, and effects will be limited in duration. The numbers of individuals affected are predicted to be low. Population modelling has shown that this will have no impact on the future trajectory of the Moray Firth bottlenose dolphin population and therefore there will be no Adverse Effect on Integrity in relation to the site's conservation objectives in relation to any disturbance effect.

7.5.6.5 In the context of the bottlenose dolphin population associated with the Moray Firth SAC, the 'structure, function and supporting processes' of habitats supporting the species relates to the availability and density of prey within the foraging areas used by the dolphins. As discussed above, there is no significant effect predicted for any of the bottlenose dolphin prey species, nor on any benthic habitats, there is therefore no Adverse Effect on Site Integrity predicted in relation to habitat supporting the bottlenose dolphin population.

7.6 Assessment of Adverse Effects – In Combination

7.6.1 Approach to In-Combination Effects

7.6.1.1 The in-combination assessment considers the impacts associated with the Development together with other projects and plans. The projects and plans selected as relevant to the assessments presented within this section are based upon the results of a CIA screening exercise (Appendix 4.3). Each project on the CIA long list has been considered on a case by case basis for scoping in or out of the RIAA based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved.

Other Project, Plans and Impacts Requiring Consideration in the RIAA for Marine Mammals

7.6.1.2 Table 7.6.1 summarises the other plans, projects and impacts requiring consideration in the RIAA with respect to in-combination effects on marine mammal SACs.

Table 7.6.1: Projects Considered for Marine Mammal In-Combination Assessment

SAC	Qualifying Feature	Impacts Requiring Assessment	Project Requiring Consideration in the Breeding Season	Assessed Project Parameters
Dornoch and Morrich More SAC	Harbour seal	Underwater noise from piling	Beatrice Offshore Wind Farm	As built parameters included in the DSLP (84 x 7 MW turbines). #animals impacted was not quantified in assessment.
			Moray East Offshore Wind Farm	Consented Parameters (number of animals predicted to be disturbed during each piling event (522)) with most likely scenario of 100 WTGs (Piling Strategy) used for modelling.
Moray Firth SAC	Bottlenose dolphin	Underwater noise from piling / blasting	Beatrice Offshore Wind Farm	As built parameters included in the DSLP (84 x 7 MW turbines). No dolphins were predicted to be disturbed.
			Moray East Offshore Wind Farm	Consented Parameters (#dolphins predicted to be disturbed during each piling event (17)) with most likely scenario of 100 WTGs (Piling Strategy) used for modelling.
			Neart na Gaoithe	Revised application (54 WTGs, # dolphins disturbed per activity = 2).
			Inch Cape	Existing consent (213 WTGs, #dolphins disturbed per activity = 3).
			Seagreen	Revised application (120 WTGs, #dolphins disturbed per activity = 3).
			Aberdeen Harbour Expansion Project (AHEP)	Number of animals identified as being disturbed by blasting (53).

7.6.2 Harbour Seal

7.6.2.1 Table 7.6.2 presents compiled information on the predicted effects from a range of projects included in the quantitative cumulative assessment for harbour seals within the Moray Firth Management Area (population taken to be equivalent to the SAC population).

7.6.2.2 It is important to note that these assessments have used different methods and thresholds to indicate levels of disturbance and they are not generally comparable. In addition, the potential disturbance as a result of the construction of the Beatrice Offshore Wind Farm was not quantified, so it was not possible to include a quantitative estimate of the number of animals disturbed as a result of piling at the Beatrice Offshore Wind Farm.

7.6.2.3 The construction of the Moray East Offshore Wind Farm and Moray West Offshore Wind Farms are not expected to overlap in time therefore there is the possibility that some individuals may be repeatedly disturbed over a longer period (over one year during the Beatrice construction period, over one year during construction at Moray East and then over nine months during construction at the Moray West Offshore Wind Farm. Given uncertainties surrounding animal turnover and movements at this temporal and spatial scale it is very challenging to predict the overall level of disturbance. As detailed in Chapter 9 of the EIA report (Volume 2), simulations carried out to inform the EIA for both harbour seals and bottlenose dolphins indicated that the scenarios where projects carried out piling activity using single vessel piling had a slightly higher level of overall population level impact than scenarios where projects carried out concurrent piling activity leading to an overall shorter piling duration. Therefore the scenario where both Moray Firth projects were predicted to install with single piling vessels was used to inform this assessment (Table 7.6.2).

Table 7.6.2: Modelled Scenarios for the Harbour Seal In-Combination Scenarios. Shaded Cells Highlight the Median Counterfactual Values

Project	Pile Type	# WTG	# Piles	# Vessels	# Piles/Day	Total Piling Days	Piling	# Seals Disturbed	Construction Years	Source
Longest Duration (Single Vessel Installation)										
Moray East	PP	100	400	1	3	134	Year round	522	2019-2020	Moray East Piling Strategy and Moray East ES
Moray West	PP	85	340	1	3	133	Year round	7	2022-2023	This ES

Table 7.6.3: Results of the iPCoD Modelling for Harbour Seals Under the In-Combination Scenario

Result Parameter		Value
Median Population Size Year 24	**Baseline**	1,312
	Impacted	1,268
	#difference	44
	Impacted as % of baseline	96.65%
Additional Risk of a 1% Decline	**Yr 1**	0
	Yr 6	0.229

Table 7.6.3: Results of the iPCoD Modelling for Harbour Seals Under the In-Combination Scenario		
Result Parameter		**Value**
	Yr 12	0.099
	Yr 18	0.045
	Yr 24	0.013
Ratio of the impacted to un-impacted population size of 1000 paired simulations	**Yr 1 Min**	1
	Yr 6 Min	0.7821
	Yr 12 Min	0.8213
	Yr 18 Min	0.8169
	Yr 24 Min	0.8245
	Yr 1 Median	1
	Yr 6 Median	0.9661
	Yr 12 Median	0.9751
	Yr 18 Median	0.9769
	Yr 24 Median	0.9793
	Yr 1 Mean	1
	Yr 6 Mean	0.955
	Yr 12 Mean	0.9631
	Yr 18 Mean	0.966
	Yr 24 Mean	0.9687
Ratio of impacted to un-impacted annual growth rate of 1000 paired simulations	**Yr 1 Min**	1
	Yr 6 Min	0.932
	Yr 12 Min	0.991
	Yr 18 Min	0.9893
	Yr 24 Min	0.9882
	Yr 1 Median	1
	Yr 6 Median	0.991
	Yr 12 Median	1
	Yr 18 Median	1
	Yr 24 Median	0.9999
	Yr 1 Mean	1
	Yr 6 Mean	0.9883
	Yr 12 Mean	1.001
	Yr 18 Mean	1.001
	Yr 24 Mean	0.9996
	Yr 1	50
	Yr 6	10

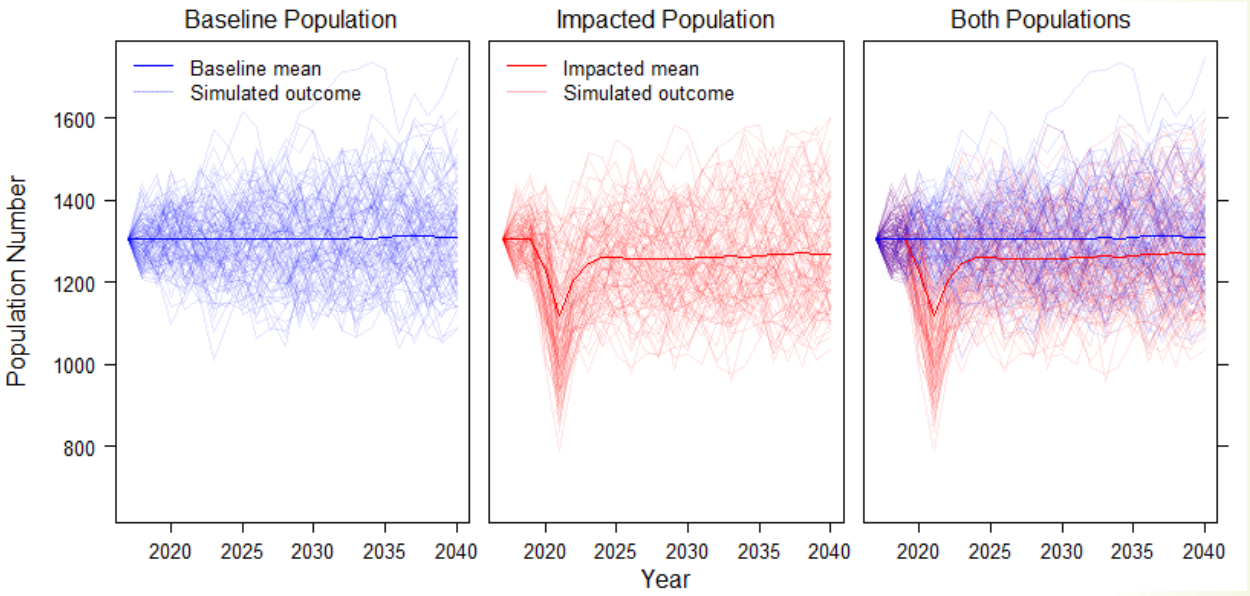
Table 7.6.3: Results of the iPCoD Modelling for Harbour Seals Under the In-Combination Scenario		
Result Parameter		**Value**
Centile for un-impacted population which matches the 50th centile for the impacted population of 1000 paired simulations	**Yr 12**	31
	Yr 18	33
	Yr 24	36

7.6.2.4 The simulations demonstrated that in probabilistic terms, there was an increase in the risk of population decline in the impacted population. In the sixth year of simulation there was a maximum of a 22.9% increase in the probability a 1% population decline and a 14.9% increase in the risk of a 2% decline (Table 7.6.4). This impact was short term, and by year 12, the increase in the probability of a 1% decline decreased from 22.9% to 9.9%, by year 18 had decreased to 4.5%, and by year 24 had decreased to 1.3%.

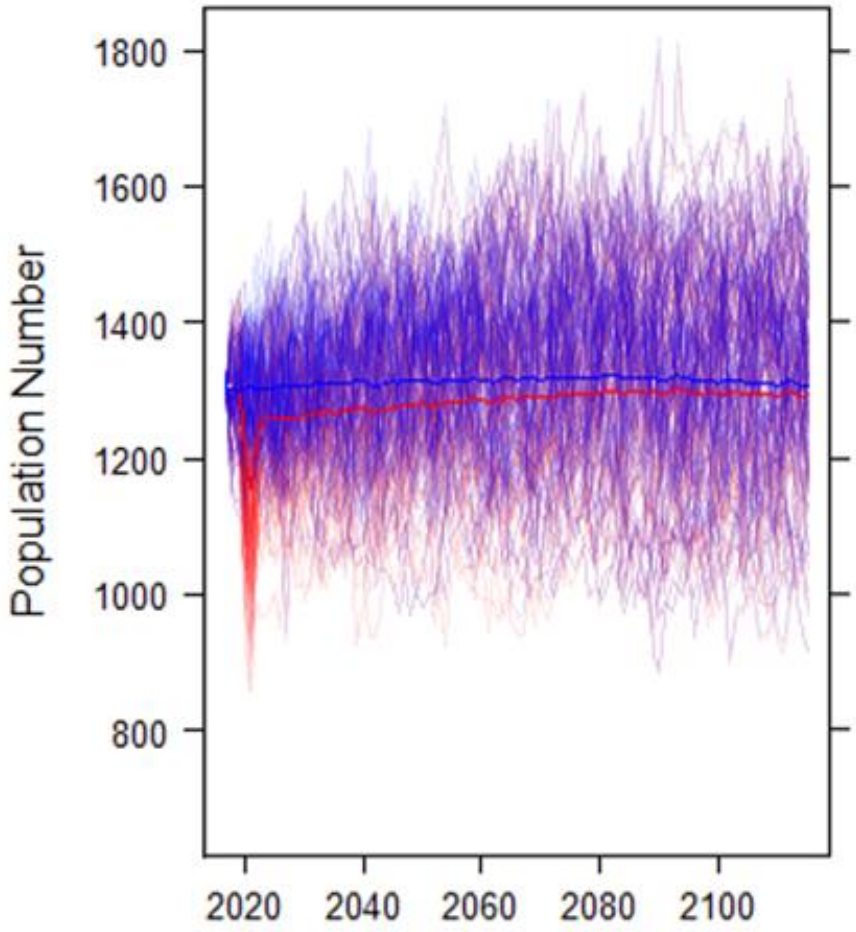
7.6.2.5 After 24 years of simulation, the median baseline population size (across 1,000 simulations) was 1312 (95% CI: 1108 - 1514), and the median impacted population size (across 1,000 simulations) was 1268 (95% CI: 1048 - 1492), This means that after a simulated 24 years the size difference between the median baseline and impacted population was 44 seals, but with a large overlap in confidence intervals.

7.6.2.6 The population trajectory for both the baseline and the impacted populations (the mean and each individual 1,000 simulated outcomes) are presented in Graph 7.6.1. This demonstrates that the mean impacted population is predicted to experience a decline in population size relative to the baseline population as a result of the impact, however, following the end of the disturbance the growth rate increases and the population size increases rapidly to a level where the population size is only slightly smaller than the baseline population size. The growth rate then slows down but remains slightly elevated above the baseline growth rate. When extending the duration of the population simulations to a longer period, it is evident that the impacted population size is predicted to eventually return to the same as the unimpacted population (Graph 7.6.2).

Table 7.6.4: Additional Risk of a 1, 2 and 5% Decline Across Years for the Harbour Seal Population Simulations Resulting from the Simulated Disturbance Predicted During the Longest Duration Cumulative Scenario			
Year of Simulation	**Additional Probability of a 1% Decline**	**Additional Probability of a 2% Decline**	**Additional Probability of a 5% Decline**
1	0	0	0
6	0.229	0.149	0
12	0.099	0.007	0
18	0.045	0	0
24	0.013	0	0



Graph 7.6.1 Simulated harbour seal population sizes for both the baseline and the impacted populations under the longest duration cumulative scenario



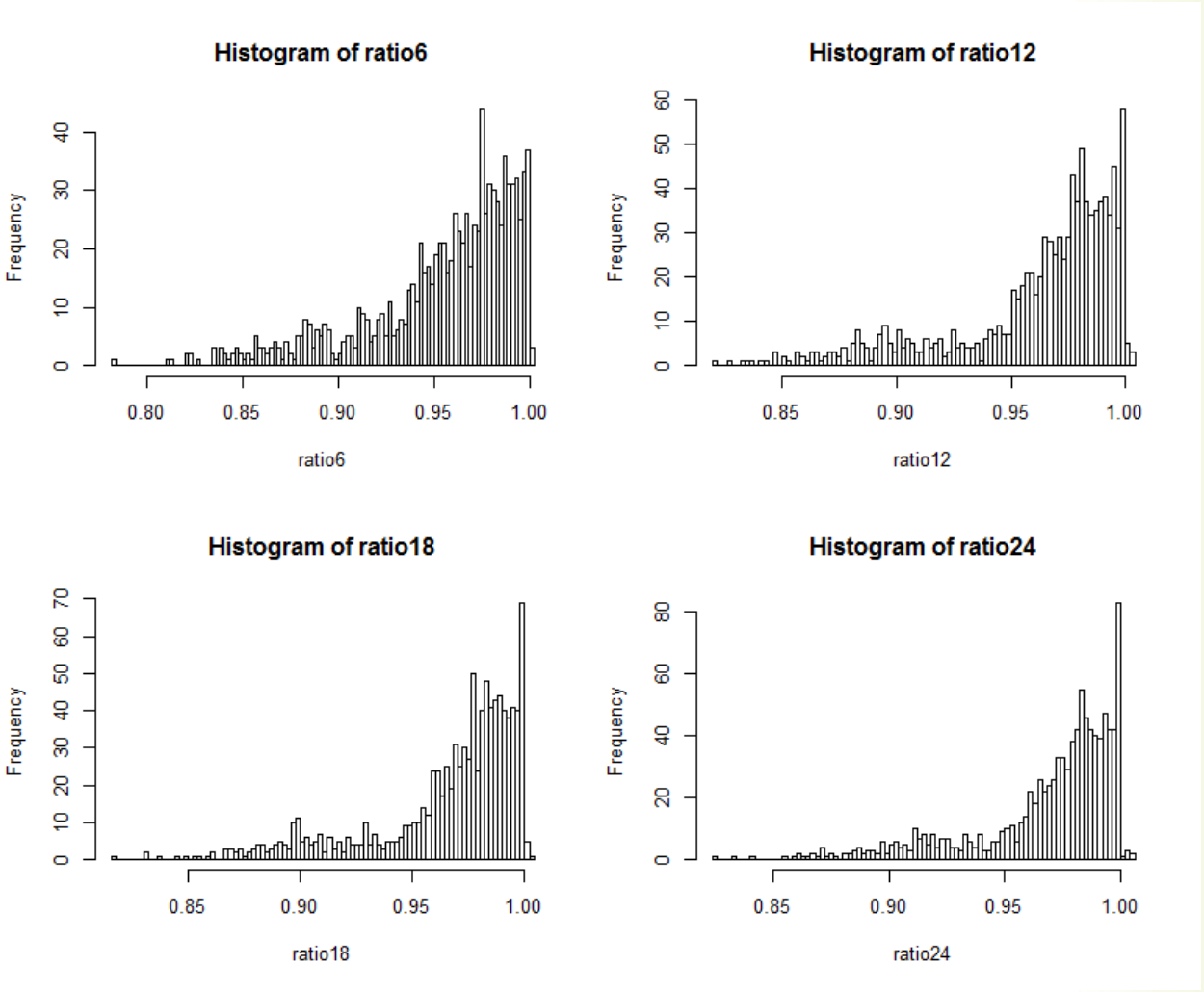
Graph 7.6.2 Simulated harbour seal population sizes for both the baseline and the impacted populations under the longest duration cumulative scenario over an extended period of 100 years.

Comparing Population Size Between Baseline and Impacted Simulations

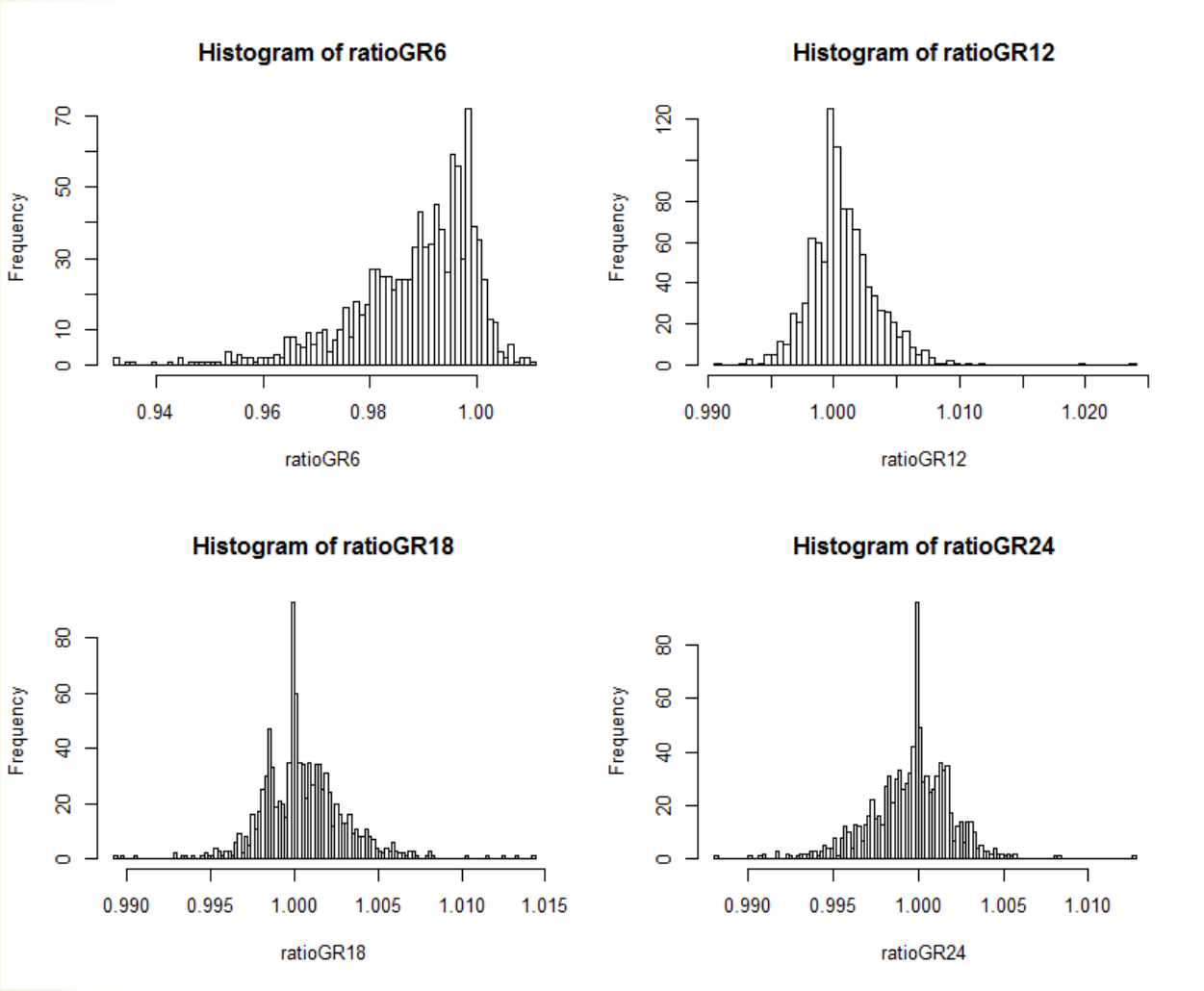
7.6.2.7 Across all 1,000 paired simulations, the median ratio of baseline and impacted population sizes was between 0.9661 and 0.9793 and the mean ratio of the impacted to the baseline population was between 0.955 and 9687 (excluding year 1) which indicates that some of the simulations resulted in impacted populations that were smaller than the paired baseline population in all simulation years, although the effect was very small; mean ratios (excluding year 1) were between 95.5 and 96.9% of the paired baseline population size (Table 7.6.5). The maximum ratio of the impacted to the baseline population (excluding year 1) ranged between 1.002 and 1.005, which means that in a very small number of the 1,000 paired simulations, the impacted population size was greater than that of the baseline population size. The minimum ratio between the impact and the baseline population size (excluding year 1) was between 0.78 and 0.82, which means that the minimum impacted population size (the lowest out of 1000 simulations) was between 78.21% and 82.45% of the size of the baseline population.

Table 7.6.5: Summary Statistics of the Ratio of the Impacted to Unimpacted Population Size Across Years for the 1,000 Harbour Seal Population Simulations for the Harbour Seal In-Combination Scenario

Year of Simulation	Minimum	1st Quartile	Median	Mean	3rd Quartile	Maximum
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	0.7821	0.9395	0.9661	0.9550	0.9842	1.0020
12	0.8213	0.9536	0.9751	0.9631	0.9880	1.0030
18	0.8169	0.9578	0.9769	0.9660	0.9894	1.0030
24	0.8245	0.9609	0.9793	0.9687	0.9903	1.0050



Graph 7.6.3 The ratio of the impacted population size to the baseline population size for each of the 1,000 paired simulations run for year 6, 12, 18 and 24 under the harbour seal in-combination scenario.



Graph 7.6.4 The ratio of the impacted population growth rate to the baseline population growth rate for each of the 1,000 paired simulations run for year 6, 12, 18 and 24 under the harbour seal in-combination scenario.

7.6.2.8 Since the Moray West Development alone scenarios (Section 7.5.1) showed no impact on the harbour seal population as a result of disturbance from Moray West, the population size shown in this cumulative assessment is driven entirely by the level of impact predicted for the Moray East Offshore Wind Farm.

7.6.2.9 There is a considerable difference between the numbers of harbour seals predicted to experience disturbance from the Moray East Offshore Wind Farm assessment in comparison to the Moray West Offshore Wind Farm assessment. This is due to the differences in the methods; in particular the difference in thresholds, dose response curves and density surfaces used.

7.6.2.10 For the displacement assessment, the Moray East Offshore Wind Farm used the previous harbour seal density surface based on telemetry data obtained between 1989 and 2009. In comparison the Moray West Offshore Wind Farm assessment used an updated density surface, incorporating 2014 and 2015 telemetry data into the habitat modelling. This resulted in the revised density surface having significantly fewer seals predicted in grid cells offshore and around both wind farm sites, compared to the earlier surface. In addition to this, the behavioural dose-response curve differed significantly between the two assessments. The Moray East Offshore Wind Farm assessment used the Thompson *et al.,* (2013) dose response curve, produced using harbour porpoise data from Horns Rev II (Brandt *et al.,* 2011). The Moray West Offshore Wind Farm assessment used the new dose-response curve based on harbour seal response data from Russell *et al.,* (2016). By comparison, the seal dose response curve from Russell and Hastie (2017) predicts a much lower probability of response below received SEL_{ss} of

170 dB compared to the Thompson *et al.,* (2013) dose response curve. The combination of the different density surface and the different dose response curve results in significantly fewer harbour seals predicted to experience disturbance in the Moray West Offshore Wind Farm assessment in comparison to the Moray East Offshore Wind Farm assessment.

7.6.2.11 As a result of the use of the more conservative harbour porpoise dose response curve and older telemetry data, the Moray East Offshore Wind Farm predictions are likely to be significant overestimates of the potential for disturbance. The predicted noise levels from the piling activity were not significantly higher than the noise levels from the activity assessed for the Moray West Offshore Wind Farm. As such, if this assessment was updated, using refined piling parameters from the Moray East Piling Strategy, and the updated methodology, the magnitude of impact would be expected to be similar to the quantified level of impact from the Moray West Offshore Wind Farm. There is no overlap in the timing of piling across both Moray Firth projects so any impact would be sequential therefore the overall impact would be expected to be of the magnitude of a single project, but extending over multiple projects.

7.6.2.12 Despite the predicted decline in population size as a result of the overestimated impacts of the Moray East piling, the harbour seal population is expected to recover after the disturbance and therefore no lasting population level effects are predicted. Since the numbers of seal predicted to be impacted by Moray East Offshore Wind Farm are likely to be significant overestimates, the true predicted population level effect would be much smaller than that presented in this in-combination assessment.

7.6.2.13 It is also noted that an application has recently been submitted for development of the Cromarty Port (May 2018). The EIA Report supporting this application indicates that Phase 4 (which will involve both percussion piling and vibropiling) is expected to take place between November 2018 and March 2019. Due to the timing of the availability of information on this development, it has not been possible to include this potential impact quantitatively. However, given that the piling / vibropiling activities are not expected to overlap with construction of the Moray West Offshore Wind Farm and that the assessment has not identified any significant effects on the harbour seal population it is not expected that this project would add significantly to potential disturbance at the management unit/population scale.

Conclusion

7.6.2.14 The predicted in-combination disturbance represents a small and temporary change in the trajectory of the harbour seal population. Therefore it is considered that there is no Adverse Effect on the harbour seal population as a result of displacement effects associated with the Moray West Offshore Wind Farm in-combination with other plans and projects.

7.6.3 Bottlenose Dolphin

7.6.3.1 As identified in Table 4.5.4, in the response to the HRA Screening Report, the Scottish Ministers advised that for bottlenose dolphin the following projects should be considered in a quantitative way:

- Beatrice Offshore Wind Farm;
- Moray East Offshore Wind Farm;
- Neart na Gaoithe (NNG) Offshore Wind Farm;
- Inch Cape Offshore Wind Farm; and
- Seagreen Offshore Wind Farm.

7.6.3.2 It was also advised that for the Forth and Tay sites the worst case of the 2014 consents or the 2017 proposals should be considered in the in-combination assessment. Other projects were advised to be included qualitatively.

7.6.3.3 MS-LOT also advised that on the basis of the previous consents for NNG and Seagreen, they may be removed from the iPCoD cumulative impact assessment based on the grounds that, with the current best information available in the public domain, these developments predicted that no bottlenose dolphins would experience disturbance or PTS. This information has been taken from the Appropriate Assessment for Aberdeen Harbour Expansion Project (AHEP). However, since this advice was given, updated information has become available from both these projects, both of which predict a small number of dolphins will potentially experience disturbance from piling activities. Therefore both NNG and Seagreen have been included in the in-combination assessment, based on their revised design envelopes and revised assessments. The worst case for the Inch Cape project remains the existing consent, largely as a result of the much higher number of turbines and therefore a longer period of disturbance than is expected in the revised project.

7.6.3.4 The east coast offshore wind farm demonstration sites (Aberdeen Bay, Hywind, Kincardine and Forthwind), are not considered in this in combination assessment since percussive pile driving is not anticipated at any of these sites and SNH have previously advised that these four wind farms will not give rise to any significant levels of bottlenose dolphin disturbance.

7.6.3.5 Aberdeen Harbour Expansion Project has been included in this assessment. The number of animals that could be disturbed by blasting at AHEP could be up to 53 in total, which is all of the animals thought to use the area between Aberdeen and Stonehaven. No animals were considered to be exposed to noise levels sufficient to cause PTS. MS-LOT also advised that impact piling does not need to be included in the assessment since AHEP have now undertaken to use rotary piling. It is our understanding that blasting works have yet to commence at the project, but are likely to do so in 2018.

7.6.3.6 In order to incorporate AHEP in the in-combination assessment using the iPCoD framework for population modelling, there are three requirements:

- An estimate of the number of animals disturbed on a single day of the activity;
- An estimate of the total number of days on which that activity will take place; and
- A schedule of when these days of activity are likely to take place.

7.6.3.7 To address the first of these, the disturbance impact range of 7.17 km was obtained from the Environmental Statement (ES) for the AHEP, this was applied to the same underlying density surface as used in the Moray West Offshore Wind Farm assessment. This provided an estimate for the number of dolphins predicted to experience disturbance on a single day.

7.6.3.8 For the latter two requirements, an approximate blasting schedule can be extracted from information in the Appropriate Assessment and the Construction Environmental Management Plan Document (Chapter 7) for AHEP. Specifically, the blasting is expected to take place once or twice a day and will be followed by dredging for a period of up to one week (i.e. a break in blasting for up to one week); these works are expected to last for up to seven consecutive months. Based on this information, one day of blasting followed by a seven day break over a seven month period, between May and October 2018 was used as an estimate of the blasting schedule.

7.6.3.9 Impacts from the other port developments in the Moray Firth were not included in the population modelling for the following reasons:

- Port of Ardersier Ltd have gone into administration and there is currently no publicly available information on the future plans for the site; and
- Port of Cromarty Firth: Although an application was made in May 2018, information from the EIA Report submitted with the application was not available in sufficient time for inclusion in the population modelling carried out for the Moray West Offshore Wind Farm

(submitted early June 2018). However, information from the application and findings from the assessment have been considered in the assessment from qualitative perspective.

7.6.3.10 The scenario assessed here for the Moray East Offshore Wind Farm is based upon advice from the Moray East ES (2012) and the Moray East Piling Strategy (Moray East, 2017). The Moray East Piling Strategy is based on the construction of 100 WTGs (Project One of the Telford, Stevenson and MacColl consents), rather than the 339 WTGs assessed in the Moray East ES (2012). The Piling Strategy is therefore considered to be more representative of the realistic worst case scenario for the Moray East offshore wind farm development in terms of turbine numbers which comprises 100 turbines and three OSPs. The Piling Strategy is also based on the use of two concurrent vessels (as opposed to six concurrent piling vessels presented in the Moray East ES (2012)). This assessment assumes that the number of animals disturbed on one day of piling is as presented in the Moray East ES (2012) based on the worst case hammer energy parameters.

7.6.3.11 The Moray East ES (2012) anticipated piling over a maximum of five years (2016 to 2020). However, this has been also revised, with construction of the Moray East Offshore Wind Farm, based on the realistic worst case scenario, now expected to take up to 12 months to complete, commencing in 2019.

7.6.3.12 The number of bottlenose dolphins predicted to experience disturbance as a result of the Moray East assessment is likely to be a significant overestimate of actual disturbance due to the fact that the Moray East Offshore Wind Farm assessment used the previous bottlenose dolphin density surface models which predicted bottlenose dolphin presence in the outer Moray Firth and along the Northern coast. The results of the ECOMMAS surveys have found that these dolphins are more likely to be Risso's or white-beaked dolphins based on their click characteristics (Palmer *et al.,* 2017). As a result, the bottlenose dolphin density surface model used in the Moray East Offshore Wind Farm assessment was revised for the Moray West Offshore Wind Farm assessment by re-distributing bottlenose dolphins from the northern coast to the coastal inner Moray Firth. Since the Moray East Offshore Wind Farm is further northeast and more offshore than Moray West Offshore Wind Farm, it is actually more likely that the number of bottlenose dolphins predicted to experience behavioural disturbance from the Moray East Offshore Wind Farm will be lower than that for Moray West Offshore Wind Farm as the Moray East Site is further from the density surface grid cells that are predicted to contain bottlenose dolphins. However, keeping the predictions of impact from the Moray East Offshore Wind Farm assessment will ensure a precautionary assessment.

7.6.3.13 The population modelling carried out to inform the Offshore EIA Report demonstrated that the longest duration scenarios from each of the different projects, where sequential rather than concurrent construction was modelled was slightly worse in terms of long term population impacts than concurrent construction with multiple vessel piling. This is detailed in Section 9.8.2 of Chapter 9 of the EIA Report (Volume 2). Therefore the longest duration construction scenario from each project has been combined in the population modelling to inform the assessment on SAC integrity.

7.6.3.14 There was also a significant difference in the long term population trajectory of the impacted population depending on whether auditory injury in the form of PTS was included in the predicted impacts. The only project which predicted any bottlenose dolphins would experience PTS was the consented Inch Cape Project which predicted that up to 1.2 dolphins would experience PTS per piling day under the single scenario, and up to 1.9 dolphins would experience PTS per piling day under the concurrent scenario. However, Inch Cape have obligations in terms of the Section 36 consent to produce a piling strategy which has due regard to marine mammals (see condition 11) and also to implement a PEMP in terms of condition 24. This provides specifically for marine mammals in sub-paragraph (b).

To understand the effect of the predicted level of PTS on the population level consequences and to differentiate it from the effects of disturbance, the worst case cumulative scenario was also run without any PTS included.

Table 7.6.6: Modelled Scenario for the In-Combination Assessment

Project	# WTG	# Piles	# Vessels	# Piles/Day/ vessel	Total Piling Days	Piling	# Dolphins Disturbed per Activity	# Dolphins with PTS per activity	Years	Source
Moray East	100	400	2	3	134	Year round	17	0	2019-2020	Moray East Piling Strategy
Inch Cape (consented)	213	852	1	2	426	Year round	3	1.2	2020-2021	Inch Cape ES old
NNG (revised)	54	324	1	6	54	Year round	2	0	1/7/21 - 30/9/22	NNG ES 2018
Seagreen (revised)	120 (70 A, 50 B)	480	1	2	240	Year round (80% between Apr-Oct)	3 A 2 B	0	2022-2023	Pre-application information
Moray West	85	85	1	3	133	year round	10	0	2022-2023	This ES
Aberdeen Harbour Expansion	NA	NA	NA	2 blasts	36	May-Nov	4	0	2018	AHEP & MS-LOT

Population Modelling Results

7.6.3.15 Under the longest duration cumulative scenario with PTS from Inch Cape included, the simulations demonstrated that in probabilistic terms, there was an increase in the risk of population decline in the impacted population. In the sixth year of simulation there was a maximum of a 48.1% increase in the probability of a 1% population decline and a 40.5% increase in the risk of a 2% decline (Table 7.6.6). This impact was long term, and by year 24, the increase in the probability of a 1% decline was still at 58.9%.

7.6.3.16 After 24 years of simulation, the median baseline population size (across 1,000 simulations) was 274 (95% CI: 174 - 388), and the median impacted population size (across 1,000 simulations) was 130 (95% CI: 30 - 302). This means that after a simulated 24 years the size difference between the median baseline and impacted population was a total of 144 individuals and the impacted population size was only 47% of the baseline population size (Table 7.6.7). Therefore, there was a very significant difference between the predicted baseline (unimpacted) and impacted population sizes as a result of the predicted levels of disturbance and PTS.

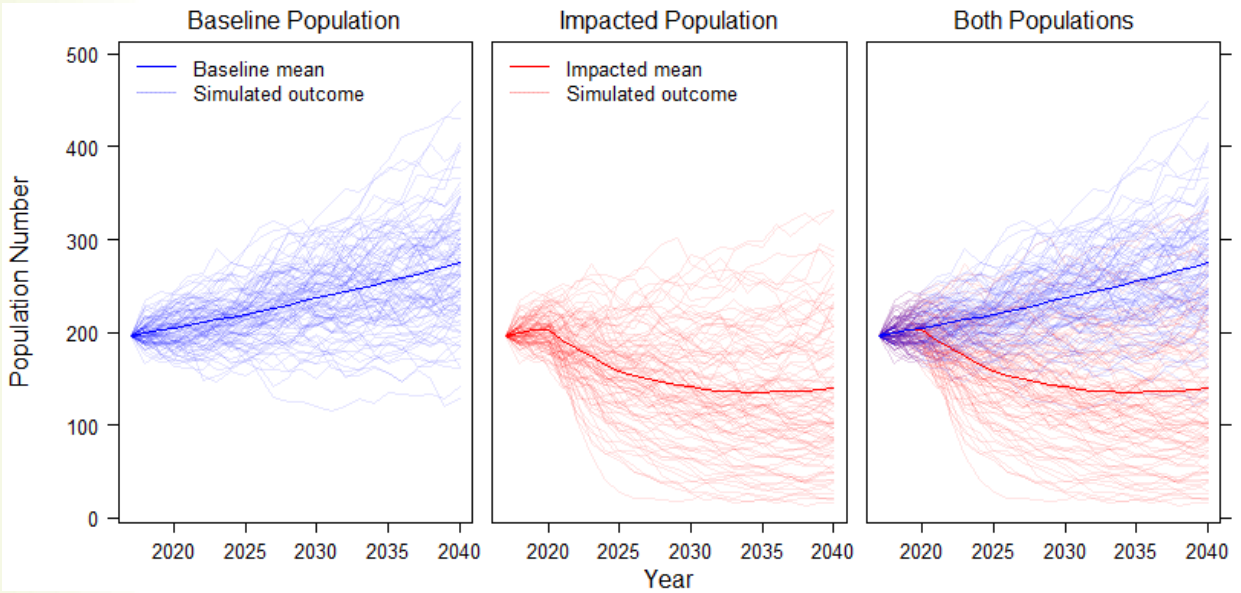
Table 7.6.7: Results of the iPCoD Modelling for Bottlenose Dolphins Under the Two In-Combination: Single Piling (Longest Duration) with PTS and Single Piling (Longest Duration) without PTS. Shaded Cells Highlight the Median Counterfactual Values

Result Parameter		Longest Duration (with PTS)	Longest Duration (no PTS)
Median Population Size Year 24	**Baseline**	274	272
	Impacted	130	256
	# animals difference	144	16

Table 7.6.7: Results of the iPCoD Modelling for Bottlenose Dolphins Under the Two In-Combination: Single Piling (Longest Duration) with PTS and Single Piling (Longest Duration) without PTS. Shaded Cells Highlight the Median Counterfactual Values			
Result Parameter		**Longest Duration (with PTS)**	**Longest Duration (no PTS)**
	Impacted as % of baseline	47.4%	94.1%
Additional Risk of a 1% Decline	**Yr 1**	0	0
	Yr 6	0.481	0.171
	Yr 12	0.636	0.082
	Yr 18	0.648	0.037
	Yr 24	0.589	0.018
Ratio of the paired impacted to un-impacted population size	**Yr 1 Min**	1	1
	Yr 6 Min	0.2712	0.6638
	Yr 12 Min	0.06977	0.6471
	Yr 18 Min	0.07246	0.5918
	Yr 24 Min	0.06034	0.54
	Yr 1 Median	1	1
	Yr 6 Median	0.84	0.9912
	Yr 12 Median	0.627	0.9917
	Yr 18 Median	0.5296	0.9932
	Yr 24 Median	0.4922	1
	Yr 1 Mean	1	1
	Yr 6 Mean	0.8187	0.946
	Yr 12 Mean	0.6121	0.9479
	Yr 18 Mean	0.5277	0.9446
	Yr 24 Mean	0.4988	0.9456
Ratio of paired impacted to un-impacted annual growth rate	**Yr 1 Min**	0.9608	0.9688
	Yr 6 Min	0.9529	0.9612
	Yr 12 Min	0.7065	0.9688
	Yr 18 Min	0.785	0.9674
	Yr 24 Min	0.8412	0.9595
	Yr 1 Median	1	1
	Yr 6 Median	1.076	1
	Yr 12 Median	0.9654	1
	Yr 18 Median	0.9865	1
	Yr 24 Median	1.008	1
	Yr 1 Mean	0.9994	0.9995

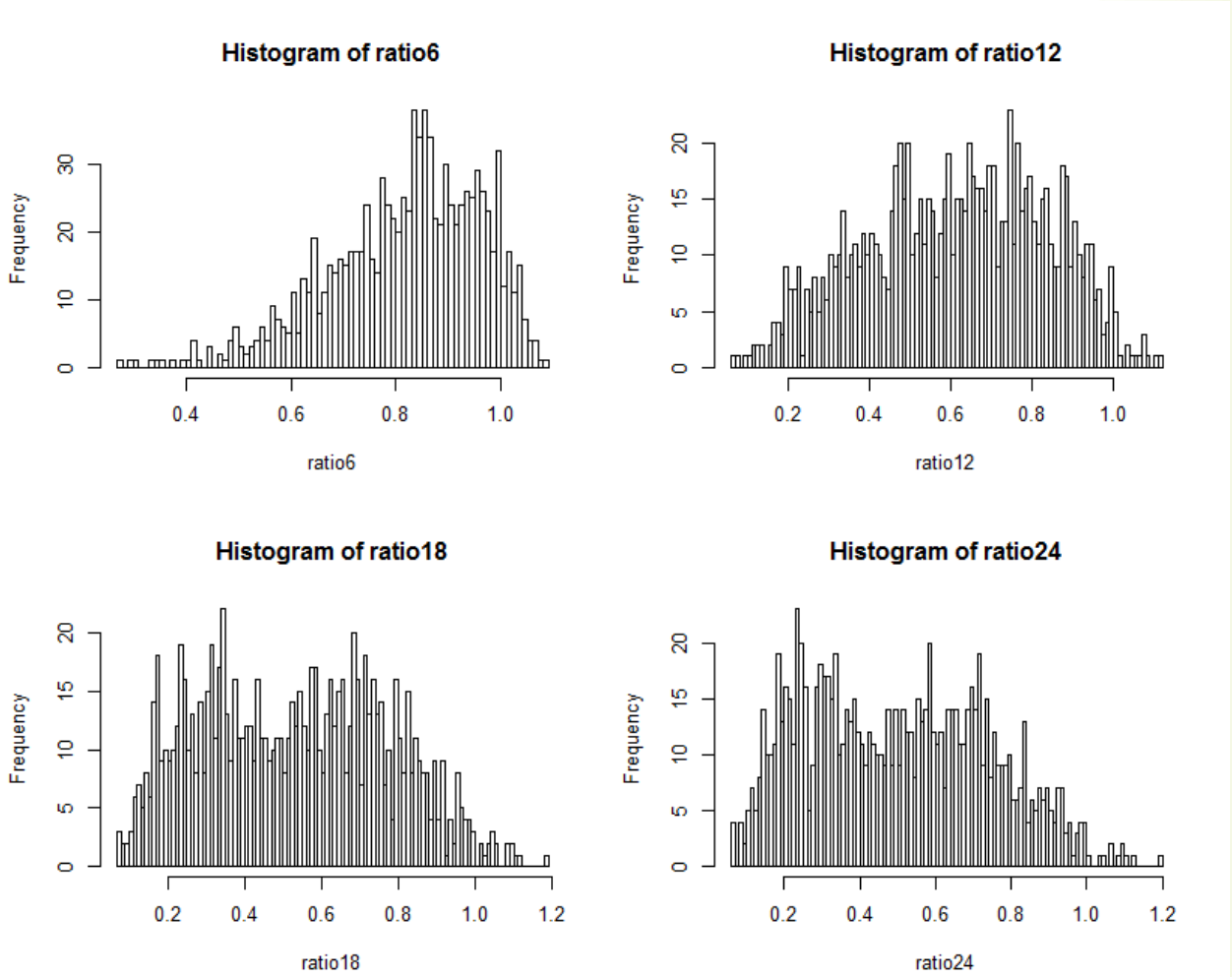
Table 7.6.7: Results of the iPCoD Modelling for Bottlenose Dolphins Under the Two In-Combination: Single Piling (Longest Duration) with PTS and Single Piling (Longest Duration) without PTS. Shaded Cells Highlight the Median Counterfactual Values			
Result Parameter		**Longest Duration (with PTS)**	**Longest Duration (no PTS)**
	Yr 6 Mean	1.097	1.021
	Yr 12 Mean	0.9571	1
	Yr 18 Mean	0.9844	1
	Yr 24 Mean	1.009	1
Centile for un-impacted population which matches the 50th centile for the impacted population	**Yr 1**	50	50
	Yr 6	8	36
	Yr 12	1	36
	Yr 18	1	38
	Yr 24	1	39

7.6.3.17 The population trajectory for both the baseline and the impacted populations (the mean and each individual of the 1,000 simulated outcomes) are presented in Graph 7.6.5. This demonstrates that the mean impacted population is predicted to experience a decline in population size at the end of year 2020 and continues to decline in size from a mean population size of 202 at the start of 2020 to a lowest mean population size of 136 at the start of year 2033, after which it increases slightly to a mean population size of 140 by the start of 2040. This therefore demonstrates a significant long term population effect of the cumulative scenario with PTS on the bottlenose dolphin population.



Graph 7.6.5 Simulated bottlenose dolphin population sizes for both the baseline and the impacted populations under the in-combination scenario including disturbance and PTS

7.6.3.18 The detailed comparison of both impacted and baseline populations are shown in Graph 7.6.6. Across all 1,000 paired simulations, the median ratio of paired baseline and impacted population sizes was between 0.49 and 0.84, the mean ratio of the impacted to the baseline population was between 0.50 and 0.82 and the 3rd quartile ratio was between 0.50 and 0.93 (excluding year 1) which indicates that most of the simulations resulted in impacted populations that were smaller than the paired baseline population in all simulation years (excluding year 1).



Graph 7.6.6 The ratio of the impacted population size to the baseline population size for each of the 1,000 paired simulations run for year 6, 12, 18 and 24 under the in-combination scenario including PTS and disturbance

7.6.3.19 However, the inclusion of PTS impacts as a result of the consented Inch Cape project design is not necessarily appropriate for the in-combination assessment. There are a number of differences between the methodology used in the original Inch Cape assessment and current best practice. These are detailed below:

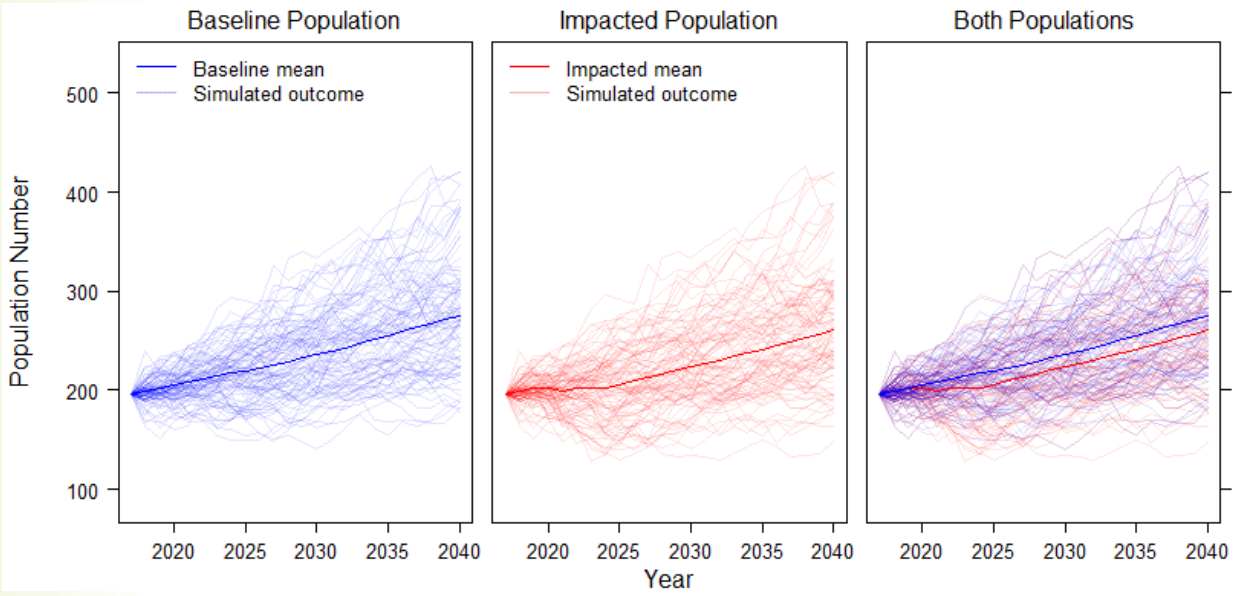
- The original consent application assessment used the Southall *et al.,* (2007) PTS SEL threshold and weighting for impulsive noise (M_{lf} weighted SEL 198 dB re 1 µPa^2/s) which is likely to have overestimated the PTS risk relative to the use of the updated National Marine Fisheries Service (2016) weighting which is more closely aligned to the functional group's audiogram compared to the 'flat' weighting of the Southall M weighting functions.
- The assessment used the SAFESIMM framework to predict the number of animals at risk; SAFESIMM adopts highly precautionary assumptions in relation to animal responsive movement, where animals move in a 'directed random walk' in response to exposure rather

than the direct 'fleeing' assumed in other models. In addition the swim speeds adopted are much lower than the values agreed in the current assessment.

7.6.3.20 As a result of these considerations, if the consented Inch Cape piling parameters were assessed using the same methodology applied in the revised assessment, no PTS would be predicted. Therefore the in-combination scenario was repeated without the inclusion of PTS at Inch Cape. This is considered to be a more likely and realistic scenario, given the results of the revised Inch Cape modelling and the adoption of an MMMP which should ensure that the PTS zone is clear of marine mammals before the onset of piling.

7.6.3.21 The removal of PTS at Inch Cape clearly had a significant effect on the population trajectory results compared to the scenario with PTS. Without the impact of PTS at Inch Cape, the impacted population size after 24 years was 94.1% of the size of the baseline population. With PTS included, the model predicted a 48% increase in the risk of a 1% decline in year 6, compared to the model with no PTS which predicted only a 17% increase in the risk of a 1% decline in year 6.

7.6.3.22 The model without PTS resulted in no significant long term population effect. The population trajectory for both the baseline and the impacted populations (the mean and each individual of the 1,000 simulated outcomes) are presented in Graph 7.6.7. This demonstrates that the mean impacted population is predicted to experience an initial decline in growth rate relative to the baseline population, after which it then returns to the same growth rate as the baseline population and continues to increase at the same rate as the baseline population for the remainder of the simulations.



Graph 7.6.7 Simulated bottlenose dolphin population sizes for both the baseline and the impacted populations under the in-combination scenario without PTS

Comparing Baseline and Impacted Population Sizes

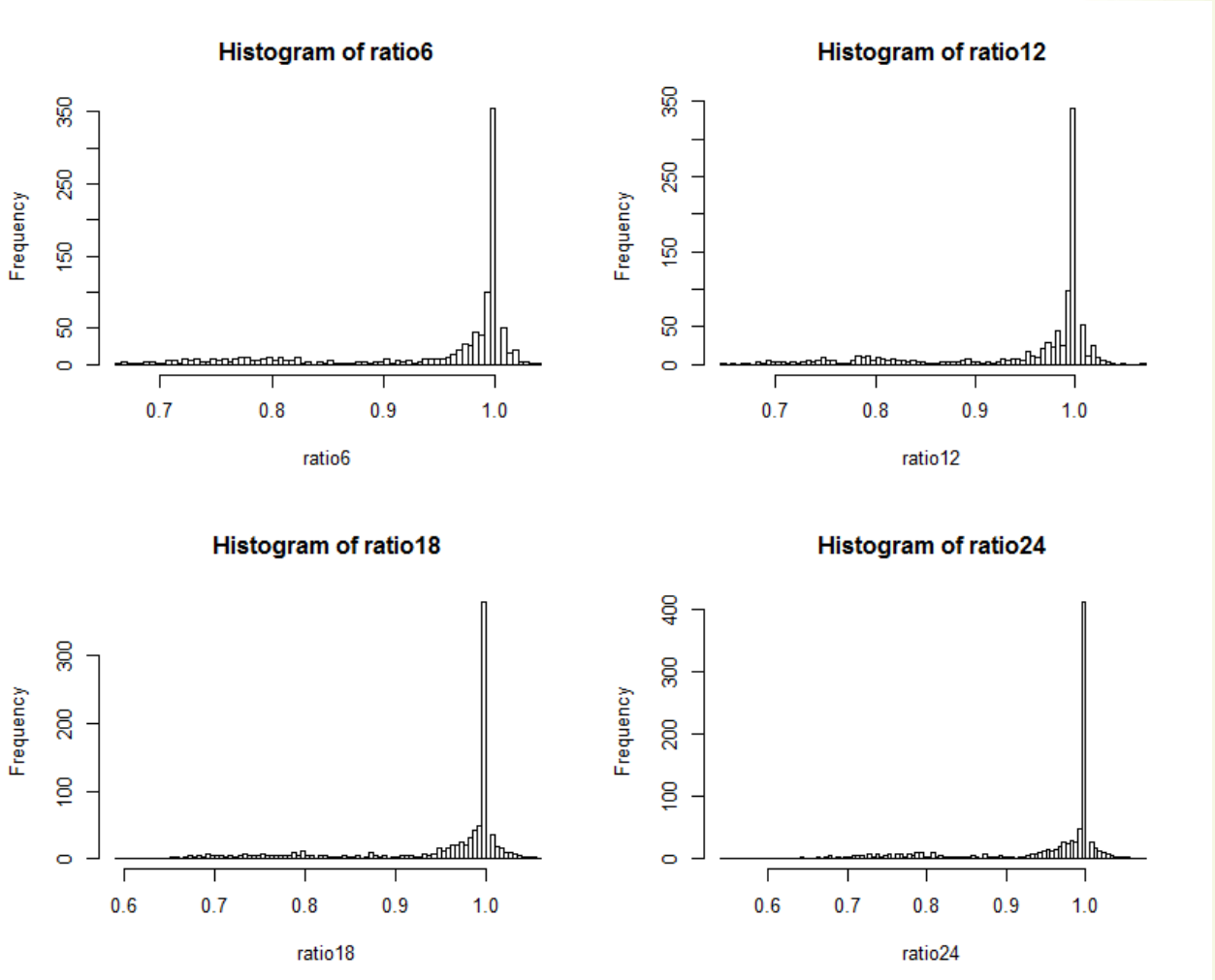
7.6.3.23 Across all 1,000 paired simulations, the median ratio of baseline and impacted population sizes was between 0.99 and 1.00 and the mean ratio of the impacted to the baseline population was around 0.94 (excluding year 1) which indicates that a small number of the simulations resulted in impacted populations that were smaller than the paired baseline population across all simulation years, although the effect was very small; mean ratios (excluding year 1) were between 94.5 and 94.8% of the paired baseline population size (Table 7.6.8). The maximum ratio of the impacted to the baseline population (excluding year 1) ranged between 1.04 and 1.07, which means that in a very small number of the 1,000 paired simulations, the

impacted population size was greater than that of the baseline population size. The minimum ratio between the impact and the baseline population size (excluding year 1) was between 0.54 and 0.66, which means that in the most extreme of the paired simulations, the minimum impacted population size was between 54% and 66% of the size of the baseline population.

7.6.3.24 The ratio of the impacted to baseline population size is further demonstrated in Graph 7.6.8 which clearly demonstrates that in most of the 1,000 paired simulations, the impacted population size is equal to or only slightly less than the baseline population size.

Table 7.6.8: The Ratio of Impacted to Baseline Population Size in Years 1, 6, 12, 18 and 24 across all 1,000 Paired Bottlenose Dolphin Population Simulations for the Longest Duration Cumulative Scenario Without PTS

Year	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
1	1	1	1	1	1	1
6	0.6638	0.9444	0.9912	0.946	1	1.039
12	0.6471	0.94	0.9917	0.9479	1	1.067
18	0.5918	0.9393	0.9932	0.9446	1	1.059
24	0.54	0.9405	1	0.9456	1	1.074



Graph 7.6.8 The ratio of the impacted population size to the baseline population size for each of the 1,000 paired simulations run for year 6, 12, 18 and 24 under the longest duration cumulative scenario without PTS

7.6.3.25 Overall, for the in-combination scenario without PTS, the bottlenose dolphin population showed a small initial decline relative to the baseline as a result of the disturbance events, after which it then returned to the same growth rate as the baseline population and continued to increase at the same rate as the baseline population for the remainder of the simulations. Therefore, there is no predicted long term effect on the East Coast Scotland bottlenose dolphin population as a result of the cumulative disturbance from the Moray East Offshore Wind Farm, Moray West Offshore Wind Farm, AHEP, Neart na Gaoithe, Seagreen and Inch Cape Offshore Wind Farms. Due to the lack of any density dependent mechanism being included in the modelling, the mean impacted population is not predicted to increase above the baseline growth rate and therefore although the population growth rate is expected to recover once the period of disturbance is over, the population size may remain slightly lower than the equivalent baseline population.

7.6.3.26 It is unclear exactly why the inclusion of PTS has such a large effect on the simulated impacted population trajectory but it is directly linked to the results of the expert elicitation process that was carried out when the iPCoD framework was developed. Given the uncertainty and lack of empirical data on the individual consequences of PTS for individuals, a very precautionary approach was taken by some experts who felt that the effect of PTS on survival and fecundity could be quite high. Additional work carried out since then on the magnitude and frequency of PTS as a result of exposure to noise has demonstrated that the amount of PTS that bottlenose dolphins could receive from exposure to piling noise is relatively limited and that it would be likely limited to specific frequency bands largely outside the region of highest hearing sensitivity and therefore have relatively little effect on the ability of bottlenose dolphins to find food, detect risks and communicate (Kastelein *et al.,* 2012a, Kastelein *et al.,* 2012b, Finneran 2015, Kastelein *et al.,* 2017). A recent workshop revisiting the expert elicitation process for the iPCoD framework, as yet unpublished, concluded that the effects of PTS were likely to be far less than specified during the original expert elicitation (C. Booth, SMRU Consulting, pers comm). Nevertheless, regardless of the uncertainty surrounding the consequences of PTS, the more realistic scenario is that no bottlenose dolphins are likely to experience PTS as a result of any piling activity in the East Coast Management Unit and therefore the conclusions of this assessment is based on the latter set of iPCoD modelling results presented above.

7.6.3.27 It is also noted that an application has recently been submitted for development of the Cromarty Port (May 2018). The EIA Report supporting this application indicates that Phase 4 (which will involve both percussion piling and vibropiling) is expected to take place between November 2018 and March 2019. Due to the timing of the availability of information on this development, it has not been possible to include this potential impact quantitatively. However, given that the piling / vibropiling activities are not expected to overlap with construction of the Moray West Offshore Wind Farm and that the assessment has not identified any significant effects on the harbour seal population it is not expected that this project would add significantly to potential disturbance at the management unit/population scale. It is also highly likely that construction and operation of the port facility will be subject to measures to ensure that this project would not add significantly to potential disturbance to bottlenose dolphins.

Conclusion

7.6.3.28 The predicted in-combination assessment demonstrates that disturbance (without PTS) may cause a small and temporary change in the trajectory of the bottlenose dolphin population. Therefore it is considered that there is no Adverse Effect on the bottlenose dolphin population as a result of displacement effects associated with the Moray West Offshore Wind Farm in-combination with other plans and projects.

7.7 Summary

7.7.1.1 The screening process indicated that LSE on the interest features of the Dornoch Firth and Morrich More SAC and the Moray Firth SAC could not be discounted and so a systematic assessment of the potential for an adverse effect on the integrity of this site has been undertaken.

7.7.1.2 The assessment has considered the potential impacts of Moray West Offshore Wind Farm during construction, operation and maintenance and decommissioning, alone and in-combination with other relevant plans and projects with respect to the site's Conservation Objectives.

7.7.1.3 With respect to these SACs, there is no indication that the construction, operation and maintenance or decommissioning will lead to a significant change in the extent and distribution of the habitats of any of the qualifying features for those sites.

7.7.1.4 There is no indication that the structure and function of the habitats of the qualifying features will be significantly altered, nor the supporting processes on which those habitats rely. In each case the distribution of qualifying features within each site will also be maintained.

7.7.1.5 With respect to the population of each of the qualifying features, the likely effects arising from the construction and operation of the Moray West Offshore Wind Farm alone and in-combination with other plans and projects (other offshore wind farms in this case) has been predicted. Based on the in-combination scenarios assessed, there was no significant long term effect on the population trajectory of either harbour seals or bottlenose dolphin populations.

7.7.1.6 Having considered the information provided in the EIA Report (Volume 2) – Chapter 9: Marine Mammal Ecology and the precautionary quantitative assessments described above, the potential risks from the different impact pathways, in the presence of the embedded mitigation (the development of a piling strategy including an MMMP to reduce the risk of injury and mortality including a piling hammer energy soft start and other mitigation measures as agreed, the development of a vessel management plan) the Moray West Offshore Wind Farm, alone or in-combination with other plans or projects, will not adversely affect the integrity of the Moray Firth SAC with respect to bottlenose dolphins or the Dornoch and Morrich More SAC with respect to harbour seals.

8 Assessment of Adverse Effects Upon Site Integrity – Habitats

8.1 Introduction

8.1.1.1 Although potential LSE upon the Moray Firth SAC and its qualifying feature of 'Sandbanks which are slightly covered by sea water all the time' (subsequently referred to as 'subtidal sandbanks') was originally screened out of the Moray East HRA, and was also proposed as screened out within the HRA Screening Report for this development (Appendix 4.1), it was concluded by the CA, within their HRA Screening Opinion (Appendix 4.2) that LSE could not been screened out as the physical processes modelling was not available at the HRA Screening stage. As the physical processes modelling is now available it is presented, along with an assessment, in this section. The conservation objectives for this qualifying habitat feature are given below, followed by a description of the baseline environment relevant to this site and feature and the findings of the assessment of adverse effect is then presented.

8.2 Conservation Objectives

8.2.1 Moray Firth SAC

8.2.1.1 The conservation objectives for the Moray Firth SAC that are associated with the feature of subtidal sandbanks are:

- To avoid deterioration of the qualifying habitat 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 habitat 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.

8.3 Potential Impacts

8.3.1.1 As outlined in Section 4.6.4 and Table 4.6.1, the potential impacts that could lead to an adverse effect upon the integrity of the Moray Firth SAC and the qualifying feature of subtidal sandbanks are:

- Increased SSC and changes to physical processes due to WTG and OSP foundations or cable laying activities during construction; and
- Changes to physical processes (including hydrodynamic processes) due to the presence of WTG and OSP foundations during operation.

8.3.1.2 As discussed in Chapter 4 all other potential impacts were screened out of the HRA on the basis of there being no route to impact. This was confirmed in the Moray West Offshore Wind Farm HRA Screening Opinion with MS-LOT and SNH only requesting that effects associated with physical processes should be appraised.

8.4 Baseline Characterisation

8.4.1 Moray Firth SAC

8.4.1.1 The Moray Firth SAC was designated in 2005 for its qualifying interests of bottlenose dolphins (see Section 7.4.3) and subtidal sandbanks and covers an area of approximately 15,1274 ha. The SAC covers the full coastline between Helmsdale in the north (Highland Council) to Lossiemouth in the south (Moray Council) and extends seawards to cover an area of the inner Moray Firth west of a straight line between Helmsdale and Lossiemouth[15] (Figure 8.4.1). The Moray Firth SAC overlaps with the Cromarty Firth, and Dornoch Firth and Loch Fleet SPAs, which are designated for their ornithological qualifying features (see Section 4.6.1).

8.4.1.2 The subtidal sandbank habitat covers an area of approximately 45,382 ha (based on partial data with some extrapolation; JNCC, 2015) and is considered important as the SAC supports a significant amount of this Annex I habitat in a UK context. Within the SAC, this Annex I habitat is present as a qualifying feature, but not a primary reason for selection of this site (JNCC, 2015). The latest site condition monitoring assessment was undertaken August 2004, when it was recorded as being Favourable Maintained, as described in the framework of Common Standards Monitoring, and there are no negative pressures recorded as being present by SNH.

8.4.1.3 According to JNCC[16], these subtidal sandbanks consist of sandy sediments that are permanently covered by shallow sea water, typically at depths of less than 20 m below chart datum (but sometimes including channels or other areas greater than 20 m deep). The habitat comprises distinct banks (i.e. elongated, rounded or irregular 'mound' shapes) which may arise from horizontal or sloping plains of sandy sediment. Where the areas of horizontal or sloping sandy habitat are closely associated with the banks, they are included within the Annex I type.

8.4.1.4 The diversity and types of community associated with this habitat are determined particularly by sediment type together with a variety of other physical, chemical and hydrographic factors. These include geographical location (influencing water temperature), the relative exposure of the coast (from wave-exposed open coasts to tide-swept coasts or sheltered inlets and estuaries), the topographical structure of the habitat, and differences in the depth, turbidity and salinity of the surrounding water. Within the UK's inshore waters, subtidal sandbanks can be categorised into four main sub-types:

- gravelly and clean sands;
- muddy sands;
- eelgrass *Zostera marina* beds; and
- maerl beds (composed of free-living *Corallinaceae*)

8.4.1.5 The latter two sub-types are particularly distinctive and are of high conservation value because of the diversity of species they may support and their general scarcity in UK waters.

8.4.1.6 Shallow sandy sediments are typically colonised by a burrowing fauna of worms, crustaceans, bivalve molluscs and echinoderms. Mobile epifauna at the surface of the sandbank may include shrimps, gastropod molluscs, crabs and fish. Sand-eels *Ammodytes* spp., an important food for birds, live in sandy sediments. Where coarse stable material, such as shells, stones or maerl is present on the sediment surface, species of foliose seaweeds, hydroids, bryozoans and ascidians may form distinctive communities. Shallow sandy sediments are often important spawning and nursery areas for fish and feeding grounds for seabirds.

[15] As illustrated on the SAC map provided on the SNH Site Link website (https://gateway.snh.gov.uk/sitelink/siteinfo.jsp?pa_code=8327)
[16] http://jncc.defra.gov.uk/ProtectedSites/SACselection/habitat.asp?FeatureIntCode=H1110 (Accessed May 2018).

8.4.1.7 Subtidal sandbanks can support large nursery populations of flatfishes and round fishes prior to their movement offshore and eventual commercial exploitation. Sandbanks support commercial fisheries for scallops or other bivalve shellfish. Sandbanks can provide minerals for extraction, possibly for building but also for beach nourishment. The subtidal mobile sandbanks may occur in areas subject to oil and gas exploration and exploitation. Finally, subtidal sandbanks provide nearshore protection against shore-eroding conditions

8.4.1.8 The Moray Firth SAC subtidal sandbanks are found throughout, including within the Cromarty Firth, Dornoch Firth and in the in the narrows between Chanonry and Fort George and are included within the management scheme that is in place for the SAC (Moray Firth SAC Management Group, 2016), which aims to conserve their condition. This includes a sandbank management strategy. One of the activities covered by the management scheme relates to coastal development, which has been extended latterly to cover offshore wind farm developments. The current levels of sea defence, road and pier maintenance are not thought to have a detrimental impact on the sandbank features and it is noted that such developments may be the subject of an appropriate assessment. The upcoming interest in offshore wind farm development is also noted as a future activity to be considered. Under the present 'management regime', interference with hydrographic patterns is acknowledged as potentially leading to the reduction in certain species and to increased instability or changes in environmental parameters. Along with coastal development and offshore renewables, other main concerns for subtidal sandbank appear to be linked with in-land runoff (e.g. sedimentation, contaminants), boat anchoring, dredging and disposal, fishing activities and oil pollution. However, within the Management Scheme, current activities in the SAC are considered unlikely to cause impact to the sandbank feature and therefore no restoration or maintenance action is currently required to achieve the Conservation Objectives.

8.4.2 Existing Physical Processes within the Moray Firth

8.4.2.1 This RIAA is informed by the detailed baseline characterisation that is presented within Chapter 6: Physical Processes and Water Quality and Technical Appendices 6.1 (Physical Processes Baseline) and 6.2 (Physical Processes Numerical Modelling) of the Offshore EIA Report (Moray West, 2018). A brief summary of the key findings is presented here.

Study Area

8.4.2.2 The marine processes and water quality study area within which baseline conditions and potential changes have been considered is defined as:

- The Moray West Site;
- The Offshore Export Cable Corridor; and
- The seabed and water column that may be influenced by changes to marine processes due to the Development (separated into a near-field and a far-field extent).

8.4.2.3 With respect to marine processes and water quality, the far field spatial extent of the study area has primarily been determined using expert judgment, drawing upon knowledge developed from other Round 3 projects and in particular modelling results showing the anticipated extent of change from the Moray East and Beatrice Offshore Wind Farms.

8.4.2.4 The near-field study area includes the Moray West Site and Offshore Export Cable Corridor, and up to one spring tidal excursion distance outside these areas. The spring tidal excursion distance (which is calculated using outputs from ABPmer *et al*., 2008) is spatially variable, but is typically in the range 2 to 6 km.

Currents

8.4.2.5 Information available on the strength of tidal currents in the region of the Moray West Site shows that recorded (depth-averaged) peak spring current speeds are around 0.25-0.3 m/s, with the fastest speeds recorded in the north of the Moray West Site.

8.4.2.6 Peak spring current speeds increase to the north of the Moray West Site towards the Pentland Firth. Peak spring current speeds are similarly low (0.3 m/s or less) elsewhere in the Moray Firth.

8.4.2.7 Along most of the Offshore Export Cable Corridor, peak spring current speeds are typically less than 0.3 m/s.

8.4.2.8 Both storm waves and storm surges may cause short term modification of astronomically-driven tidal currents. During a 1:1 year storm event, orbital currents are likely to approach 1 m/s in the north of the Moray West Site, in the relatively shallow water over the crest of Smith Bank. Currents of this magnitude are considerably greater than that observed during peak spring tidal flows. Similarly, under an extreme (1 in 50-year return period) storm surge, current speeds may be more than twice that encountered under normal peak spring tide conditions.

8.4.2.9 Residual tidal currents (over a period of days to weeks) are directed generally into the Moray Firth. Climate change is not expected to have any effect on the local tidal current regime (currents are largely controlled by the corresponding tidal range) over the lifetime of the proposed development.

Waves

8.4.2.10 The wave regime in the Outer Moray Firth includes both swell waves generated elsewhere in the North Sea and locally generated wind waves. The wave regime in the Outer Moray Firth is typically characterised by wind waves, although longer period swell waves can be identified within the observational wave records collected from within and nearby to the Moray West Site.

8.4.2.11 The Offshore Export Cable Corridor is likely to be exposed to waves of equal or possibly larger size than the Moray West Site from exposed offshore sectors; the size of waves from other fetch limited sectors will vary along the cable corridor route depending upon the wind direction and corresponding fetch. The variable and on average greater water depths along the Offshore Export Cable Corridor mean that the ability of a given wave condition to penetrate to the seabed may also be variable.

8.4.2.12 Even though water depths within the Moray West Site are no less than 35 m, storm waves sufficiently large to cause water motion at the seabed are not uncommon.

8.4.2.13 Along the coastlines of the mid and Inner Moray Firth, waves have a critical role to play in driving sediment transport through the process of longshore drift.

8.4.2.14 Climate change is predicted to cause variability in the inter-annual wave climate over the lifetime of the proposed Development; however, historical trends have shown that this variability may include both increases and decreases in mean storminess on decadal timescales.

Sediments

8.4.2.15 Seabed sediments across the Moray West Site generally consist of Holocene gravelly sand and sand with a minor proportion of fines (<5 to 10% silt and clay sized). A modal peak grain size between 150 to 215 µm (fine sand) was found in the majority of the grab samples collected from the Moray West Site. Other modal peak grain sizes were also variably observed, ranging from 24,000 µm (pebble gravel) to 350 µm (medium sand). The proportion of shell in sediment samples from and nearby to the Moray West Site are frequently in excess of 50% (Partrac, 2010; British Geological Survey (BGS), 1987).

8.4.2.16 Seabed sampling was successfully undertaken at 12 locations within the Offshore Export Cable Corridor (for further detail on sampling, see Volume 3, Technical Appendix 7.1: Benthic Survey Report). Near to the Moray West Site, in intermediate water depths, the Offshore Export Cable Corridor transits areas of mixed sands and gravels, with a small proportion of fines (<5 to 10%) present. Seabed sediments become progressively finer in deeper water along the route, becoming relatively muddy (30 to 65% fines) in the deepest parts. The sediment character and distribution in these offshore sections is the result of the relatively benign tidal regime and the spatially variable effect of wave action at the seabed, depending upon the local water depth.

8.4.2.17 Across much of the Moray West Site, surficial marine sediments are generally thick (~5 to 15 m in the west of the Moray West Site, up to 30 m in the east) In some locations, the underlying glacial till is very close to the surface (<2 m thickness).

8.4.2.18 An extensive blanket of Quaternary deposits is present across almost the entire Moray Firth with sediment thicknesses in excess of 100 m commonly observed. Within the Moray West Site the Quaternary units are of variable thickness, ranging from <10 m to c. 150 m. These sediments are underlain by a thick unit of firm to very hard Lower Cretaceous clay.

8.4.2.19 The available evidence suggests that (bedload) material is travelling into the Firth from the north, passing along the Caithness coast and towards the Inner Moray Firth. Tidal currents are largely incapable of mobilising anything larger than fine sand-sized material within the Moray West Site and as a result, there is only limited net bedload transport of sediment due to tidal currents alone.

8.4.2.20 However, the combination of tidal and non-tidal currents and wave induced currents during storms results in considerably higher current speeds at the seabed. As a result, it is likely that the commonly present fine sand is regularly mobilised within the Moray West Site during storms. Owing to the combination of slightly higher tidal current speeds and smaller water depths, it is likely that the northern areas of the Moray West Site are most active in this way.

8.4.2.21 Within the Moray West Site, SSC is typically very low (approximately < 5 mg/l). However, during storm events, near seabed SSC can be significantly increased in the short-term due to the influence of waves stirring the seabed. Coarser sediments may be transported a short distance in the direction of ambient flow or down-slope under gravity before being redeposited. Finer material that persists in suspension will eventually be transported in the direction of net tidal residual flow, i.e. to the south-west, into the Firth.

8.5 Assessment of Adverse Effects – Project Alone

8.5.1 Increased SSC and Changes to Physical Processes Due to WTG and OSP Foundations or Cable Laying Activities During Construction

8.5.1.1 Technical Appendix 6.3 (Physical Processes Impact Assessment) of the Offshore EIA Report sets out full details of the methodologies used to carry out sediment disturbance assessments, as well as a more detailed description of the nature / extent / duration of the changes for specific activities (such as dredging for seabed preparation, release of drill arisings during piled foundation installation or due to cable installation). These activities will cause a disturbance of the local seabed sediments. Due to the nature of the activities, sediment would be put into suspension either by energetic disturbance at or near to the seabed or by release at or near to the sea surface. This will result in a temporary and localised sediment plume, within which SSC is elevated above ambient levels. Over time, the disturbed sediment in suspension settles back to the seabed. The assessments undertaken for the Offshore EIA Report, quantified the likely thickness and extent of any sediment deposit that might form.

8.5.1.2 The changes were identified as follows:

- SSC will be increased by tens to hundreds of thousands of mg/l at the point of sediment release for the duration of the activity;
- In the case of dredging and drilling, the source of the sediment release is static and may last for hours, up to a few days. In the case of cable burial, the source of sediment release is moving and so the local change will be limited in time to a matter of seconds;
- SSC will reduce with time and distance from the source due to dispersion and resettlement of sediment to the seabed. Sands and gravels will settle out faster than finer material. The overall duration of change will depend on the relative proportions of grain sizes present, which may vary by location and activity type;
- If released at the water surface, SSC of low tens of mg/l will be present in a narrow plume (tens to a few hundreds of metres wide), up to one tidal excursion in length (up to ~3.5 to 4.2 km on spring tides and half that distance on neap tides) aligned to the tidal current downstream from the source;
- If the activity occurs over more than one flood or ebb tidal period, the plume feature may be present in both downstream and upstream directions;
- Outside of the area up to one tidal excursion upstream and downstream of the foundation location, SSC less than 10 mg/l may occur more widely due to ongoing dispersion and dilution of material;
- Following the end of drilling, locally high SSC at the source will recover quickly (within minutes) to background levels as the sediment plume is advected away and coarser sediments or clasts settle back onto the seabed;
- Sufficiently fine sediment may persist in suspension for hours to days or longer, but will become diluted to very low concentrations (<5 mg/l, indistinguishable from natural background levels and variability) within timescales of around one day; and
- Over longer timescales, net movement of any fine grained material persisting in suspension would generally be in an approximate southerly (south-easterly through south-westerly) direction across most of the Moray West Site in accordance with the direction of residual flow in this area.

8.5.1.3 Within Chapter 6: Physical Processes and Water Quality, the thickness of the seabed deposit resulting from the disturbance or release of sediment has been averaged as 0.05 m, potentially covering a worst case area of 76.14 km^2 (33.6% of the Moray West Site). This is for both installation of WTG / OSP foundations and all cable laying). Due to the minimum distance between WTG being 1,050 m, if activities were to overlap with one another at different locations (e.g. installation of two foundations at the same time), it would be unlikely that sediments would disperse sufficiently for there to be an additive effect on sediment deposit thickness. Sediment deposition will be additive if and where the footprints of the deposits on the seabed overlap, leading to a thicker overall unit.

8.5.1.4 The potential impact of cable protection measures was assessed and whilst any effects may persist for the duration of the operational lifetime of the Development, the capacity of cable protection to cause blockage to sediment transport is fundamentally limited and is unlikely to cause any measurable effect other than very locally to the protection itself.

8.5.1.5 Based upon the above modelling outcomes of suspended sediment deposition rates, durations and magnitudes, construction activities are only considered likely to impact designated marine features within one tidal excursion of the Moray West Site and Offshore Export Cable Corridor. The planned activities offshore have the potential to affect the form and function of the seabed, only in these areas, by sediment disturbance. The Moray Firth SAC is too distant from the locations of foundation and cable installation activities in the Moray West Site and Offshore

Export Cable Corridor (outwith one tidal excursion) to be potentially affected by any direct or indirect impacts on SSC, sediment deposition or disturbance of the seabed.

8.5.1.6 In terms of reduced wave energy, the potential effects of this are assessed under operational effects (section 8.5.2) as the WTG and OSP foundations and piles will not be fully constructed during this phase until the later stages prior to commissioning, with individual piles being at various stages of the construction process at different times throughout the construction phase. The worst case scenario for reduced wave energy will be when all WTGs and OSPs are constructed and all cables are laid with any areas of cable protection in place.

8.5.1.7 As the physical processes numerical modelling confirms the view presented within the HRA Screening Report that there is no (direct or indirect) connectivity between the Moray Firth SAC and its qualifying features of subtidal sandbanks to the Moray Firth Site or Offshore Export Cable Corridor (located at a distance of more than 17 km away and outside of one tidal excursion), it is concluded that increased SSCs created by the Project will have no adverse effect upon the integrity of the SAC or its FCS with respect to subtidal sandbanks.

8.5.2 Changes to Physical Processes (Including Hydrodynamic Processes) Due to Presence of WTG and OSPs During Operation

8.5.2.1 There is potential for the WTGs and OSPs foundations and piles to present a blockage to waves and currents, causing a reduction in wave height and current speed that might extend to the Moray Firth SAC. A persistent reduction in wave height or current speed of sufficient magnitude within the SAC could cause a change to the normal form and function of the physical subtidal sandbank environment, both directly in terms of wave and current activity, and indirectly in terms of sediment transport, morphological evolution, locally generated SSC, and the strength or location of stratification front features. Such far field changes have the potential to affect the Moray Firth SAC.

8.5.2.2 As identified in Section 8.5.1, the resulting impact on sediment transport has been assessed and it is concluded that locally generated SSC would not be transported over the large distance to the SAC and there would be no change to SSC as a result, with no adverse effect upon the SAC.

8.5.2.3 The potential impact of WTG and OSP foundations and piles has been assessed in relation to currents and waves within Section 6.7.3 of Chapter 6: Physical Processes and Water Quality of the Offshore EIA Report. The assessment found that:

- Changes to current speed and direction would not be measurable outside of the local wake from individual foundations. Any effects can only extend as far as one tidal excursion length and so would be largely confined to the extent of the Moray West Site;
- Wave height could be reduced by up to 6 to 14 % (0.25 to 0.68 m) within the Moray West Site, but only intermittently in other locations by some lesser amount due to wave recovery (up to 3-4% in the offshore part of designated areas and less than 1 to 2% (less than 0.1 m) in more distant or shallow coastal locations). There would be no measureable change to wave period or direction. Waves must pass through the Moray West Site before interacting with the receptor for any impact to occur, which limits the proportion of time that any effect could be experienced at a given receptor location. The change in wave height at the SAC would be small in both absolute and relative terms and is not considered likely to change the local wave climate beyond the range of natural variability; and
- Due to the small magnitude of effect on waves and no change to currents, it is concluded that there will be no measurable change to the naturally occurring rates and directions of sediment transport (including levels of SSC) naturally occurring in SAC. Therefore, there will also be no consequential change to the naturally occurring seabed type or onward morphological evolution of these sites.

8.5.2.4 Given that the SAC is located a distance of 17 km from the Project, that modelling shows that a maximum wave height reduction of between 4% in the SAC offshore waters and 2% in the coastal shallower areas (where the subtidal sandbanks are generally located) would occur and be within existing naturally occurring ranges, and that there is no measurable change to current speed, wave period or direction, that there would be no adverse effect upon the integrity or the FCS of the SAC or the subtidal sandbanks.

8.6 Assessment of Adverse Effects – In Combination

8.6.1 Projects Being Considered

8.6.1.1 Detailed consultation has taken place to determine a list of projects that require consideration as part of the cumulative assessment and the projects to be considered within this assessment are listed within Table 8.6.1.

Table 8.6.1: Projects for cumulative assessment

Development Type	Project	Status	Location	Data confidence assessment/ Phase
Offshore Wind Farm	Moray East (formerly Telford, Stevenson and MacColl wind farms)	Consent authorised	7.1 km from the Moray West Site	High - Third party project details published in the public domain and confirmed as being 'accurate'
Offshore Wind Farm	Beatrice Offshore Wind Farm	Under construction	0 km from the Moray West Site (boundary shared)	High - Third party project details published in the public domain and confirmed as being 'accurate'
Oil and gas	Decommissioning of the Beatrice Oil Field and Demonstrator Turbines	Scoping	0 km from the Moray West Site (boundary shared)	Production Ceased The decommissioning EIA is currently underway. Plugging of the wells has already commenced. Decommissioning of the main structures (four platforms, pipelines and demonstrator turbines) is expected to occur between 2024 and 2027.

8.6.1.2 Construction of the Moray East (Telford, Stevenson and MacColl) Offshore Wind Farm is due to commence in 2019 for completion in 2021. The Beatrice Offshore Wind Farm, which began construction in 2017, is expected to become fully operational in 2019. Decommissioning of the Beatrice Oil Field is expected to occur between 2024 and 2027 (Repsol Sinopec, 2017).

8.6.1.3 Given that the construction of the Moray West Offshore Wind Farm is not planned to commence until 2022, spanning 36 months and ending in 2024, there will be no temporal overlap of the construction phases of these projects, with the exception of decommissioning of the Beatrice Oil Field and demonstrator turbines, and cumulative construction effects are not assessed any further.

8.6.1.4 It is possible that the decommissioning of the Beatrice Oil Field and demonstrator turbines may overlap with the construction of the Moray West Offshore Wind Farm and Moray West OfTI, A total of five platforms, two turbines, buried pipelines and buried power cables will potentially be removed. The Decommissioning Plan is not yet publicly available, and it is anticipated that the buried pipelines and cable will be left in-situ, but it is possible that one option may be to remove power cables and pipelines entirely. If this is implemented then there will be potential for in combination effects from increased SSC.

8.6.1.5 Although these two projects share a boundary, it is likely that any increased SSC concentrations arising at the Beatrice Oil Field and demonstrator turbines will follow a similar pattern to the Moray West Site and that increased SSC will be localised only and within one tidal excursion of the decommissioning works. It is considered that little overlap will therefore take place and any in combination effects will be localised to each development, short term and minor in nature. It is anticipated that this would result in a not significant in combination effect.

8.6.1.6 The operational phase of Moray East and Beatrice will however overlap with Moray West and so these cumulative operational effects are assessed.

8.6.2 Changes to Physical Processes (including Hydrodynamic Processes) due to Presence of WTG and OSPs During Operation

8.6.2.1 Physical processes modelling has been undertaken to assess the cumulative effects and is detailed in the following sections.

Changes to the Tidal Regime

8.6.2.2 To quantify the likely magnitude and extent of interaction between the tidal regime and the operational Moray West, Moray East and Beatrice Offshore Wind Farms, the same numerical tidal model (described in Technical Appendix 6.2 (Volume 4): Physical Processes Numerical Modelling) was used to simulate representative seastate conditions for both baseline and the cumulative 'with Development' scenario.

8.6.2.3 The potential cumulative impact of the Moray West, Moray East and Beatrice Offshore Wind Farms on tidal currents during a representative mean spring tidal cycle is shown in Figure 6.9.1 of the Offshore EIA Report Chapter 6: Physical Processes and Water Quality. Results for neap tidal range conditions are proportionally smaller (around half) than that reported here for spring tides. The results show that:

- The maximum magnitude of effect on tidal water levels in any location and at any time during a typical spring-neap tidal cycle is less than 0.001 m;
- The maximum magnitude of effect on tidal current speed in any location and at any time during a typical spring-neap tidal cycle is less than 0.02 m/s (in the Moray East Site) and less than 0.01 m/s in the Moray West Site;
- No consistent measureable effect on tidal current direction is expected in any location and at any time during a typical spring-neap tidal cycle; and

8.6.2.4 Given the similarity in processes, a similar (low) order of effect on non-tidal (surge) water levels and current speeds and directions is inferred.

Changes to the Wave Regime

8.6.2.5 To quantify the likely magnitude and extent of interaction between the wave regime and the operational Moray West, Moray East and Beatrice Offshore Wind Farms, the same numerical wave model (described in Technical Appendix 6.2 (Volume 4): Physical Processes Numerical Modelling) was used to simulate representative seastate conditions for both baseline and the cumulative 'with Development' scenario.

8.6.2.6 The potential cumulative effect of the Moray West, Moray East and Beatrice Offshore Wind Farms on significant wave height during a 1:1, 1:10 and 1:50 year return period seastate is shown in Figure 6.9.2, Figure 6.9,3 and Figure 6.9.4 of the Offshore EIA Report Chapter 6: Physical Processes and Water Quality, respectively. The results of the modelling show that:

- The maximum local reduction in wave height within the three site boundaries would vary between 0.35 and 0.85 m, or 7 to 12% of the local baseline wave height, depending on the wave direction and return period (based on the 8 directions and 3 return periods tested). It should be noted that the largest proportional reduction is not necessarily associated with the largest absolute reduction in wave height. The greatest absolute effects would be on the largest waves that also pass through the long axis of the three Sites (i.e. from 45 and 90 °N). The highest proportional effects would be on largest waves from the southwest and west (215 and 270 °N) while the smallest proportional effects would be on waves from the southeast (125 °N);
- The area of maximum effect on wave height in every case would be relatively small (length scale of order 1 km^2) and would be located where waves have transitioned through the greatest width of the three Sites in that orientation;
- The effect would gradually develop from no effect at the upwind edge of the three Sites to the maximum value in proportion to the distance travelled through the Site, i.e. 50% of the Site area will experience less than 50% of the maximum level of effect, and 25%, less than 25% of the maximum effect, etc;
- Behind the Moray West Site, any near-field reduction in wave height would recover towards ambient values at a non-linear rate (i.e. recovering quickly over small distances but smaller magnitude effects can persist over greater distances). These residual effects would extend in the direction of wave travel (with some lateral spreading);
- The maximum local reduction in wave height at any of the adjacent coastlines within the Moray Firth (including the various designated coastlines and surfing venues in the area) would be in the order of centimetres (less than 0.1 m) in comparison to a wave height in the order of several metres, i.e. only a small (not measurable) absolute and relative difference. Only a limited area of coastline downwind of the Moray West Site would be affected at all at any one time. The time that waves might come from any particular direction (and therefore the area of coastline potentially affected) is limited depending on water depth, wind direction and corresponding fetch (details in Technical Appendix 6.1 (Volume 4): Physical Processes Baseline);
- The maximum local effect on wave period in all cases considered would be less than one second. The spatial pattern of the effect is not well defined, would recover with distance from the Moray West Site, and the small magnitude of the effect would not be measurable in practice; and
- There would be no measurable effect on instantaneous wave direction in the near- or far-field.

Changes to Sediment

8.6.2.7 As the potential effects from increased SSC are restricted to within one tidal excursion of the Moray West Site and Offshore Export Cable Corridor, there is limited scope for other activities or developments to have cumulative effects on physical processes, unless they are within one tidal excursion and operating at the same time as the Moray West Site and the Offshore Export Cable Corridor. Even if a development was within one tidal excursion, any increased SSC would be localised to the Moray West Offshore Wind Farm, Moray West OfTI or the other development being considered cumulatively and increased SSC would not reach the Moray Firth SAC (as identified by modelling explained above). During operation, the opportunity for increased SSC

is limited to scour, wave action or maintenance around turbine foundations In term of consequential effects on sediment transport, the magnitudes of cumulative effect on the tidal and wave regimes are effectively the same those previously reported for the Moray West Offshore Wind Farm alone.

8.7 Summary

8.7.1.1 An assessment of the potential physical processes and hydrodynamic changes that may occur as a result of the construction and operation of the Moray West Site and the Offshore Export Cable Corridor has shown, through the application of numerical modelling, that increased SSCs would occur within the construction phase, but that these would be localised and within one tidal excursion of the Project. In addition, there would be no measurable change to current speeds, wave direction or wave period and that any wave height reduction would be small (0.1 m within coastal waters) and within existing wave height ranges that naturally occur. The assessment shows that there would therefore be no adverse effect upon the Moray Firth SAC and its designated feature of subtidal sandbanks.

8.7.1.2 The assessment also shows, through numerical modelling, that when the Moray West Site is considered cumulatively with other relevant operational projects in the area and the decommissioning of the Beatrice Oil Field and Demonstrator turbines there would be no adverse effect upon the Moray Firth SAC and its designated feature of subtidal sandbanks.

9 Summary and Conclusions

9.1.1.1 The HRA screening process indicated that LSEs on the ornithological, marine mammal and habitat qualifying features of interest for a total of four SPAs and one pSPA (Buchan Ness to Collieston Coast SPA, East Caithness Cliffs SPA, North Caithness Cliffs SPA, Troup, Pennan and Lion's Head SPA and Moray Firth pSPA) and two SACs (Dornoch Firth and Morrich More SAC and Moray Firth SAC) could not be discounted and so a systematic assessment of the potential for an adverse effect on the integrity of these sites has been undertaken.

9.1.1.2 The assessment has considered the potential impacts of the Development during construction, operation, maintenance and decommissioning, alone and in-combination with other relevant plans and projects with respect to the site's conservation objectives.

9.1.1.3 Table 9.1.1 summarises the information presented in Sections 6, 7 and 8 and concludes on whether there is potential for an adverse effect on the integrity of the European sites and their qualifying features.

Table 9.1.1. Conclusion of the Potential for Adverse Effects Upon the Integrity of the European Sites

SPAs / pSPAs	
Moray Firth pSPA	The likely effects of the construction, operation and decommissioning of the Moray West Offshore Wind Farm on the ornithological qualifying features of the SPA have been assessed alone and in combination with other plans and projects. The assessment has concluded that, with the inclusion of the mitigation identified in Section 5, there will be no adverse effect on site integrity.
East Caithness Cliffs SPA	The likely effects of the construction, operation and decommissioning of the Moray West Offshore Wind Farm on the ornithological qualifying features of the SPA have been assessed alone and in combination with other plans and projects. The assessment has concluded that, with the inclusion of the mitigation identified in Section 5, there will be no adverse effect on site integrity.
North Caithness Cliffs SPA	The likely effects of the construction, operation and decommissioning of the Moray West Offshore Wind Farm on the ornithological qualifying features of the SPA have been assessed alone and in combination with other plans and projects. The assessment has concluded that, with the inclusion of the mitigation identified in Section 5, there will be no adverse effect on site integrity.
Buchan to Colliston Coast SPA	The likely effects of the construction, operation and decommissioning of the Moray West Offshore Wind Farm on the ornithological qualifying features of the SPA have been assessed alone and in combination with other plans and projects. The assessment has concluded that, with the inclusion of the mitigation identified in Section 5, there will be no adverse effect on site integrity.
Troup, Pennan and Lion's Head SPA	The likely effects of the construction, operation and decommissioning of the Moray West Offshore Wind Farm on the ornithological qualifying features of the SPA have been assessed alone and in combination with other plans and projects. The assessment has concluded that, with the inclusion of the mitigation identified in Section 5, there will be no adverse effect on site integrity.
SACs	

Table 9.1.1. Conclusion of the Potential for Adverse Effects Upon the Integrity of the European Sites	
Dornoch Firth and Morrich More SAC	The likely effects of the construction, operation and decommissioning of the Moray West Offshore Wind Farm on the harbour seal as a qualifying feature of the SAC have been assessed alone and in combination with other plans and projects. The assessment has concluded that, with the inclusion of the mitigation identified in Section 5, there will be no adverse effect on site integrity.
Moray Firth SAC	The likely effects of the construction, operation and decommissioning of the Moray West Offshore Wind Farm on the bottlenose dolphin and subtidal sandbank as qualifying features of the SAC have been assessed alone and in combination with other plans and projects. The assessment has concluded that, with the inclusion of the mitigation identified in Section 5, there will be no adverse effect on site integrity.

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MORAY WEST
OFFSHORE WINDFARM

Moray West Offshore Habitats Regulations Appraisal

HRA Screening Report September

2017

Moray Offshore Windfarm (West) Limited

Appendix 4.1

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Glossary

AA	Appropriate Assessment
AC	Aberdeenshire Council
Birds Directive	Directive 2009/147/EC of 30 November 2009 on the conservation of wild birds
BOWL	Beatrice Offshore Wind Farm Limited
CA	Competent Authority
CES	Central East Scotland
cSAC	Candidate Special Area of Conservation
DDV	Drop down video
DECC	Department of Energy and Climate Change
dSAC	Draft Special Area of Conservation
DTI	Department of Trade and Industry
ECC	East Caithness Cliffs
EDPR	EDP Renovaveis
EDPR UK	EDP Renewables UK Ltd
EIA	Environmental Impact Assessment
EIA Regulations	The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017
EMF	Electromagnetic Field
ER	Environmental Report (referred to as the Environmental Statement and the EIA Report in different pieces of EIA legislation)
ES	Environmental Statement (referred to as the Environmental Report and the EIA Report in different pieces of EIA legislation)
ESAS	European Seabirds at Sea
FAME	Future of the Atlantic Marine Environment
GAM	Generalised Additive Model
GBS	Gravity Base Structure
GNS	Greater North Sea
GPS	Global Positioning System
GW	Gigawatt
GWDTE	Groundwater dependent terrestrial ecosystem
Habitats Directive	Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora
Habitats Regulations	Conservation (Natural Habitats, &c.) Regulations 1994 (as amended)
HAT	Highest astronomical tide
HDD	Horizontal directional drilling
HDPE	High density polyethylene
HRA	Habitats Regulations Appraisal
HVAC	High voltage alternating current
IAMMWG	Interagency Marine Mammal Working Group
IROPI	Imperative Reasons of Overriding Public Interest
JCP	Joint Cetacean Protocol
JNCC	Joint Nature Conservation Committee
km	Kilometre
kV	Kilovolt
LAT	Lowest astronomical tide
LSE	Likely Significant Effect
MC	Moray Council

MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MMMP	Marine Mammal Monitoring Programme
Moray East	Moray Offshore Windfarm (East) Limited
Moray East Offshore Wind Farm	The wind farm to be developed in the Moray East Site
Moray East Site	The area of the Zone in which the Moray East Offshore Wind Farm will be located, previously known as the Eastern Development Area
Moray Firth Zone	UK offshore wind Round 3 Zone 1 area held under a Zone Development Agreement (ZDA) by Moray Offshore Renewable Power Limited which is comprised of the Moray East Site and the Moray West Site
Moray West	Moray Offshore Windfarm (West) Limited
Moray West Offshore Wind Farm	The wind farm being proposed by Moray West
Moray West Site	The area of the Zone in which the Moray West Offshore Wind Farm and elements of the Moray West OfTI will be located, previously known as the Western Development Area
MORL	Moray Offshore Renewables Limited (now known as Moray East)
MPA	Marine Protected Area
MS-LOT	Marine Scotland Licensing Operations Team
MSS	Marine Scotland Science
MSW	Multi Sea Winter
MU	Management Unit
MW	Megawatt
Natura site	A Natura 2000 site which forms a network of nature protection areas in the territory of the European Union. It is made up of SACs and SPAs designated respectively under the Habitats Directive and Birds Directive. The network includes both terrestrial and marine sites (MPAs).
NCC	North Caithness Cliffs
NETS	National Electricity Transmission System
nm	Nautical mile
NMPi	National Marine Planning Interactive
NNR	National Nature Reserve
NRMSD	National Research and Monitoring Strategy for Diadromous Fish
Offshore ECC	Offshore Export Cable Corridor
Offshore Habitats Regulations	The Offshore Marine Conservation (Natural Habitats &c) Regulations 2007 (as amended)
OfTI	Offshore Transmission Infrastructure
O&M	Operation and maintenance
OnTI	Onshore Transmission Infrastructure
OSP	Offshore Substation Platform
PAM	Passive Acoustic Monitoring
PCOD	Population consequences of disturbance
pSAC	Possible Special Area of Conservation
pSPA	Potential Special Protection Area
PTS	Permanent Threshold Shift
QA	Quality Assurance

Ramsar	A wetland site designated of international importance under the Ramsar Convention. The Convention on Wetlands, known as the Ramsar Convention, is an intergovernmental environmental treaty established in 1971 by UNESCO, and coming into force in 1975.
REZ	Renewable Energy Zone
RIAA	Report to Inform an Appropriate Assessment
RSBP	Royal Society for the Protection of Birds
SAC	Special Area of Conservation
SCANS	Small Cetaceans in the European Atlantic and North Sea
Scoping Study Area	The area of search for the OnTI that is located landward of MLWS, as illustrated in Figure 1.1.1
SCI	Site of Community Interest
SCOS	Special Committee on Seals
SMRU	Sea Mammal Research Unit
SNCBs	Statutory Nature Conservation Bodies
SNH	Scottish Natural Heritage
SPA	Special Protection Area
SPP	Scottish Planning Policy
STAR	Seabird Tracking and Research
TCE	The Crown Estate
The Project	The Moray West OfTI, OnTI and Offshore Wind Farm combined together
TI	Transmission Infrastructure
WTG	Wind Turbine Generator
WWT	Wildfowl and Wetlands Trust
ZDA	Zone Development Agreement

Acknowledgements

GoBe Consultants Ltd (GoBe) has produced this report on behalf of Moray West.

GoBe would like to thank the following people / organisations for their assistance and contributions to the preparations of this Scoping Report:

- Moray Offshore Windfarm (West) Limited;
- Niras; and
- Scottish Mammal Research Unit.

1 Introduction

1.1 Background

Moray Offshore Windfarm (West) Limited (known as Moray West) is promoting the development of the Moray West Offshore Wind Farm. The wind farm will be located in the Outer Moray Firth (Figure 1.1.1), approximately 22 km south of the Caithness coastline at its nearest point. It will comprise an offshore array of Wind Turbines Generators (WTGs), connected to one another by subsea inter-array cables, which will in turn connect the WTGs to the Offshore Transmission Infrastructure (OfTI).

The OfTI will comprise one or two Offshore Substation Platform(s) (OSP(s)) (joined by an interconnector cable if two are required) and up to two offshore export cable circuits that carry the power to an onshore landfall location to join the Onshore Transmission Infrastructure (OnTI). Each OfTI circuit is likely to comprise three core cables in a trefoil arrangement with a typical voltage of 132 to 400 kilovolts (kV) and may also include a fibre optic communication link either embedded within the cables or as separate, smaller cables running alongside in the same trench. The OnTI will comprise up to two onshore cable circuits that will transmit the power inland to a new onshore substation where it will be transformed before being fed (via buried cables) into the National Electricity Transmission System (NETS) at the existing Blackhillock substation, approximately 1.5 km south of Keith in Moray.

1.2 The Moray Firth Zone Development Strategy

In January 2010, Moray Offshore Renewables Limited was awarded a Zone Development Agreement (ZDA) by The Crown Estate (TCE) to develop Zone 1 of the nine UK offshore wind Round 3 zones. Zone 1 (the Moray Firth Zone) is located within the Outer Moray Firth within the UK Renewable Energy Zone (REZ) (Figure 1.1.1). The ZDA is now held by Moray Offshore Renewable Power Limited which owns 100% of Moray West.

Using a zonal constraints analysis, Moray East identified two distinct development areas, the Moray East Site and the Moray West Site.

Moray East was the first of the two development areas to be progressed and was subject to Environmental Impact Assessment (EIA) under Section 36 of the Electricity Act 1989, with consent awarded in March 2014.

After updating the zonal constraints analysis following consent award for Moray East, a decision was taken to commence development work on Moray West Site. The Moray West Offshore Windfarm and the associated OfTI will require Marine Licences under the Marine (Scotland) Act 2010 and Marine and Coastal Access Act 2009. A consent under Section 36 of the Electricity Act 1989 will also be required for the wind farm. A Scoping exercise was undertaken in May 2016 for the Moray West Offshore Wind Farm (offshore wind turbines, foundations and substructures, and inter-array cables) and a Scoping Opinion was received from the Scottish Ministers in August 2016. A separate Scoping exercise for the Moray West OfTI commenced in May 2017 with the Scoping Opinion being issued on 30 August 2017.

A planning application for Planning Permission in Principle will be submitted to both Moray Council (MC) and Aberdeenshire Council (AC) for construction of the OnTI under the Town and Country Planning (Scotland) Act 1997 as amended by the Planning etc. (Scotland) Act 2006. A Scoping exercise for the OnTI commenced in June 2017 with the Scoping Opinion being issued on 8 August 2017.

An integral part of the planning process is to demonstrate due regard to the European Council Directives 92/43/EEC on the Conservation of Natural Habitats and of Wild Flora and Fauna Habitats Directive (European Commission, 1992; 'Habitats Directive') and 2009/147/EC of the European Parliament and of

the Council of 30 November 2009 on the conservation of wild birds (codified version) (European Commission, 2009; 'Birds Directive') with the promoter required to provide sufficient information to enable the competent authority (CA) (which is the Scottish Ministers in the case of offshore works for Moray West) to undertake an Appropriate Assessment (AA). This offshore Habitats Regulation Appraisal (HRA) Screening Report considers the Moray West Offshore Windfarm and the OfTI together. Any HRA requirements for the OnTI will be addressed separately.

1.3 Definitions

The definitions listed below have been applied throughout this HRA Screening Report. They provide an update to the definitions used in the Moray West Offshore Wind Farm Infrastructure EIA Scoping Report (Moray West, 2016) and reflect the recent establishment of Moray West, distinct from Moray East.

- **Moray Firth Zone** - UK offshore wind Round 3 Zone 1 area held under a ZDA by Moray Offshore Renewable Power Limited which is comprised of the Moray East Site and the Moray West Site.
- **Moray West** - Moray Offshore Windfarm (West) Limited.
- **Moray West Site** - The area of the Moray Firth Zone in which the Moray West Offshore Wind Farm will be located, previously known as the Western Development Area.
- **Moray West Offshore Wind Farm** - The wind farm to be developed in the Moray West Site.
- **Moray West Offshore Transmission Infrastructure (OfTI)** - The Offshore Transmission Infrastructure associated with the Moray West Offshore Wind Farm.
- **Moray West OfTI Site** - The area within which the OfTI will be located. It includes the Moray West Site, within which the OSP(s) and a portion of the export cable circuits will be located, and the Offshore Export Cable Corridor within which the remainder of the export cable circuits will be located.
- **Moray West OnTI Site** – The area within which the OnTI will be located. It includes onshore transition bays at landfall, up to two onshore cable circuits that transmit power to a new onshore substation along with buried interconnecting cables that connect into the NETS.
- **Moray West Onshore Transmission Infrastructure (OnTI)** - The Onshore Transmission Infrastructure associated with the Moray West Offshore Wind Farm.
- **The Project** - Moray West Offshore Wind Farm, Moray West OfTI and the Moray West OnTI.
- **Moray East** - Moray Offshore Windfarm (East) Limited, formerly known as Moray Offshore Renewables Limited (MORL).
- **Moray East Site** - The area of the Moray Firth Zone in which the Moray East Offshore Wind Farm will be located, previously known as the Eastern Development Area.
- **Moray East Offshore Wind Farm** - The wind farm to be developed in the Moray East Site.
- **Moray East Modified Transmission Infrastructure (TI)** - Offshore and onshore electricity transmission infrastructure associated with the Moray East Offshore Wind Farm.
- **Telford, Stevenson and MacColl offshore wind farms** - The three consented offshore wind farms proposed to be located within the Moray East Site and collectively comprising Moray East Offshore Wind Farm.

1.4 Purpose of this Document

This Offshore HRA Screening Report has been produced to inform the HRA process for the Moray West Site, as requested by MS-LOT in their Scoping Opinion following the EIA Scoping process for Moray West Offshore Windfarm (Moray West, 2016). This Offshore HRA screening is required for the Moray West Offshore Wind Farm as it has the potential to affect the site integrity and / or the qualifying features of nearby Natura (European) sites. A similar HRA screening request is expected to be made by the consenting authorities for the OfTI (also MS-LOT) as part of their EIA Scoping process.

This document provides information to enable offshore HRA screening of the Moray West Site with respect to likely significant effects (LSEs) on European sites of nature conservation importance. As the substation site and preferred onshore cable route are yet to be identified, there will be a separate Onshore HRA Screening Report, if required. The intention is to then produce one Report to Inform Appropriate Assessment (RIAA) that covers both onshore and offshore proposals, which would be submitted with the consent and planning applications.

The steps in the HRA process and associated reporting requirements are described in Section 2 and Figure 2.2.1.

The assessment provided in this document is based on the current understanding of the baseline environment and the scope and nature of the proposed project activities. Further environmental survey and assessment work, consultee and advisor responses to this document, and refinements to the project design may change this assessment. These changes will be reflected in any future Report to Inform Appropriate Assessment (RIAA) that will be submitted with the consent and planning applications for the Moray West Offshore Wind Farm, OfTI and OnTI.

1.5 Structure of this Document

This Offshore HRA Screening Report is structured as outlined in Table 1.5.1 below.

Table 1.5.1 HRA Screening Report Structure

Section	Heading	Overview
Section 1	Introduction	Introduces the project and sets out the background to the proposals and the need for an Offshore HRA Screening Report, along with stating the purpose of the Offshore HRA Screening Report.
Section 2	The HRA Process	Sets out and defines the basis for HRA, the legal requirements and need for the process along with identifying the various stages of assessment that make up the overall process.
Section 3	Description of Development	Provides a description of each of the key components of the Moray West Offshore Wind Farm and the Moray West OfTI and outlines the approach being applied at the construction, operation and maintenance and decommissioning phases of the project.
Section 4	Screening	Provides details of the screening criteria that have been applied to identify European sites and qualifying features requiring consideration, identification of the European sites and Ramsar sites with connectivity to the Moray West Site and OfTI, and determination of routes to impact. Concludes with a summary of the qualifying features and the European sites / Ramsar that have potential for LSE.

Section	Heading	Overview
Section 5	Assessment for Non-Trivial Abundance and Determination of LSE	Identification of the qualifying features and routes to impact that can be screened out due to non-trivial abundance and those that will require further consideration within the RIAA due to potential LSE, with a summary of screening in or out conclusions.
Section 6	In-combination Assessment	Consideration of the cumulative LSE of the Moray West Site and OfTI in combination with other Offshore Wind Farms (e.g. Moray East and Beatrice Offshore Wind Farm), other marine development projects and other projects currently in the planning system, consented or under construction within that may, together with the Moray West Site and OfTI, have cumulative effects upon European sites or Ramsar (and their qualifying features).
Section 7	References	Sources of information that have been used to inform the baseline characterisation, the HRA Screening appraisal and the conclusions.

2 The HRA Process

2.1 Legislative Context

Within Scotland, the Conservation (Natural Habitats, & c.) Regulations 1994, as amended (referred to as the 'Habitats Regulations') and the Offshore Marine Conservation (Natural Habitats &c) Regulations 2007, as amended (referred to as the 'Offshore Habitats Regulations') implement the Habitats Directive and the Birds Directive.

Under Article 6(3) of the Habitats Directive, a HRA is required where a plan or project is likely to have a significant effect upon a European site (also known as a 'Natura 2000' site) either individually or in combination with other plans or projects. European sites include the following:

- Special Areas of Conservation (SACs) designated under the Habitats Directive for their habitats and/or species of European importance; and
- Special Protection Areas (SPAs) classified under the Birds Directive for rare, vulnerable and regularly occurring migratory bird species and internationally important wetlands.

In the UK, the requirements of the Habitat Regulations also extend to the consideration of effects on:

- Sites that are proposed for designation and inclusion in the Natura 2000 network and sites that are currently in the process of being classified such as potential SPAs (pSPAs), candidate and possible SACs (cSACs and pSACs) and Sites of Community Importance (SCIs).

The Habitats Regulations specify, amongst other issues, how development control decisions which could directly or indirectly affect Natura sites are to be reached. It is Scottish Government policy (as outlined in Scottish Planning Policy (SPP); Scottish Government, 2014) that the Regulations should also apply to sites identified as Ramsar sites (under the Ramsar Convention on Wetlands of International Importance) and these are also referred to as 'Natura Sites'. The relevant sections of the Habitats Directive are Articles 6(3) and 6(4) (as implemented in the Habitats Regulations by Regulations 48 and 49).

Article 6(3) of the Habitats Directive [92/43/EEC] states:

"Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives."

It is therefore necessary, in the first instance, to determine whether it is possible to conclude that there is no LSE on the site. Only where it is not possible to conclude this, does an AA need to be carried out by the CA. The European Court of Justice ruling in the case of Waddenzee (Case C-127/02), stated that an AA of a project is necessary, "if it cannot be excluded, on the basis of objective information, that it will have a significant effect on the site." It is therefore clear that if it cannot be objectively ruled out, then an effect is likely. The test is therefore negative, and embeds precaution within it.

Regulation 48 of the Habitats Regulations states that an AA must be undertaken by the CA before any decision to give consent for any plan or project that is not directly connected with or necessary to the [conservation] management of a European site and which could significantly affect that site (either alone or in combination with other known plans or projects). An AA is required for all plans or projects "likely to have a significant effect" on a Natura site and applies only to the qualifying interests of the Natura site.

2.2 The Habitats Regulations Appraisal Process

The European Commission's guidance on Planning for the Protection of European Sites: Appropriate Assessment (European Commission, 2001) identifies a staged process to the assessment of the effects of plans or projects on European sites. Cumulatively, these stages are referred to as a Habitats Regulations Appraisal, in order to clearly distinguish the whole process from the second stage within it, which is referred to as AA.

There are potentially up to four stages:

- HRA Stage 1 - Screening;
- HRA Stage 2 - AA;
- HRA Stage 3 – Mitigation and Alternatives; and
- HRA Stage 4 – Assessment of "Imperative Reasons of Overriding Public Interest" (IROPI).

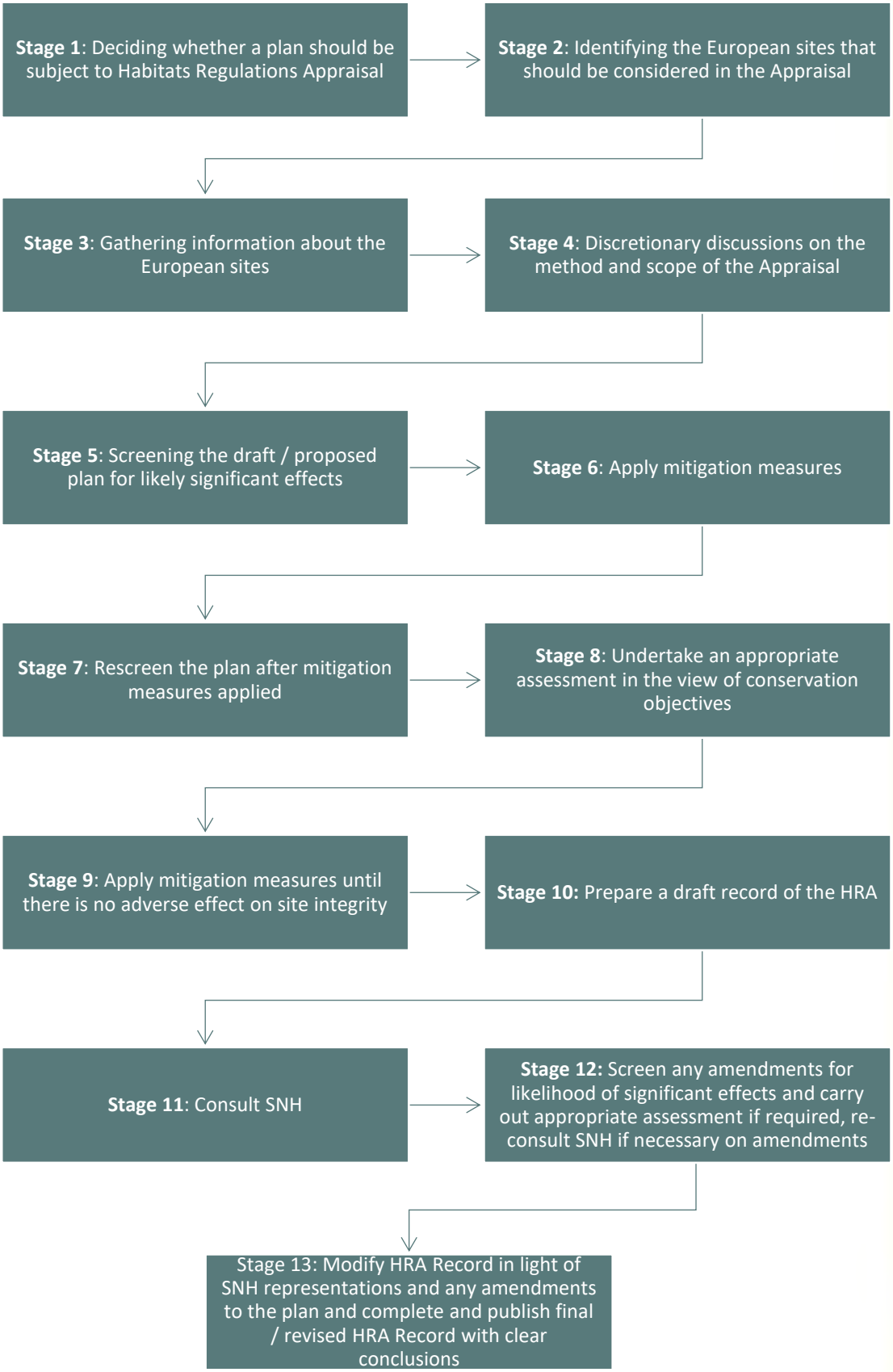
This report comprises the "Screening" stage, where the identification of LSE is reported. In this context, LSE is defined as 'any effect that may reasonably be predicted as a consequence of a plan or project that may affect the conservation objectives of the features for which the site was designated, but excluding trivial or inconsequential effects' (English Nature, 1999). Within the SNH Guidance (Tyldesley, D and Associates, 2015) paragraph 4.3 defines LSE as 'one that cannot be ruled out on the basis of objective information. The test is a 'likelihood' of effects rather than a 'certainty' of effects'. LSE should therefore 'not simply be interpreted as 'probable' or 'more likely than not', but rather whether a significant effect can objectively be ruled out'.

Within Scotland, the HRA process draws upon and follows the advice provided within the Scottish Natural Heritage (SNH) HRA guidance document 'Habitats Regulations Appraisal of Plans. Guidance for Plan-making Bodies in Scotland' (Tyldesley, D and Associates, 2015). This guidance sets out a 13-stage process of statutory procedures which are designed to assess the potential effects of plans and projects on European sites. The guidance is referred to within 'Planning Circular 6 2013. Development Planning' (Scottish Government, 2013). The 13 steps and the order in which they are applied are illustrated in Figure 2.2.1. This document is set out to address Stages 5 - 13 (screening and assessment stages).

Other guidance documents that have been used to inform this appraisal include:

- Department of Energy and Climate Change (DECC) (2016). Guidance on when new marine Natura 2000 sites should be taken into account in offshore renewable energy consents and licences. May 2016;
- SNH (2000). Natura Casework Guidance: Consideration of Proposals affecting SPA and SAC. Guidance Note Series; and
- Oxford Brookes (2001). Assessment of Plans and Projects Significantly Affecting Natura 2000 Sites: Methodological Guidance on the provisions of Article 6(3) and 6(4) of the 'Habitats' Directive 92/43/EEC. November 2001.

Figure 2.2.1 Illustration of HRA Process as set out within SNH Guidance (Tyldesley, D and Associates, 2015).



2.3 Approach to Screening

Screening is a relatively coarse filter to identify those European sites and qualifying features with connectivity to the Moray West Site for which a LSE cannot be discounted. In order to screen for LSE, it is necessary to consider three hierarchical aspects:

- Connectivity;
- Route to impact; and
- Non-trivial abundance.

Connectivity is defined as the presence of the qualifying feature of an SPA, SAC or Ramsar site in the zone of influence of a project. So, if a qualifying feature has no connectivity to the Moray West site, it leads to the conclusion of no LSE. Where connectivity cannot be objectively ruled out for any one qualifying feature, it is necessary to conclude that LSE cannot be excluded on the grounds of connectivity.

The next stage of the LSE consideration process is to consider potential for a route to impact (be it direct or indirect). Where connectivity has been identified, but it is determined that there is no route to impact on the qualifying feature, then it may still be possible to objectively conclude no LSE. If, however, a route to impact exists then a conclusion of LSE cannot be ruled out at this stage. Site-specific screening criteria are identified that assist with this part of the appraisal (Section 4.1).

Finally, if (following confirmation of potential for connectivity and route to impact) the abundance of a qualifying feature within the zone of influence is deemed trivial, it may be argued that no LSE can be concluded, as the conservation objectives of the site will not be compromised. The classification of trivial abundance is considered on a case by case basis and will vary between features, based on their habitat extent or population size.

Following the above process, for each European site (and their qualifying features) considered within the HRA screening it will be concluded that either:

- There are no LSEs on the European site(s) and their qualifying features, so therefore no further assessment is required; or
- LSEs on the European site(s) and their qualifying features cannot be discounted and therefore an AA requires completion by the CA.

Given the comparatively high level nature of screening a precautionary approach will be applied and so where any doubt as to the potential for LSE exists then the feature will be screened into the subsequent stage of the HRA process.

With respect to in-combination effects, this screening report identifies the categories of plans and projects that will need to be considered, but recognises that further discussion with the CA will be required to identify specific projects for inclusion in the in-combination assessment. The HRA will include, for those European sites and qualifying features screened into the assessment, a detailed in-combination assessment drawing on the findings of the EIA (including cumulative assessment) that will be undertaken specifically for the Moray West Site to understand the magnitude of those effects and whether they may lead to an adverse effect on site integrity.

3 Description of the Development

3.1 Introduction

This section provides a description of the infrastructure associated with the proposed Moray West Offshore Wind Farm and the OfTI. It is based on the design information available at the time of writing and it should be noted that the design of the Project infrastructure will be subject to further refinement throughout the pre-application phase. However, the level of detail presented below is deemed sufficient to inform HRA Screening, with any further refinement to the design and programme information being made available to inform any future RIAA that may be required by the CA as part of any future AA process.

3.2 Development Location and Boundaries

As described in Section 1.1 and shown on Figure 1.1.1, the Moray West Site is located within the Outer Moray Firth. The Project comprises the Moray West Offshore Wind Farm, the OfTI and the OnTI.

The Moray West Offshore Wind Farm is situated approximately 22 km from the Caithness coast, covering an area of approximately 225 km^2 and will comprise an offshore array of WTGs, connected to one another by subsea inter-array cables, which will in turn connect the WTGs to the OfTI. The Moray West Offshore Wind Farm is located on the western edge of an area known as Smith Bank.

The OfTI will be located within the Outer Moray Firth, and the export cables will make landfall on the Moray / Aberdeenshire coastline as shown in Figure 1.1.1. The OfTI will comprise one or two Offshore Substation Platform(s) (OSP(s))s to be located within the wind turbine array in the Moray West Offshore Wind Farm (their precise location within the array is yet to be confirmed), which will transform the power generated by the turbines before being transported via offshore export cable circuits, located within an Offshore Export Cable Corridor, to a shoreline landfall location on the Moray or Aberdeenshire coast where it joins the OnTI.

The OnTI will comprise onshore transition bays near the landfall where the offshore and onshore cable circuits are joined together, two underground onshore cable circuits located with the Onshore Export Cable Corridor from landfall to a new Moray West substation and buried interconnecting cables between the new substation and existing Blackhillock substation. The precise location of these infrastructure remains under investigation and will be presented in greater detail within the Onshore EIA and any Onshore HRA Screening Report that may be produced.

3.3 Offshore Wind Farm Infrastructure

3.3.1 Offshore Wind Turbines

Table 3.3.1 provides a summary of the indicative wind turbine parameters currently proposed.

Table 3.3.1 Indicative Wind Turbine Parameters

Indicative Parameter	Parameter Range
Indicative capacity (MW)	Up to 850 MW
Indicative number of turbines	Up to 90
Hub height range (m HAT)	118 - 155
Maximum rotor diameter (m)	250
Maximum tip height (m HAT)	280

Indicative Parameter	Parameter Range
Minimum air draft range (m HAT)	22
Minimum downwind spacing (m)	1,200
Minimum crosswind spacing (m)	1,050
Layout concept	The wind turbine layout will have some form of regularity in plan (i.e. Grid or Diamond patterns with minimum spacings as stated above) with the exception of the wind turbines around the perimeter which could have a tighter spacing compared to the ones within the wind farm array. It should be noted that there may be empty spaces within the layout pattern.

3.3.2 Offshore Wind Farm Infrastructure Foundations and Substructures

This section includes information on the foundations and substructures for the wind turbines and meteorological mast (if required). Table 3.3.2 provides a summary of the indicative parameters currently proposed for foundations and substructures.

Table 3.3.2 Indicative Foundation and Substructure Parameters

Infrastructure Type	Indicative Parameter	Maximum Parameter
Gravity Base Structures (GBS)	Maximum base diameter (m)	55
Steel lattice jacket (with pin piles)	Maximum number of legs	4
	Maximum depth (m)	60
	Maximum number of piles per foundation	4
	Maximum diameter of pile (m)	4
Steel lattice jacket (with suction caissons)	Maximum diameter with scour protection (m)	45
Suction Caisson	Maximum diameter (m)	25
Monopile	Maximum diameter of Pile (m)	15

Based on the known physical properties within the Moray West Site and the inherent uncertainty with the seabed properties a range of foundations and substructures are being considered. These include the following:

- Three or four legged steel lattice jacket structure with pin piles;
- Three or four legged steel lattice jacket structure with suction caissons;
- GBS;
- Suction caisson; and
- Monopile.

At this current time, due to changing economic and technological circumstances that may prove one or another technology more appropriate nearer the time of construction, Moray West is not currently excluding any of the above foundation types. Turbine support structures will include access facilities and

appropriate lighting and marking for surface navigation. Options for the configuration of the support structures, and details of their potential environmental impacts, will be included in the RIAA.

3.3.2.1 Steel Jacket Structure

Jackets are steel structures with three or four legs, each of which is fixed to the seabed using a steel "pin" pile or use of a suction caisson. Jacket structures can assume different configurations with sub–concepts including braced monopods, tripod structures and three or four-legged lattice structures. Pin piles are generally expected to be driven but drilling may be required at some locations. Pin pile diameters would vary depending on specific design but are expected to be up to 4 m in diameter. It is possible that suction caisson foundations could be used at the base of the jacket instead of the pin piles. These would be of a greater diameter, possibly up to 25 m (45 m including scour). Scour protection (e.g. scour mats or rock) may be used around each leg. Corrosion protection will be required for the steel structures, both above and below water level. This is likely to take the form of cathodic protection and / or protection coatings for the submerged areas, and protective coating for areas above the water line.

3.3.2.2 Gravity Base Structure

The generic GBS is composed of one or more hollow concrete base, which is filled with ballast for stability, and either a concrete or steel structure on top. The GBS may have a steel "skirt" which penetrates the seabed. The maximum base diameter of the structure is anticipated to be 81 m. The concept may require the preparation of the seabed with the installation of a flat gravel bed to provide a stable foundation for the GBS. Depending on the seabed soil conditions an area of seabed may require to be dredged prior to the installation of the gravel bed. If dredging is required it is expected that the area of seabed which is excavated will be greater than the final area of the laid gravel bed. In some cases, grouting injected under the GBS or rubber friction-enhancing mats may be a suitable alternative to the gravel bed foundation. The placing of scour protection around the concrete base (graded rock placement, concrete mattress or scour mats) is likely. As with a steel jacket or monopile, corrosion protection will be required for any steel work (including boat landings and ladders) of the substructure. This is likely to take the form of cathodic protection and / or protective coatings for the submerged areas, and protective coating for areas above the water line.

3.3.2.3 Suction Caisson

This concept has had limited use to date in the offshore wind industry but has been used extensively in oil and gas as alternatives to piles at the base of jackets. The concept consists of a steel cylindrical skirt or skirts up to an anticipated diameter of 25 m which penetrate into the seabed. Corrosion protection will be required for this substructure. This is likely to take the form of cathodic protection and / or protective coatings for the submerged areas, and protective coating for areas above the water line.

3.3.2.4 Monopile

This concept is the most commonly used solution on operational wind farm developments to date in water depths typically ranging up to 35 m, but technology evolution is making possible its use in deeper waters. The structure consists of a steel cylindrical pile with an anticipated maximum diameter of 15 m. Conical transitions are occasionally used to reduce the diameter of the structure at the top of the foundation. Corrosion protection will be required for this substructure. This is likely to take the form of cathodic protection and / or protective coatings for the submerged areas, and protective coating for areas above the water line. Scour Protection The substructure and foundation concept as well as the environmental conditions (current and waves) determines the type and extent of scour protection required, and typically a 'scour allowance' is specified during the design phase. Generally as foundation size increases the potential scour depth around the structure also increases and hence there is a greater need to protect

the foundation. Measures to minimise the extent of scour include the installation of rock armour on the seabed around foundations or the gravel bed in the case of a GBS foundation. Such a method has been commonly used in the North Sea, including the Moray East Offshore Meterological Mast. This involves the placement of carefully specified graded rock to act as a scour protection blanket. The suitability of installing rock armour or mattresses for cable protection especially around turbine bases will be assessed based on seabed sediment information and using the seabed current data across the Moray West Site.

3.3.3 Inter-Array Cabling

Table 3.3.3 provides a summary of the indicative parameters currently proposed for the network of subsea inter-array cables that will connect the wind turbines to the OSPs.

Table 3.3.3 Indicative Inter-Array Cable Network Parameters

Indicative Parameter	Parameter Range
Voltage of Cabling (kV)	33 to 72.5
Entry / Exit Method from Turbine	J-tube or Flexible Conduit Type Arrangement
Target Burial Depth (m)	0-3
Indicative Cable Installation Method	Ploughing, Jetting, Trenching, Rock Cutting
Protection where Burial Unachievable	Rock placement, Concrete Mattresses, Proprietary Steel, Plastic Ducting, Protecting Sleeves, Grout Bags.

The electrical infrastructure required in order to collect the energy generated by the wind turbines will comprise inter-array cabling between the turbines and any OSP(s). These cables are likely to be designed to operate at a voltage in the range of 33 to 72.5kV and may include fibre optic communication links.

3.4 Offshore Transmission Infrastructure

The OfTI will collect the energy generated by the Offshore Wind Farm (as described in the Moray West Offshore Wind Farm Infrastructure EIA Scoping Report, May 2016), located in the Outer Moray Firth, and transfer the energy to the OnTI, which will in turn connect the offshore wind farm to the onshore national electricity transmission system.

OfTI components are as follows:

- Up to two OSPs – these are the offshore equivalent of onshore electrical substations; they collect and transform the electricity generated by WTGs before it is transmitted to shore. The OSPs will be high voltage alternating current (HVAC) OSP colouring, lighting and marking requirements will be as per current relevant standards and guidance, as well as being informed through consultation with relevant bodies;
- OSP foundations and substructures – these structures, fixed to the seabed, support the topsides of the OSP(s), which sit above the surface of the sea. The substructure and foundation options being considered for the OSP(s) are GBSs, monopiles and steel lattice (or jacket) structures;
- Interconnector cables (if required) – these subsea cables connect multiple OSP(s) to one another. The voltage range will be between 33 -400 kV. The extent of the possible cabling between OSP(s) has not yet been determined and cable length will depend upon the distance between OSP(s), which will be located within the Moray West Site;

- Offshore export cables – these subsea cables (comprising up to two cable circuits installed in separate trenches) transmit the electricity generated by the wind farm, from the OSP(s) to the shore. Spacing between the cables has yet to be determined, but will be in the region of four times water depth; and
- Landfall – this is the location where the subsea offshore export cables are physically brought ashore and where they connect to the onshore export cables, which form part of the OnTI. The limit of the OfTI for application purposes is mean high water spring (MHWS). The export cable circuits will make landfall on the Moray or Aberdeenshire coast between Portknockie and Portsoy, as shown in Figure 1.1.1. The means by which the cables will be installed at landfall will depend upon the characteristics of the selected landfall location. The export cables will be buried, and will either be installed in a trench or routed below the shoreline using other techniques, such as horizontal directional drilling (HDD).

3.5 Construction Programme

The current indicative programme for the Moray West site suggests a start to construction in 2022 at the earliest, with the onshore substation installation starting first in Quarter 2 (Q2) 2022 with completion in Q1 2023. The offshore turbine foundations and substructure installation would start in Q2 2022 and be completed in Q3 2023. The inter-array cables would be installed between Q1 and Q4 in 2023, with the OSP(s) installed in Q2 / Q3 2023. Following installation of the OSP(s), the export cables would be installed between Q3 2023 and Q1 2024. WTG installation would then take place between Q1 2024 and Q4 2024. The overall construction programme is therefore scheduled to take approximately 34 months from first installation of infrastructure to first generation, with full generation anticipated for Q4 2024.

It is likely that construction of the onshore substation and installation of the onshore cable circuits will occur in parallel. However, installation of the onshore cable circuits will be transient in that it will progress along the chosen route, with construction activities occurring in any one location for a short period only. This would be the same for the offshore export circuits.

3.6 Operation and Maintenance

Once operational, the Moray West Offshore Wind Farm and OfTI will require regular inspections, service and maintenance throughout its lifetime. It is likely that the Moray West Offshore Wind Farm and the OfTI will each be managed, operated and maintained from their own onshore facility. Onshore activities will include the following:

- Control room for remote operation of the Moray West Offshore Wind Farm and OfTI;
- Port facilities where vessels, maintenance equipment, spares and consumables are stored;
- Onshore operations base for management of work and personnel; and
- Helicopter hangar and base (if required).

Operation and maintenance (O&M) activities may be required at any time, 24 hours per day, 365 days per year.

The majority of control activities will be undertaken remotely from shore using a control centre, however offshore access and intervention will be required to maintain and potentially repair or refit plant and equipment. Maintenance can be generally separated into three categories:

- Planned maintenance: This includes general inspection and testing, investigation of faults and minor fault rectification, as well as replacement of consumables. It is anticipated that these events will be undertaken during summer months as the weather is likely to be more

favourable, offering an increased maintenance window. Scheduled maintenance and inspection of each OSP is likely to occur every six to twelve months. Inspections of subsea cables will be performed on a periodic basis;

- Unplanned maintenance: This applies to defects occurring that require rectification out-with the planned maintenance periods. The scope of such maintenance would range from small defects on non-critical systems to failure or breakdown of main components potentially requiring them to be repaired or replaced; and
- Periodic overhauls: These will be carried out in accordance with equipment manufacturer's warranty and specifications. These are likely to be planned for execution in periods of the year with the best access conditions.

The Crown Estate Scotland lease for Moray West Offshore Wind Farm will be for 50 years, with the design life of the turbines and other components of the wind farm being of a similar order when repowering is considered.

3.7 Decommissioning

Decommissioning requirements are set out in the Energy Act 2004 and will influence all stages of design of the Moray West Offshore Wind Farm and OfTI. This will be a key requirement under the Crown Estate Scotland lease agreement.

The Moray West Offshore Wind Farm, OSP(s) and cables will be decommissioned following the end of their operational life. The extent of decommissioning is dependent on the type of foundations / substructures adopted for the WTGs and OSP(s), so options will be assessed in conjunction with the design of the development in the ER.

A Decommissioning Programme will be prepared for the Wind Farm and OfTI prior to construction, in line with the requirements of the Energy Act 2004. For the purpose of this Scoping Report the following has been assumed; that foundations and substructures of the OSP(s) would be removed, where practicable, with piled foundations removed to just below seabed. There is no statutory requirement for decommissioned subsea cables to be removed, though the approach to decommissioning, including cable decommissioning, will be reviewed as part of the Decommissioning Programme. It is expected that OfTI decommissioning will require similar vessels to those used in construction and take a similar period of time.

4 Screening

4.1 Screening Criteria

The criteria by which European sites and features are identified as having connectivity or having the potential for a LSE with the Moray West Site and or OfTI boundary are set out in Table 4.1.1.

Table 4.1.1 Screening Criteria for the Initial Identification of European Sites.

Criteria for the initial identification of European Sites	Specific Criteria
European site or Ramsar that overlaps with the Moray West Site and / or OfTI	All: physical overlap between project boundary and designated site.
SACs supporting mobile populations of qualifying features (e.g. Annex II marine mammals or migratory fish) that may interact with potential effects associated with the Moray West Site and / or OfTI.	Extent of the mobile species study area – e.g. management units for marine mammals.
European site or Ramsar with qualifying features whose mean maximum foraging or migratory range overlaps with the Moray West Site and / or OfTI.	Birds – based on standard ranges; Seal – based on standard foraging range from haul out sites; and Marine mammals & migratory fish – based upon known key migrations routes.
European sites with marine mammal and migratory fish qualifying features who may be exposed to auditory injury (Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS)).	Based on hearing thresholds identified through research and published data and project specific underwater noise modelling outputs
European sites with marine mammal and migratory fish qualifying features who may suffer behavioural changes or effects.	Assessment of behavioural responses to underwater noise taking into consideration published research findings.
European site or Ramsar and / or a qualifying feature located within the potential extent of impacts associated with the Moray West Site and / or OnTI.	Indirect pathways to features e.g. pollution or suspended sediment reaching designated sites / features.
European site or Ramsar qualifying species recorded during site specific surveys.	Presence of a qualifying species that can be associated with a designated site.

4.2 Identification of Sites and Features with Connectivity

This section identifies the European sites and Ramsar (and qualifying features) for which there is potential connectivity with the Moray West Site and OfTI. These sites and their qualifying features have been identified through the application of the criteria set out within Table 4.1.1 and in accordance with the approach set out in Section 2.3. Those sites for which there is connectivity will be taken forward for determination of LSE.

The Scoping Opinion received from Marine Scotland for the Moray West Offshore Wind Farm (Marine Scotland, 2016) clearly identifies the European sites and Ramsar that the CA and its statutory advisors consider to require assessment as part of the AA. However, a review of all sites that have potential to have connectivity with the Moray West Site and OfTI has been undertaken within this report to ensure that all screening out is justified and validated.

The Moray West Site does not overlap with any European site or Ramsar, whilst the OfTI overlaps with the Moray Firth pSPA in the near shore extent. Therefore, with the exception of the pSPA, any

connectivity will be associated with either the potential for mobile species to be present within the zone of influence from the Project, or for the zone of influence to extend out to European or Ramsar sites that are close by.

Consideration has been given to the existing Moray East AA (Marine Scotland, 2014) and also the feedback from key stakeholders to date on the Moray West Site scoping report. From these sources it is identified that consideration would need to be given to mobile marine mammal, ornithological and fish receptors from designated sites whose presence within the Project's zone of influence may be anticipated. In addition to these receptors that may be connected to designated sites considerable distance from the Project, consideration is also given to any European sites or Ramsar within the Moray Firth, where non-mobile designated species / features may have the potential to be affected either directly or in-directly by the Project.

4.2.1 Sites Designated for Ornithological Features

The Offshore Export Cable Corridor component of the Moray West OfTI partially overlaps the Moray Firth pSPA (see Figure 4.2.1 and Table 4.2.1), as a result the potential for a LSE on the features of this pSPA cannot be discounted. The features include breeding and wintering shag (*Phalacrocorax aristotelis*), wintering red-throated diver (*Gavia stellata*), great northern diver (*Gavia immer*), common scoter (*Melanitta nigra*), velvet scoter (*Melanitta fusca*), eider (*Somateria mollissima*), goldeneye (*Bucephala clangula*), long-tailed duck (*Clangula hyemalis*), scaup (*Aythya marila*) and Slavonian grebe (*Podiceps auritus*).

Table 4.2.1 European Sites (SPAs) and Ramsar which Overlap with the Moray West Site and OfTI.

Site	Qualifying Features	Overlap With	
		Moray West Offshore Wind Farm	OfTI
Moray Firth pSPA	Shag, breeding and non-breeding; Common scoter, non-breeding; Eider, non-breeding; Goldeneye, non-breeding; Great northern diver, non-breeding; Long-tailed duck, non-breeding; Red-breasted merganser (*Mergus serrator*), non-breeding; Red-throated diver, non-breeding; Scaup, non-breeding; Slavonian grebe, non-breeding; and Velvet scoter, non-breeding.	No	Yes

In addition to impacts resulting from direct effects (i.e. based on overlap between the Moray West Site and the Moray Firth pSPA), there may be potential for LSE on ornithological qualifying features of sites located further afield, where birds forage and / or migrate through the Moray West Site. These features include:

- Breeding birds;
- Migratory seabirds; and
- Waterbirds (waders and wildfowl).

The criteria used in Table 4.1.1 for screening of sites with these features are given below by feature type.

4.2.1.1 Sites Designated for Mobile Breeding Ornithological Features

During the breeding season foraging birds may travel some distance from their breeding colonies. The information available on the distances that breeding birds will forage depends on the species. Thaxter *et al.* (2012) provide data on recorded foraging ranges for a wide range of species, including the mean and maximum distances travelled. Typically, the mean-maximum range (i.e. the mean average of the maximum foraging trips recorded) has been used as a criterion for establishing whether there is likely to be connectivity (and hence risk of a LSE between an SPA breeding colony and the Moray West Site.

In some cases, more specific information is available from GPS / satellite tracking studies such as, for example, the initiatives for great black-backed gull and herring gull as part of Moray East EIA and the Future of the Atlantic Marine Environment (FAME) / Seabird Tracking and Research (STAR) programmes implemented by the Royal Society for the Protection of Birds (RSPB) and others.

Mean-maximum foraging ranges as reported by Thaxter *et al.* (2012) have been used to determine potential connectivity with the Moray West Site and OfTI, unless specific relevant tracking data are available (where the latter is deemed to have priority).

Those species observed within the Moray West Site that have the potential to be associated with designated sites are summarized in Appendix 2.

Figure 4.2.2 to Figure 4.2.11 present foraging ranges for ten breeding qualifying features of SPAs (fulmar (*Fulmarus glacialis*), cormorant (*Phalacrocorax carbo*), shag, guillemot (*Uria aalge*), razorbill (*Alca torda*), puffin (*Fratercula arctica*), kittiwake (*Rissa tridactyla*), herring gull (*Larus argentatus*), great black-backed gull (*Larus marinus*) and sandwich tern (*Thalasseus sandvicensis*)). All other breeding seabird qualifying features are disregarded for the purposes of this report, as the Moray West Offshore Wind Farm is understood to lie considerably beyond mean-maximum (or even maximum) foraging range. For these species it is concluded that there is therefore a lack of connectivity between an SPA and the Moray West Site during the breeding season.

Two SPAs in Orkney (Hoy SPA and Copinsay SPA) include breeding seabird qualifying features whose foraging ranges stretches as far as Moray West. The Moray East ES (Moray East, 2012) considered these sites and no impacts were deemed appropriate to apportion to the populations in question (due to distance and likely distribution of features foraging away from colonies). No LSE on the SPAs were therefore predicted and these sites are therefore screened out at this stage of the report and are not considered further.

Fulmar

The mean-maximum foraging range for fulmar is substantial at 400 km. Although sites such as Forth Islands and those in Orkney / Shetland technically fall within range, only those sites considered previously by Moray East are included here. Considering the wide foraging range of the species and their catholic foraging preferences, the likelihood of significant Fulmar connectivity between these sites and Moray West is considered low. Indeed, no effect on the three nearest SPAs including fulmar as qualifying feature were predicted in Moray East (2012) and therefore a high degree of certainty was attached to predicted no effects on SPAs further distant. Mean-maximum foraging ranges from all regional SPAs where this species qualifies (East Caithness Cliffs, North Caithness Cliffs, Troup, Pennan and Lion's Head and Buchan Ness to Collieston Coast SPAs) are connected with the Moray West Site (Figure 4.2.2). On this basis, the potential for a LSE on this species from each of these sites cannot be discounted (for both the Moray West Offshore Wind Farm and OfTI).

Cormorant

Cormorant has a mean-maximum of 25 km and this range from East Caithness Cliffs SPA extends to the Moray West Offshore Wind Farm (Figure 4.2.3). When a single standard deviation on the published foraging range is considered, the northern elements of the OfTI also lie within range of the SPA. On this basis, the potential for a LSE on this species from this site cannot be discounted (for both Moray West Offshore Wind Farm and the OfTI).

Shag

Shag is a qualifying feature of both East Caithness Cliffs and Buchan Ness to Collieston Coast SPAs. Shag has a limited mean-maximum foraging range of 14.5 km, so that the Moray West Site lies outside of projected interaction from both SPAs even when a single standard deviation is considered (Figure 4.2.4). On this basis, the potential for a LSE on this species from these two sites is discounted (for both the Moray West Offshore Wind Farm and the OfTI).

Guillemot

Figure 4.2.5 shows the mean maximum foraging ranges plus one standard deviation for guillemot from regional SPAs (84.2 km). Guillemot is a feature of four SPAs in the region; the Moray West Offshore Wind Farm and OfTI lie within this range for three of these SPAs (North Caithness Cliffs, East Caithness Cliffs and Troup, Pennan and Lion's Head SPAs). The Moray West OfTI also lies within mean-maximum foraging range from Buchan Ness to Collieston Coast SPA as does the Moray West Offshore Wind Farm when a single standard deviation is considered (Figure 4.2.5). On this basis, the potential for a LSE on this species from each of these four sites cannot be discounted (for both the Moray West Offshore Wind Farm and the OfTI).

Razorbill

Figure 4.2.6 shows the mean maximum foraging ranges plus one standard deviation for razorbill from regional SPAs (48.5 km). Razorbill is a feature of three SPAs in the region; the Moray West Offshore Wind Farm lies within this range for two of these SPAs (North Caithness Cliffs and East Caithness Cliffs) while the OfTI lies within range of East Caithness Cliffs and Troup, Pennan and Lion's Head SPA. When a single standard deviation on the foraging range is considered, the Moray West Site is within reach of all three SPAs (Figure 4.2.6). On this basis, the potential for a LSE on this species from each of these three sites cannot be discounted (for both the Moray West Offshore Wind Farm and the OfTI).

Puffin

Puffin has a mean-maximum of 105.4 km and this range from North Caithness Cliffs SPA extends to the Moray West Site (Figure 4.2.7). On this basis, the potential for a LSE on this species from this site cannot be discounted (for both the Moray West Offshore Wind Farm and the OfTI). SNH are recommending to Government that puffin be removed from the East Caithness Cliffs SPA citation as a named assemblage species. It is understood that breeding puffin are restricted to North Caithness Cliffs as SPA.

Kittiwake

Figure 4.2.8 shows the mean-maximum foraging range for kittiwake from all relevant SPAs in the region. The mean-maximum foraging range of 60 km for this species suggests that the Moray West Site is within range of East Caithness Cliffs, North Caithness Cliffs and, Troup, Pennan and Lion's Head. On this basis, the potential for a LSE on this species from each of three sites cannot be discounted. Buchan Ness to Collieston Coast SPA is within range of the OfTI only. Therefore an LSE on the kittiwake feature of Buchan Ness to Collieston Coast SPA is discounted for the proposed wind farm but it cannot be discounted for any effects associated with the OfTI.

Herring Gull

Figure 4.2.9 shows the mean-maximum foraging range for herring gull from all relevant SPAs in the region. The mean-maximum foraging range of 61.1 km for this species suggests that the Moray West Site lies within range of East Caithness Cliffs and, Troup, Pennan and Lion's Head while the OfTI is within reach of Buchan Ness to Collieston Coast SPA. When considered the single standard deviation on foraging range, the Moray West Offshore Wind Farm is within reach of Buchan Ness to Collieston Coast SPA (Figure 4.2.9). On this basis, the potential for a LSE on this species from each of three sites cannot be discounted (for both the Moray West Offshore Wind Farm and the OfTI). It is however noted that tracking work from East Caithness Cliffs in 2014 (Moray East, 2015) found that none of the herring gulls fitted with tags foraged within the boundary of the Moray West Site.

Great Black-backed Gull

Figure 4.2.10 shows the mean-maximum foraging range for great black-backed gull from all relevant SPAs in the region. The mean-maximum foraging range of 60 km for this species suggests that the Moray West Site lies within range of East Caithness Cliffs SPA (Figure 4.2.10). On this basis, the potential for a LSE on this species from each of three sites cannot be discounted (for both the Moray West Offshore Wind Farm and the OfTI). It is however noted that tracking work from East Caithness Cliffs in 2014 (Moray East, 2015) found that none of the great black-backed gulls fitted with tags foraged within the boundary of the Moray West Site.

Sandwich Tern

Figure 4.2.11 shows the mean-maximum foraging range for Sandwich tern from the relevant SPA in the region (Loch of Strathbeg). The mean-maximum foraging range of 49 km for this species suggests that the Moray West Site does not lie within range of the SPA (Figure 4.2.11). When the single standard deviation is considered, sandwich tern may potentially forage to the Moray West Offshore Wind Farm. On this basis, the potential for a LSE on this species from the SPA cannot be discounted (for the OfTI only).

Summary of Sites with Breeding Features Taken Forward for Determination of LSE

Table 4.2.2 presents a summary of sites and designated ornithological features with foraging ranges relating to the Moray West Site and OfTI.

Table 4.2.2 Mobile Species Supported by European and Ramsar Sites Whose Mean Maximum Foraging and / or Migratory Range Overlaps with the Moray West Site.

Site	Designated Species	Migratory or Foraging Range (km)	Distance To Closest Point (km)	
			Moray West Offshore Wind Farm	OfTI
East Caithness Cliffs SPA[1]	Shag; Cormorant; Fulmar; Guillemot; Razorbill; Great black-backed gull; Herring gull; and Kittiwake.	14.5 ± 3.5 25.0 ± 10.0 400 ± 245.8 84.2 ± 50.1 48.5 ± 35.0 60 61.1 ± 44.0 60.0 ± 23.3	19.8	30.0

[1] SNH are recommending to Government that puffin be removed from the East Caithness Cliffs SPA citation as a named assemblage species.

Site	Designated Species	Migratory or Foraging Range (km)	Distance To Closest Point (km)	
			Moray West Offshore Wind Farm	OfTI
North Caithness Cliffs SPA	Fulmar; Guillemot; Razorbill; Puffin; and Kittiwake.	400 ± 245.8 84.2 ± 50.1 48.5 ± 35.0 105.4 ± 46.0 60.0 ± 23.3	41.8	57.1
Troup, Pennan and Lion's Heads SPA	Fulmar; Guillemot; Razorbill; Herring gull; and Kittiwake.	400 ± 245.8 84.2 ± 50.1 48.5 ± 35.0 61.1 ± 44.0 60.0 ± 23.3	52.4	20.8
Buchan Ness to Collieston Coast SPA	Shag; Fulmar; Guillemot; Herring gull; and Kittiwake.	14.5 ± 3.5 400 ± 245.8 84.2 ± 50.1 61.1 ± 44.0 60.0 ± 23.3	92.9	59.8
Loch of Strathbeg SPA	Sandwich tern.	49.0 ± 7.1	76.7	47.7

4.2.1.2 Breeding Seabird Features in the Non-Breeding Season

Seabird species in general disperse widely during non-breeding seasons, so that impacts to some degree may be felt on the SPA populations during these seasons. The species are not constrained by extents of central-place foraging and for that reason a LSE on all species detailed above that are SPA / pSPA qualifying or non-listed assemblage features cannot be discounted. It is however expected that densities of species will be lower in the non-breeding seasons (especially in the case of herring gull) or lower apportioning values to the relevant SPA will be appropriate (compared to the breeding season).

4.2.1.3 Sites Designated for Migratory Seabirds and Waterbirds

Seabirds that breed in sites designated as SPAs in areas of the UK that are distant from the Moray West Site have some potential to interact with the Moray West Offshore Wind Farm during bi-annual migratory movements. In order to determine whether there is potential for a LSE with respect to the Moray West Site, the RIAA will include an extended screening exercise for migratory seabirds. The process involves calculating the proportion of each species' migratory front represented at the Moray West Site which is then incorporated into, for example, collision risk modelling. Any projected SPAs that have relevance to this modelling are not specifically listed in this HRA Screening report.

The movement of migratory waders and wildfowl is characterised by long distance flights, which occur as a series of flights between discrete wetlands or 'staging areas'. The majority of these movements occur across broad fronts with radar studies showing that waders will migrate at altitudes of 500 m - 4,000 m (e.g. van de Kam *et. al.*, 2004). Only when migrating waders encounter unfavourable weather will birds descend to lower heights following landscape features such as coastlines until they reach suitable staging areas.

Table 4.2.3 lists SPAs on the north-east Scotland coastline that support migratory waders and wildfowl as features. Those species / sites already screened in through direct overlap with the Moray West Site (i.e. Moray Firth pSPA) with foraging range connectivity (Table 4.2.2) are not included.

Table 4.2.3 Mobile Species Supported by European and Ramsar Sites which may Interact with Potential Effects Associated with the Moray West Site.

Site	Designated Species	Mobile Species Study Area	Distance To Closest Point (km)	
			Moray West Offshore Wind Farm	OfTI
Moray and Nairn Coast SPA	Bar-tailed godwit (*Limosa lapponica*), non-breeding; Common scoter, non-breeding; Dunlin (*Calidris alpina alpina*), non-breeding; Greylag goose (*Anser anser*), non-breeding; Long-tailed duck, non-breeding; Osprey (*Pandion haliaetus*), breeding; Oystercatcher (*Haematopus ostralegus*), non-breeding; Pink-footed goose (*Anser brachyrhynchus*), non-breeding; Red-breasted merganser, non-breeding; Redshank (*Tringa totanus*), non-breeding; Velvet scoter, non-breeding; Waterfowl assemblage, non-breeding; and Wigeon (*Anas penelope*), non-breeding.	NE Scotland	36.8	10.5
Dornoch Firth and Loch Fleet Ramsar	Bar-tailed godwit, non-breeding; Greylag goose, non-breeding; and Wigeon, non-breeding.	NE Scotland	36.2	36.2
Dornoch Firth and Loch Fleet SPA	Bar-tailed godwit, non-breeding; Curlew (*Numenius arquata*), non-breeding; Dunlin, non-breeding; Greylag goose, non-breeding; Osprey, breeding; Oystercatcher, non-breeding; Teal (*Anas crecca*), non-breeding; and Wigeon, non-breeding.	NE Scotland	36.2	36.2

Site	Designated Species	Mobile Species Study Area	Distance To Closest Point (km)	
			Moray West Offshore Wind Farm	OfTI
Cromarty Firth SPA	Bar-tailed godwit, non-breeding; Common tern (*Sterna hirundo*), breeding; Curlew, non-breeding; Dunlin, non-breeding; Greylag goose, non-breeding; Knot (*Calidris canutus*), non-breeding; Osprey, breeding; Oystercatcher, non-breeding; Pintail (*Anas acuta*), non-breeding; Red-breasted merganser, non-breeding; Redshank, non-breeding; Scaup, non-breeding; Whooper swan (*Cygnus cygnus*), non-breeding; and Wigeon, non-breeding.	NE Scotland	54.7	54.7
Cromarty Firth Ramsar	Bar-tailed godwit, non-breeding; and Greylag goose, non-breeding.	NE Scotland	54.7	54.7
Inner Moray Firth SPA	Bar-tailed godwit, non-breeding; Common tern, breeding; Cormorant, non-breeding; Curlew, non-breeding; Goldeneye, non-breeding; Goosander (*Mergus merganser*), non-breeding; Greylag goose, non-breeding; Osprey, breeding; Oystercatcher, non-breeding; Red-breasted merganser, non-breeding; Redshank, non-breeding; Scaup, non-breeding; Teal, non-breeding; and Wigeon, non-breeding.	NE Scotland	63.1	61.5
Inner Moray Firth Ramsar	Bar-tailed godwit, non-breeding; Greylag goose, non-breeding; Red-breasted merganser, non-breeding; and Redshank, non-breeding.	NE Scotland	63.1	61.5

4.2.1.4 Designated Habitat Within a SPA or Ramsar

The potential effects on designated habitat of sites supporting ornithological features is limited to the Moray Firth pSPA, which directly overlaps with the Moray West OfTI.

4.2.1.5 Bird Species Recorded in Site Specific Surveys

Although no analysis has yet been undertaken of the recently completed digital aerial surveys of the Moray West Site, a list of the species recorded is available. Table 4.2.4 details the species recorded by month of survey from April 2016 to March 2017.

Both shag and cormorant were completely absent confirming the conclusion that LSE can be discounted for the former species (as the SPAs are outwith the mean maximum foraging range for shag) and strongly suggesting that it can also be discounted for the latter species (SPAs were identified as being within the mean maximum foraging range for cormorant even though cormorant was recorded as absent). The surveys were not designed to record species associated with the OfTI, however two qualifying species of Moray Firth pSPA, great northern diver and common eider were recorded in single months of survey.

Table 4.2.4 European or Ramsar Qualifying Species Recorded During Site Specific Surveys By Month Between April 2016 to March 2017.

Month / Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Guillemot	■	■	■	■	■	■	■	■	■	■	■	■
Razorbill	■	■	■	■	■	■	■	■	■	■	■	
Herring gull	■	■		■		■		■	■			■
Kittiwake	■	■	■	■	■	■	■	■	■	■	■	■
Shag												
Great black-backed gull	■	■	■			■	■	■	■	■	■	■
Cormorant												
Fulmar	■	■	■	■	■	■	■	■	■	■	■	■
Puffin					■	■	■	■	■	■		
Sandwich tern									■			

4.2.2 Sites Designated for Marine Mammal Features

As identified earlier in Appendix 2, within the Scoping Opinion for Moray West (Marine Scotland, 2016) SNH and JNCC identified that the key species to address for the Moray West Offshore Wind Farm were harbour (or common) seal (*Phoca vitulina*), bottlenose dolphin (*Tursiops truncatus*), harbour porpoise (*Phocoena phocoena*), minke whale (*Balaenoptera acutorstrata*) and grey seal (*Halichoerus grypus*). As this report addresses the requirements of HRA Screening, minke whale are not a SAC qualifying feature so there is no connectivity with this species in terms of HRA. SACs with marine mammal qualifying features are shown in Figure 4.2.12.

The following species of marine mammal have therefore been identified as requiring consideration in this HRA Screening:

- Harbour seal;
- Grey seal;
- Bottlenose dolphin; and

- Harbour porpoise.

4.2.2.1 SACs Supporting Mobile Populations of Marine Mammals

SACs with marine mammal qualifying features that have been identified as having connectivity due to mobile populations are presented below in Table 4.2.5. For harbour seal and grey seal, foraging ranges of 50 km and 200 km were identified as appropriate for identifying connectivity. For bottlenose dolphin it was considered that although the Moray Firth population are highly resident, there are increasing sightings of individuals outwith the Moray Firth, with individuals known to travel to the Firth of Tay and the Firth of Forth (Appendix 2). This range has been established for this specific population.

The Inner Hebrides and Minches cSAC is currently under review by the European Commission, but this cSAC is considered to be too far from the Moray Firth and comprise a different population of harbour porpoise to those that are encountered in the Moray Firth (as indicated by IAMMWG, 2015 and other data). As such it is considered that there is no connectivity to this cSAC. Similarly, the Southern North Sea pSAC is also considered to be outwith the foraging range of the Moray Firth for harbour porpoise and is considered to have no connectivity.

Table 4.2.5 Mobile Marine Mammal Species Supported by SACs Which May Interact With Potential Effects Associated With the Moray West Site.

Site	Qualifying Species	Mobile Species Study Area	Distance To Closest Point (km)	
			Moray West Offshore Wind Farm	OfTI
Moray Firth SAC	Bottlenose dolphin	North Sea	17.2	17.2
Dornoch Firth and Morrich More SAC	Harbour seal	North Sea	42.5	42.5
Faray and Holm of Faray SAC	Grey seal	North Sea	110.0	126.1
Isle of May SAC	Grey seal	North Sea	205.1	166.3
Monach Islands SAC	Grey seal	North Sea	264.8	278.9

4.2.2.2 SACs with Qualifying Marine Mammals Recorded During Site Specific Surveys

During the site specific surveys identified in Appendix 2 (with the exception of the digital aerial video surveys that have not been analysed), the qualifying species of marine mammal identified in Table 4.2.6 were recorded.

Table 4.2.6 SAC Qualifying Species Recorded During Site Specific Surveys.

Species	Distance To Closest Point (km)		Site Identified in Table 4.2.5
	Moray West Offshore Wind Farm	OfTI	
Harbour seal	Within Site	Within Site	Yes
Grey seal	Within Site	Within Site	Yes
Bottlenose dolphin	Within Site	Within Site	Yes

Species	Distance To Closest Point (km)		Site Identified in Table 4.2.5
	Moray West Offshore Wind Farm	OfTI	
Harbour porpoise	Within Site	Within Site	No – scoped out in Section 4.2.2.1

4.2.3 Sites Designated for Migratory Fish Features

Section 6.2 of the Moray West OfTI Scoping Report (Moray West, 2017a) set out the baseline conditions for the migratory fish interests that are present in relation to the Moray West Offshore Wind Farm and the OfTI. Diadromous fish species such as Atlantic salmon (*Salmo salar*) and European eel (*Anguilla anguilla*) may be present in the area, particularly adult salmon migrating to the nearby SACs, or salmon smolts migrating from the SACs into the open sea. The following SACs (Figure 4.2.13) were identified during scoping as potentially being affected upon by Moray West:

- Berriedale and Langwell Waters SAC – Atlantic salmon;
- River Borgie SAC – Atlantic salmon and freshwater pearl mussel (*Margaritifera margaritifera)*;
- River Dee SAC - Atlantic salmon and freshwater pearl mussel;
- River Naver SAC - Atlantic salmon and freshwater pearl mussel;
- River Thurso SAC – Atlantic salmon;
- River Oykel SAC - Atlantic salmon and freshwater pearl mussel;
- River Moriston SAC - Atlantic salmon and freshwater pearl mussel; and
- River Spey SAC – Atlantic salmon, sea lamprey (*Petromyzon marinus*) and freshwater pearl mussel.

Freshwater pearl mussels are reliant on salmonids for successful juvenile recruitment and population sustainability so there is connectivity between these species. This needs to be considered in parallel with the test for no LSE on SACs for Atlantic salmon. The qualifying features of brook lamprey, freshwater pearl mussel and freshwater habitats are not considered to have connectivity to Moray West (due to their wholly freshwater lifecycles as well as there being no SACs within the Scoping Study Area of the OnTI). Otter associated with SACs are also not considered to have connectivity, due to no SACs being located within the Scoping Study Area. These species are scoped out of any future offshore HRA on this basis Otter will be considered and assessed for LSE as required within any future Onshore HRA.

The following species of migratory fish have therefore been identified as requiring consideration in this HRA Screening:

- Atlantic salmon; and
- Sea lamprey.

The Scoping Opinion for the Moray West Offshore Wind Farm (Marine Scotland, 2016) and the previous AA undertaken by Marine Scotland for the Moray East Site (Marine Scotland, 2012) are clear on which European sites and features should be addressed within the HRA and given that Moray West is not aware of any new SACs being brought forward for these features then a similar suite of sites would seem logical given the likely similar nature in the zone of influence between Moray West and Moray East. Notwithstanding this, the criteria used in Table 4.1.1 for screening of sites supporting marine mammal

and migratory fish qualifying features outlined above are also applied in this assessment to validate screening, or to clarify where there is not a clear response in the scoping (migratory fish).

4.2.3.1 SACs Supporting Mobile Populations of Migratory Fish

SACs with migratory fish qualifying features that have been identified as having connectivity due to mobile populations are presented below in Table 4.2.7. Movement of Atlantic salmon and post-smolts is not clearly understood within the Moray Firth and the wider North Sea, although these species are documented as generally using the coastal and near shore waters (Appendix 2).

Table 4.2.7 Mobile Migratory Fish Species Supported by SACs Which May Interact With Potential Effects Associated With the Moray West Site.

Site	Qualifying Species	Mobile Species Study Area	Distance To Closest Point (km)	
			Moray West Offshore Wind Farm	OfTI
Berriedale and Langwell Waters SAC	Atlantic salmon	Moray Firth / North Sea / Norwegian Sea	22.7	25.6
River Borgie SAC	Atlantic salmon		79.2	82.0
River Dee SAC	Atlantic salmon		96.1	60.2
River Naver SAC	Atlantic salmon		68.7	70.0
River Thurso SAC	Atlantic salmon		40.2	43.4
River Oykel SAC	Atlantic salmon		68.1	68.1
River Moriston SAC	Atlantic salmon		121.1	114.7
River Spey SAC	Atlantic salmon Sea lamprey	Moray Firth / North Sea	37.0	11.3

4.2.4 Designated sites with non-mobile features within the Moray Firth

Within their scoping response (Marine Scotland, 2016), SNH requested that with respect to physical processes, qualifying habitats within the Moray Firth SAC, Dornoch Firth and Morrich More SAC and Culbin Bar SAC should be appraised within the HRA.

As well as being designated for its bottlenose dolphins, the Moray Firth SAC is also designated for Annex I habitat of 'Sandbanks which are slightly covered by sea water all the time. The Moray Firth SAC is approximately 17 km in distance from the Moray West Site and OfTI at its closest point so there is no spatial overlap in habitats. Although unlikely that hydrodynamic changes due to the presence of WTG and OSP foundations would cause a LSE, this cannot be ruled out at this point so there may be connectivity. The physical processes modelling and assessment work being undertaken as part of the EIA will determine whether there will be a LSE on these SAC habitats.

The Dornoch Firth and Morrich More SAC has qualifying habitats of Atlantic salt meadows, coastal dune heathland, dune grassland, glasswort (*Salicornia* spp.) and other annuals colonising mud and sand, dunes with juniper thickets, estuaries, humid dune slacks, intertidal mudflats and sandflats, lime-deficient dune heathland with crowberry, reefs, shifting dunes, shifting dunes with marram and subtidal sandbanks. The Culbin Bar SAC has qualifying habitats of Atlantic salt meadows, coastal shingle vegetation outside the reach of waves and shifting dunes. For the same reasons provided above, it is considered that any changes

in physical processes and sediment transportation will be localised and too far in distance from the marine and estuarine related habitats associated with these two SACs to have any significant or noticeable impact. As such they are considered not to be connected to the Moray West Site or OfTI and LSE is discounted.

4.2.4.1 Comparison of findings to previous AA conclusions for Moray East

The AA carried out by Marine Scotland for the Moray East Site (Marine Scotland, 2014) made no reference to the qualifying habitats of the Moray Firth SAC, Dornoch Firth and Morrich More SAC and Culbin Bar SAC, having previously screened these out from HRA and confirming that there were no connectivity or LSE.

The European sites and Ramsar identified above are in agreement with the sites identified within the Scoping Opinion (Marine Scotland, 2016) and the AA for Moray East (Marine Scotland, 2014).

4.3 Potential Routes to Impact

The next stage of the screening process is to consider whether there is a route to impact for any of the designated features identified within the connectivity assessment.

Within the Scoping Opinion for the Moray West Offshore Wind Farm (Marine Scotland, 2016) it is considered that the sites with the potential to be most significantly affected, and thus meriting the greatest attention in the HRA report, are marine mammal SACs, and SPAs classified for breeding seabirds, with those closest to the project being those most likely to be affected, but with effects also possible to sites further afield, depending on the foraging range of qualifying species and hence connectivity.

As mentioned in Appendix 2, there are potential routes to impact upon the following key features that therefore require inclusion and consideration within this HRA Screening Report:

- Ornithological features (particularly breeding colonies) associated with the suite of SPAs identified as having connectivity;
- Marine mammals and the assessment of key species associated with SACs with connectivity (harbour seal, bottlenose dolphin, harbour porpoise and grey seal); and
- Migratory fish and relevant SACs with connectivity.

For ornithology, the potential impacts are focused on the breeding season as the period of key concern where there could be significant effects on SPA breeding colonies. While the consequences of impacts outwith the breeding season on SPA breeding colonies are less clearly understood, these are also becoming increasingly important and further discussions / modelling work are required on ornithological interests to be scoped in or out in this regard.

In respect of marine mammals, the approach to EIA identified that the probability of risk to marine mammals from toxic contaminants, operational noise or electromagnetic fields is low and these potential effects have been scoped out of HRA as confirmed within the Scoping Opinion (Marine Scotland, 2016). Potential LSE from EMF upon marine mammals was also considered to be not significant and scoped out. Scoping confirmed that the key concern was the potential disturbance of marine mammals due to construction noise (particularly from pile-driving the turbine foundations) and collision risk with vessels.

For migratory fish, as outlined within Appendix 2, the key concern was associated with the likely routes to impact from underwater noise upon migration of adult salmon and smolts, as well as the effects of EMF.

Table 4.3.1 sets out the potential routes to impact that may lead to LSE from the Moray West Site as identified within the Scoping Opinion for Moray West Offshore Wind Farm (Marine Scotland, 2016) and does not include those already scoped out from further appraisal by the CA and SNCBs.

Table 4.3.1 Potential for Route to Impact and LSE arising from Moray West Site and / or OfTI

Receptor Type	Marine Mammals	Migratory Fish	Ornithology	Habitats	Justification
Construction and Decommissioning◆					
Physical / auditory injury and behavioural effects from underwater noise.	Y	Y	N	N/A	Mammals & migratory fish are sensitive to underwater noise at the frequencies emitted from the construction activity associated with the Project and therefore this presents a route to impact. Ornithological receptors spend majority of time above or at water surface therefore, less sensitive. The main diving birds are present near shore (associated with the pSPA) and therefore, beyond the likely extent of significant underwater noise. Habitats are not sensitive to noise.
Collision risk from presence of vessels.	Y	N/A	N/A	N/A	The increased vessel traffic during construction may result in an increased collision risk to marine mammals. Collision risk is not applicable to migratory fish, ornithology and habitats.
Foraging abilities may be impaired.	N	N	N/A	N/A	Due to the localised increase of sedimentation around foundations and cable laying activities and the mobile nature of the species involved, as well as application of soft start procedures, the potential for impaired ability to forage has been scoped out.
Increased suspended sediment concentrations.	N	N	N	N	No route to impact on marine mammals, migratory fish and ornithology has been identified. Due there being no spatial connectivity, but also a distance of approximately 17 km between the Moray Firth SAC and no potential for the effects of the WTG and OSP foundations or the cable laying activities to result in effects upon the sandbank habitat, this potential impact is scoped out.
Indirect effects on sediments due to changes in waves / tidal flows.	N/A	N/A	N/A	N	Evidence from similar projects (i.e. Moray East) suggest effects will be limited in their magnitude and localised. Marine mammals, migratory fish and ornithological receptors are not sensitive to such small scale effects. The designated habitats have the potential to be sensitive, however, given the distance between such features and the Project (17 km) it is considered that they are likely to be beyond the zone of influence and this potential impact is scoped out.

Receptor Type	Marine Mammals	Migratory Fish	Ornithology	Habitats	Justification
Risk of harm from toxic contaminants.	N	N	N/A	N/A	The risk of toxic contaminants affecting marine mammals was considered insignificant and scoped out within the Scoping Opinion for the Moray West Offshore Wind Farm. The same will apply to migratory fish. No route to impact is present for ornithological interests of habitats associated with the Moray Firth SAC due to the distance from the Moray West Site and OfTI (or any other further away SACs).
Disturbance of birds from important feeding grounds and roosting areas.	N/A	N/A	Y	N/A	The impact of construction activities such as increased vessel activity, underwater noise, and cable installation may result in direct disturbance or displacement of birds from important feeding and roosting areas. Applicable to ornithology only.
Disturbance and displacement of prey for important feeding areas.	N	N	Y	N/A	Due to the migratory nature of marine mammals and migratory fish and the Moray West Site not featuring as a key feeding ground for these species, this has been scoped out. Also this has not been identified as an HRA issue within the Scoping Opinion for Moray West Offshore Wind Farm. The impact of construction activities such as increased vessel activity, underwater noise, and cable installation may result in disturbance or displacement of prey from important bird feeding areas.

Receptor Type	Marine Mammals	Migratory Fish	Ornithology	Habitats	Justification
Operation					
Risk of physical / auditory injury and behavioural changes from increased underwater noise during operation.	N	N	N/A	N/A	This potential route to impact was scoped out from HRA within the Scoping Opinion for the Moray West Offshore Wind Farm. It is considered that the operational noise from the WTG and OSPs will not be sufficiently significant to cause an impact. There is no route to impact upon ornithology and habitats.
Collision risk from presence of vessels.	Y	N/A	N/A	N/A	Increased vessel traffic during operation may result in an increased collision risk to marine mammals. Collision risk is not applicable to migratory fish, ornithology and habitats.
Barrier effects and displacement.	N/A	N/A	Y	N/A	Barrier effects caused by the physical presence of WTGs and ancillary structures may prevent clear transit of birds between foraging and breeding sites, or on migration. Additional energetic costs incurred may reduce fitness and survival rate of a species.
Collision risk from presence of WTG's.	N/A	N/A	Y	N/A	Collision with rotating turbine blades will result in direct mortality of an individual bird. Increased mortality may reduce species' survival rates.
Changes to prey availability.	N	N	Y	N/A	Indirect effects upon birds may be associated with changes in prey resources. Due to the migratory nature of marine mammals and migratory fish and the Moray West Site not featuring as a key feeding ground for these species. This has been scoped out Also once constructed there will be no change to availability in prey. This has not been identified as an HRA issue within the Scoping Opinion for Moray West Offshore Wind Farm.
Disturbance and displacement arising from EMF from cables.	Y	Y	N/A	N/A	The impact of EMF (arising from installed cables) may result in disturbance and displacement of adult Atlantic salmon, smolts or sea lamprey during migration and emigration.

◆ The impacts during the decommissioning phase are considered to be similar to those outlined for the construction phase, but with a lesser potential LSE due to current proposals that infrastructure below the seabed / buried underground would be left in-situ. LSE will be further considered within the Decommissioning Plan once further confirmation of decommissioning processes and methods takes place.

4.4 Summary of Initial Screening

A summary of the European sites or Ramsar that have been screened in as having connectivity and a route(s) to impact for which LSE cannot be discounted, including the qualifying feature(s) for which each site is designated, is presented in Table 4.4.1.

Table 4.4.1 Summary of European Sites and Ramsar Requiring Consideration for LSE.

European Site / Ramsar	Qualifying Feature(s)
SPA / Ramsar	
Moray Firth pSPA	All migratory / mobile features
East Caithness Cliffs SPA	Fulmar; Guillemot; Razorbill; Great black-backed gull; Herring gull; and Kittiwake.
North Caithness Cliffs SPA	Fulmar; Guillemot; Razorbill; Puffin; and Kittiwake.
Troup, Pennan and Lion's Heads SPA	Fulmar; Guillemot; Razorbill; Herring gull; and Kittiwake;
Buchan Ness to Collieston Coast SPA	Fulmar; Guillemot; Herring gull; and Kittiwake.✪
Loch of Strathbeg	Sandwich tern✪
Moray and Nairn Coast SPA	All migratory / mobile features
Dornoch Firth and Loch Fleet SPA / Ramsar	All migratory / mobile features
Cromarty Firth SPA / Ramsar	All migratory / mobile features
Inner Moray Firth SPA / Ramsar	All migratory / mobile features
SAC	
Moray Firth SAC	Bottlenose dolphin
Dornoch Firth and Morrich More SAC	Harbour seal
Faray and Holm of Faray SAC	Grey seal
Isle of May SAC	Grey seal
Monach Islands SAC	Grey seal
Berriedale and Langwell Waters SAC	Atlantic salmon
River Borgie SAC	Atlantic salmon
River Dee SAC	Atlantic salmon

European Site / Ramsar	Qualifying Feature(s)
River Naver SAC	Atlantic salmon
River Thurso SAC	Atlantic salmon
River Oykel SAC	Atlantic salmon
River Moriston SAC	Atlantic salmon
River Spey SAC	Atlantic salmon Sea lamprey

✪ OfTI only.

5 Assessment for Non-Trivial Abundance and Determination of Likely Significant Effects

For each designated site screened in within Table 4.4.1, the potential for LSE is considered, taking into account non-trivial abundance and recent research or studies that would lead to the conclusion of no LSE. Each possible LSE that has been identified in Table 4.3.1 is discussed and appraised to determine whether:

- There is no LSE upon the European Site or qualifying feature (and so screening out of any future RIAA can take place); or
- There is likely to be a LSE and hence further consideration within a RIAA is required to assess affects upon the integrity of the European site.

5.1 Determination of LSE for SPAs and Ramsar and Qualifying Features

5.1.1 Disturbance (Construction)

During the construction phase seabed disturbance may lead to a reduction in suitable habitat for birds. Any loss of foraging habitat would be temporary, being primarily associated with the presence of machinery whilst construction works are undertaken. In addition, the anticipated habitat disturbed will be very small in the context of the wide areas in which seabirds are able to forage. Disturbance during construction may occur as a result of increased vessel activity and underwater noise. This may displace birds from an area of sea, effectively resulting in habitat loss during the period of disturbance (Drewitt and Langston, 2006).

As indicated in Table 4.3.1, bird species most likely to be vulnerable to underwater noise are those that forage by diving after fish or shellfish, and include auks, divers and seaduck. Gull and tern species feed at the surface only and are considered the least vulnerable, with no apparent responses to piling activity recorded at Egmond aan Zee by Leopold and Camphuysen (2007). Moray West is beyond the mean maximum or maximum foraging ranges for the majority of breeding seabirds potentially affected so that potential impacts on species such as auks are likely only to occur in the non-breeding season.

Taking the information above, the potential for a LSE via disturbance is relevant to features screened in for Moray Firth pSPA, East Caithness Cliffs SPA, North Caithness SPA, Troup, Pennan and Lions Head SPA, Buchan Ness to Collieston Coast SPA. Species not considered sensitive to disturbance include herring gull and great black-backed gull. For sites designated for wildfowl and waders that are outside of the boundary of the Moray West Site and OfTI, they are not considered vulnerable to disturbance during construction.

5.1.2 Disturbance of Prey (Construction)

There is potential for indirect impacts to occur on birds associated with disturbance and displacement of prey species as a result of the construction phase of Moray West. The distribution of seabirds across the wider area may indicate that those that are displaced due to indirect impacts will be able to relocate to other suitable foraging areas in response to any changes in local prey distribution. During the non-breeding period the potential foraging area for displaced seabirds is greater than during the breeding season and displaced birds that feed on widely occurring fish species will be able to relocate to other suitable foraging areas within their normal range of distribution at this time.

Taking the information above, the potential for a LSE via disturbance to prey species is relevant to features screened in for Moray Firth pSPA, East Caithness Cliffs SPA, North Caithness SPA, Troup, Pennan and Lions Head SPA, Buchan Ness to Collieston Coast. SPA Species not considered sensitive to disturbance include herring gull and great black-backed gull. For sites designated for wildfowl and waders that are outside of

the boundary of the Moray West array site and OfTI, they are not considered vulnerable to disturbance to prey species during construction.

5.1.3 Barrier Effects (Operation)

The physical presence of Moray West may result in a barrier to the movement of some bird species. Where birds avoid flying through the area of the offshore wind farm an increase in flying distance to reach their destination may occur. This may lead to increased energy expenditure, which may have a detrimental effect on fitness and / or reduce survival or fecundity rates. This is of particular concern if the area in which the wind farm is located is used for regular, daily movements (i.e. to foraging areas from a breeding colony).

The foraging ranges of the seabirds in the North Sea are relatively large during the breeding period with migratory movements through the North Sea occurring across a broad front (e.g., Thaxter *et. al*., 2012; Wemham *et. al*., 2002). Many of the species subject to this assessment migrate many thousands of kilometres each year and it is therefore anticipated that they will be capable of flying around or over Moray West should they choose to do so without a significant increase in distance travelled. The duration, magnitude and extent of impact resulting from barrier effects on SPA qualifying species are assessed as being unlikely to compromise the conservation objectives of any designated SPA. Whilst, therefore, there is no indication that barrier effects could lead to a LSE on any feature for the purposes of this screening exercise, further species-specific information is required to rule out LSEs due to barrier effects.

Taking the information above, the potential for a LSE via disturbance on birds is identified for all species screened in for East Caithness Cliffs SPA, North Caithness SPA, Troup, Pennan and Lions Head SPA, Buchan Ness to Collieston Coast SPA. Barrier effects are not considered relevant to features impacted by the OfTI only.

5.1.4 Displacement (Operation)

Evidence from existing offshore wind farms indicates that some species of seabird may avoid entering wind farms and therefore be displaced from areas that they may otherwise utilise (e.g., Zucco *et. al*., 2006). The level of displacement is species specific and the duration of displacement may vary across species, with some species avoiding offshore wind farms immediately post-construction and returning to the area after a period of time and other species showing little or no evidence of returning to the wind farm area post-construction. The likely scale of displacement effects varies by species, therefore, depending on their sensitivity (Langston, 2010) and the density within the proposed wind farm (and adjoining) areas. The implications for birds displaced from wind farms will also vary depending on the availability of other habitats which can support those birds. Quantifying the risk to birds requires, therefore, predictions based on modelling which takes into account these variables. Typically this involves estimating the proportion of birds present that are likely to be displaced and then the proportion of those birds that are displaced that will be unable to successfully relocate (leading to death or emigration). It also requires disaggregating the risk to birds that are associated with those populations that form designated SPA features from other populations that are not SPA features (as the birds recorded at a wind farm site are usually a mixture of both).

Pending more detailed displacement analysis, it is assumed that where a species vulnerable to displacement has been recorded at the Moray West Site, and where a population of that species is also a feature of an SPA that is within foraging range (for that species) of the wind farm, then, for the purposes of this screening exercise, it is assumed that a LSE could occur. This is on the basis that there is potential for foraging birds from the SPA to rely upon habitats within the operational wind farm from which they

will become excluded (wholly or partially), although at this stage the scale of that risk has yet to be quantified.

Taking the information above, the potential for a LSE via operational displacement on birds is identified for sensitive species screened in for Moray Firth pSPA, East Caithness Cliffs SPA, North Caithness SPA, Troup, Pennan and Lions Head SPA, Buchan Ness to Collieston Coast SPA. Barrier effects are not considered relevant to features impacted by the OfTI only or on wildfowl or wader features of SPAs outside of the boundary of the Moray West array site or OfTI.

5.1.5 Collision Risk (Operation)

The risk of collision with wind turbine generators depends on a number of variables, such as species-specific near and far field avoidance rates, flight heights, speed of flight, frequency of movements in or near to the turbines as well as the size and location of the turbines themselves. Further, additional factors such as weather and species' behaviour can also affect the risk of collision. Quantifying the risk to birds requires, therefore, predictions based on modelling which takes into account these variables. It also requires disaggregating the risk to birds that are associated with those populations that form designated SPA features from other populations that are not SPA features (as the birds recorded at a wind farm site are usually a mixture of both).

Pending a detailed collision risk assessment for Moray West, it is assumed that where a species vulnerable to collision impacts has been recorded during site specific surveys, and where a population of that species is also a feature of an SPA that is within foraging range (for that species) of the wind farm, then, for the purposes of this screening exercise, it is assumed that a LSE could occur. This is on the basis that there is likelihood that foraging birds from the SPA could occur within the operational wind farm and be exposed to collision risk, although at this stage the scale of that risk has yet to be quantified.

Taking the information above, the potential for a LSE via operational displacement on birds is identified for sensitive species screened in for East Caithness Cliffs SPA, North Caithness SPA, Troup, Pennan and Lions Head SPA, Buchan Ness to Collieston Coast SPA. Auk species (guillemot, razorbill and puffin) and fulmar are not sensitive to collision risk due to their low prevailing flight heights and as such there is no potential for LSE on these species. Collision risk are not considered relevant to features impacted by the OfTI only. With respect to costal SPAs supporting wildfowl and waders (including Moray Firth pSPA) the risk of collision refers to biannual migratory movements only.

5.2 Determination of LSE on SACs and Qualifying Features

5.2.1 Physical / Auditory Injury and Behavioural Effects Upon Marine Mammals Due to Increased Underwater Noise (Construction and Operation / Maintenance)

The introduction of piling activities (and other noise producing construction activities such as rock dumping and cable laying), particularly during the construction phase of the Moray West Site, is recognised as producing significant sources of underwater noise that can be detrimental to marine mammals that may be present within the Moray West Site, that are passing through, or are within the wider regional area. Underwater noise may also be increased during the operational and maintenance period arising from underwater repair work such as cable protection or burial repairs. As identified, there are potential risks to several species of marine mammal.

There is currently little information available on the levels of underwater noise that will be produced and the distances that noise is projected to occur at from each WTG / OSP foundation, as the design of the infrastructure and construction methods are not yet progressed sufficiently. Noise modelling will be

required for each of the key species of marine mammal in relation to the worst case scenario that will be applied during construction (e.g. taking the design parameters for piles rather than GBSs and using these to model the worst case scenario for noise levels). Once the noise modelling is complete, it will be possible to assess and identify any suitable mitigation that may assist to reduce potential LSE on marine mammals.

In addition, the number, type and frequency of construction vessels that will be required during construction, operation and maintenance are currently unknown. Noise from increased vessel presence could also have a potential LSE upon the marine mammal populations.

It is therefore considered that the potential for LSE, upon marine mammals connected to SACs (harbour seal, grey seal and bottlenose dolphin), as a result of underwater noise during construction and operation / maintenance (and potential for auditory injury or behavioural changes) cannot be screened out and will require further consideration in any future RIAA. Harbour porpoise have previously been screened out from HRA due to no connectivity with European sites with this qualifying feature.

5.2.2 Disturbance and / or Displacement to Migratory Fish from Underwater Noise (Construction)

There is limited knowledge of the migration behaviour of Atlantic salmon and sea lamprey once they reach the sea as post-smolts and during the return of adults to spawn within their native rivers. It has been established that Atlantic salmon prefer to use the coastal and near shore waters during migration (Malcolm *et al*, 2015; Malcolm *et al*., 2010) but the extent of how long they are present in these areas prior to migration into deeper waters to their feeding areas near Greenland, as well as the routes they migrate along through the open sea (and in this case the Moray Firth) remain little understood (Gill and Bartlett, 2010; Malcolm *et al*., 2015). The National Research and Monitoring Strategy for Diadromous Fish (NRMSD) has been set up by Marine Scotland in order to prioritise the collection of information to fill this gap in knowledge, this research is ongoing.

However, even though the movements of migratory fish are not clearly known within a local or regional context, recent research by Harding *et al.* (2016) has demonstrated that the hearing threshold of salmonids is not as sensitive as other fish species and that the noise produced from piling activities from offshore wind farm construction does not appear to have significant effects upon the movement behaviour or physiological behaviour of Atlantic salmon and individuals do not show a startle response or stress to this source of underwater noise.

Research reports that Atlantic salmon are known to detect low frequency acoustic stimuli below 380 Hz, coinciding with the dominant frequencies produced during impact piling operations (100 Hz to 2 kHz; Hawkins & Johnstone, 1978). More recent research has been undertaken on the hearing capabilities of Atlantic salmon (Harding *et al.*, 2016), whereby a series of hearing sensitivity tests were undertaken on wild and captive post-smolts and adult Atlantic salmon. The research reported similar findings to the previous research in terms of hearing thresholds, but also found evidence of a response to sounds at higher frequencies (400-800 Hz). Slightly less sensitive hearing was noted at 100 Hz than reported in Hawkins & Johnstone, 1978, but found more sensitive hearing than the earlier study at frequencies >200 Hz. Atlantic salmon are not as sensitive to noise as some other species (such as clupeids) due to a lack of secondary hearing modifications linking the swim bladder to the auditory system. The recent research went on to test individual salmon of both migratory phases to exposure of piling noise. In terms of behavioural effects, the findings reported no startle response was shown to individual hammer strikes and the noise of piling did not drive any differences in behaviour. Physiologically, there was no change in the active metabolism rate when exposure to pile driving noise took place. No evidence of avoidance behaviour was recorded. It was considered that Atlantic salmon are sound insensitive as they lack specialist hearing mechanisms. They therefore have a poorer ability to distinguish specific acoustic cues.

Mitigation measures that are adopted during construction of the WTG and OSP foundations, such as the application of 'soft start' procedures, will also provide additional measures to ensure that underwater noise is introduced slowly to migratory fish so as to avoid any harm or injury. By operating 'soft start' procedures, any fish will be able to react and avoid sources of noise efficiently.

On the basis of this recent research, the application of suitable mitigation measures and on the basis of the opinion expressed by SNH and JNCC within their scoping response to the Moray West Offshore Wind Farm Scoping Report (Moray West, 2017) it is considered that the effects of underwater noise can be screened out at this time and do not require further consideration within any future RIAA. Similarly, this is considered to be the case for sea lamprey, which have a similar hearing range underwater (Appendix 2 provides further details of the species' ecology). Research indicates that sea lamprey respond to sound at frequencies of between 20 Hz and 100 Hz (Lenhardt & Sismour 1995), they do not possess a swim bladder and are less sensitive to sound than fish that do possess a swim bladder (Maes et al. 2004).

During the previous HRA for the Moray East Site (JNCC & SNH, 2014), it was stated that the relevant conservation objective to consider for sea lamprey is whether or not the Moray East Site would result in any impacts on the viability of the sea lamprey population of the River Spey SAC. It was concluded at that time that while there may be some level of noise disturbance to individuals during construction this would not result in population level effects. JNCC and SNH were satisfied that operational noise would not result in LSE to sea lamprey. With proposals to adopt soft-start piling methods to help mitigate any noise disturbance and to bury cables to reduce EMF both organisations were satisfied that this mitigation would further reduce impacts to individuals, and avoid population level effects, therefore not resulting in any impact to the site integrity of the River Spey SAC.

5.2.3 Collision Risk between Marine Mammals and Vessels (Construction and Operation / Maintenance)

Marine mammals passing through the Moray West Site will be exposed to increased numbers of construction vessels, as well as some being anchored for significant periods of time. Collision of vessels with marine mammals could be significant and can result in serious injury or death. Some ducted propeller (DP) vessel activity at offshore wind farms had been associated with the phenomenon referred to as 'corkscrew' deaths or injury of marine mammals, particularly with seal species, however research undertaken by the University of Durham and SMRU in 2014 and 2015 later observed this type of injury resulting from grey seal predation by adult male grey seal. It is considered that seal predation is the main cause of his type of injury encountered but that injury / death from DP cannot currently be discounted altogether[2].

Currently the project-specific information on the numbers and types of construction vessels is not available, along with detailed information on their presence and number / frequency of journeys. It is considered that further information will be required in order to fully appraise the collision risk with marine mammals and so this potential LSE for harbour seal, grey seal and bottlenose dolphin cannot be screened out and will require further consideration in any future RIAA.

5.2.4 Disturbance and / or Displacement to Migratory Fish from EMF (Operation)

All electrical cable produce EMF and concern is sometimes raised that EMF emissions from underwater cables can have a potential LSE upon marine organisms including fish and shellfish. Over the years there has also been some concern that EMF can potentially affect the migration of Atlantic salmon and

[2] Further information can be found at:
http://www.smru.st-andrews.ac.uk/documents/scotgov/MMiS_scientific_research_supporting_policy.pdf

potentially prevent them from returning to their native rivers, or from migrating to their feeding grounds near Greenland.

Recent studies show that AC cables, as proposed at Moray West, do not emit EMF strong enough to influence salmonids and other species sensitive to EMF (Armstrong *et al*., 2015). Armstrong *et al.* (2015) reported that the effects of EMF at 50Hz (like those emitted from AC cables) result in no unusual behaviour being observed in Atlantic salmon (both adult and smolt stages). Research (Godfrey *et al*., 2014; Malcom *et al*., 2010), demonstrates that Atlantic salmon are known to migrate using coastal routes and generally only congregate at the mouths of their natal rivers prior to ascending them, so the Moray West Offshore Wind Farm is unlikely to affect migrations.

The evidence to date, based on the power rating of cables currently used by the offshore industry, is that EMFs are unlikely to get to the upper levels of sensitivity where marine animals may be repelled. The more likely outcome is that the EMFs are in the lower range and therefore provide an attractant stimulus (Copping *et al*., 2016). The design of the cable and shielding of emissions through cable burial or seabed protection measures also assists to lower EMF. With an additional distance of separation being present between cable protection material and the seabed, this also assists with reducing EMF and is considered to result in no LSE from EMF.

It is therefore proposed that the potential effects from EMF are screened out from HRA and that EMF will not require further consideration in any future RIAA. This conclusion is also validated through the outcomes of the Moray East and BOWL HRAs for which no LSE from EMF was accepted.

5.3 Summary of LSE

Table 5.3.1 Determination for Potential LSE

Potential Impact	Justification	Site and Species	Conclusion on LSE
Construction / Decommissioning			
Disturbance of birds from foraging / roosting areas.	Direct overlap with OfTI.	Moray Firth pSPA – all species	Y
	Species within foraging range of Moray West Site	East Caithness Cliffs SPA – fulmar, guillemot, razorbill, great black-backed gull, herring gull, kittiwake	Y
		North Caithness Cliffs SPA – fulmar, guillemot, razorbill, puffin, kittiwake	Y
		Troup, Pennan & Lion's Head SPA – fulmar, guillemot, razorbill, herring gull, kittiwake	Y
		Buchan Ness to Collieston Coast SPA – fulmar, guillemot, herring gull, kittiwake	Y
		Loch of Strathbeg SPA – Sandwich tern	Y
Disturbance and displacement of prey.	Direct overlap with OfTI.	Moray Firth pSPA – all species	Y
	Species within foraging range of Moray West Site.	East Caithness Cliffs SPA – fulmar, guillemot, razorbill, great black-backed gull, herring gull, kittiwake	Y
		North Caithness Cliffs SPA – fulmar, guillemot, razorbill, puffin, kittiwake	Y

Potential Impact	Justification	Site and Species	Conclusion on LSE
		Troup, Pennan & Lion's Head SPA – fulmar, guillemot, razorbill, herring gull, kittiwake.	Y
		Buchan Ness to Collieston Coast SPA – fulmar, guillemot, herring gull, kittiwake	Y
		Loch of Strathbeg SPA – Sandwich tern	Y
Physical / auditory injury and behavioural effects upon marine mammals due to increased underwater noise.	Several species that are qualifying features of SACs with connectivity to the Moray West Site have been recorded as present in and around the Project.	Bottlenose dolphin – Moray Firth SAC; Harbour seal – Dornoch Firth and Morrich More SAC; Grey Seal – Faray and Holm of Faray SAC	Y Y Y
Collision risk between marine mammals and vessels.	Several species that are qualifying features of SACs with connectivity to the Moray West Site have been recorded as present.	Bottlenose dolphin – Moray Firth SAC; Harbour seal – Dornoch Firth and Morrich More SAC; Grey Seal – Faray and Holm of Faray SAC.	Y Y Y
Disturbance and / or displacement to Migratory fish from underwater noise.	Migratory fish species that are qualifying features of SACs with connectivity to the Moray West Site may be present.	Atlantic salmon – Berriedale and Langwell Waters SAC, and the Rivers Borgie, Dee, Naver, Thurso, Oykel, Moriston and Spey SACs; Sea lamprey – River Spey SAC.	N
Operation / Maintenance			
Barrier effects.	Species within foraging range of the Moray West Site.	East Caithness Cliffs SPA – fulmar, guillemot, razorbill, great black-backed gull, herring gull, kittiwake.	Y
		North Caithness Cliffs SPA – fulmar, guillemot, razorbill, puffin, kittiwake.	Y
		Troup, Pennan & Lion's Head SPA – fulmar, guillemot, razorbill, herring gull, kittiwake.	Y
		Buchan Ness to Collieston Coast SPA – fulmar, guillemot, herring gull, kittiwake.	Y
Displacement.	Direct overlap with the OfTI for species sensitive to disturbance.	Moray Firth pSPA – all species.	Y
	Seabird species vulnerable within foraging range or likely to occur in non-breeding seasons.	East Caithness Cliffs SPA – fulmar, guillemot, razorbill, kittiwake.	Y
		North Caithness Cliffs SPA – fulmar, guillemot, razorbill, kittiwake.	Y
		Troup, Pennan & Lion's Head SPA – fulmar, guillemot, razorbill, kittiwake.	Y
		Buchan Ness to Collieston Coast SPA – fulmar, guillemot.	Y

Potential Impact	Justification	Site and Species	Conclusion on LSE
Collision.	Seabird species sensitive to collision within foraging range or likely to occur in non-breeding seasons.	East Caithness Cliffs SPA –great black-backed gull, herring gull, kittiwake.	Y
		North Caithness Cliffs SPA – kittiwake.	Y
		Troup, Pennan & Lion's Head SPA – herring gull, kittiwake.	Y
		Buchan Ness to Collieston Coast SPA – kittiwake.	Y
	Migratory wildfowl and wader features with the potential to cross through array site.	Moray Firth pSPA – all species	Y
		Moray and Nairn Coast SPA – all wildfowl/wader features.	Y
		Dornoch Firth and Loch Fleet SPA / Ramsar – all wildfowl and wader features.	Y
		Cromarty Firth SPA / Ramsar – all wildfowl and wader features.	Y
		Inner Moray Firth SPA / Ramsar – all wildfowl and wader features.	Y
Physical / auditory injury and behavioural effects upon marine mammals due to increased underwater noise.	Several species that are qualifying features of SACs with connectivity to the Moray West Site have been recorded as present.	Bottlenose dolphin – Moray Firth SAC; Harbour seal – Dornoch Firth and Morrich More SAC; Grey Seal – Faray and Holm of Faray SAC.	Y Y Y
Collision risk between marine mammals and vessels.	Several species that are qualifying features of SACs with connectivity to the Moray West Site have been recorded as present.	Bottlenose dolphin – Moray Firth SAC; Harbour seal – Dornoch Firth and Morrich More SAC; Grey Seal – Faray and Holm of Faray SAC.	Y Y Y
Disturbance and / or displacement to migratory fish from EMF from cables.	Migratory fish species that are qualifying features of SACs with connectivity to the Moray West Site may be present.	Atlantic salmon – Berriedale and Langwell Waters SAC, and the Rivers Borgie, Dee, Naver, Thurso, Oykel, Moriston and Spey SACs; Sea lamprey – River Spey SAC.	N N

6 In-combination Assessment

This section sets out how the LSE of in-combination effects will be appraised as part of the RIAA. It sets out the other developments that have been identified at this time as requiring consideration with in combination effects and then proposes what information will be presented within the RIAA.

Offshore, it is likely that it will be primarily other offshore wind farms that are most likely to potentially cause LSE on similar European sites as Moray West. These projects include Beatrice Offshore Wind Farm and Moray East Offshore Wind Farm. In addition, other non-wind related project that have been identified are the Caithness to Moray Interconnector and the decommissioning of the Beatrice Oil Field. Further discussion will be held with MS-LOT and other statutory consultees including SNH, to identify any other relevant plans and projects that should be included.

For each project, a review of all available information will take place and the current position with the project or plan will be identified. The potential channels for in-combination effects to occur will be identified through review of project or plan programmes and elements of the projects that will have potential LSE / adverse effects upon site integrity will be fully considered cumulatively with the Project.

It is envisaged that each project, in turn, will be appraised individually in-combination with the Moray West Project, followed by an appraisal of all projects that may take place simultaneously with the Moray West Project (for example, the Moray West Site will be appraised in combination with the Moray East Project, and then both will be appraised with any other projects or plans that also overlap in terms of construction activities or programmes).

The cumulative LSE and any adverse effects upon the integrity of European site or qualifying features will be presented within the RIAA and the need for any specific mitigation requirements to reduce any adverse effects upon the integrity of the European sites or Ramsar will be identified.

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Appendix 1 - Figures

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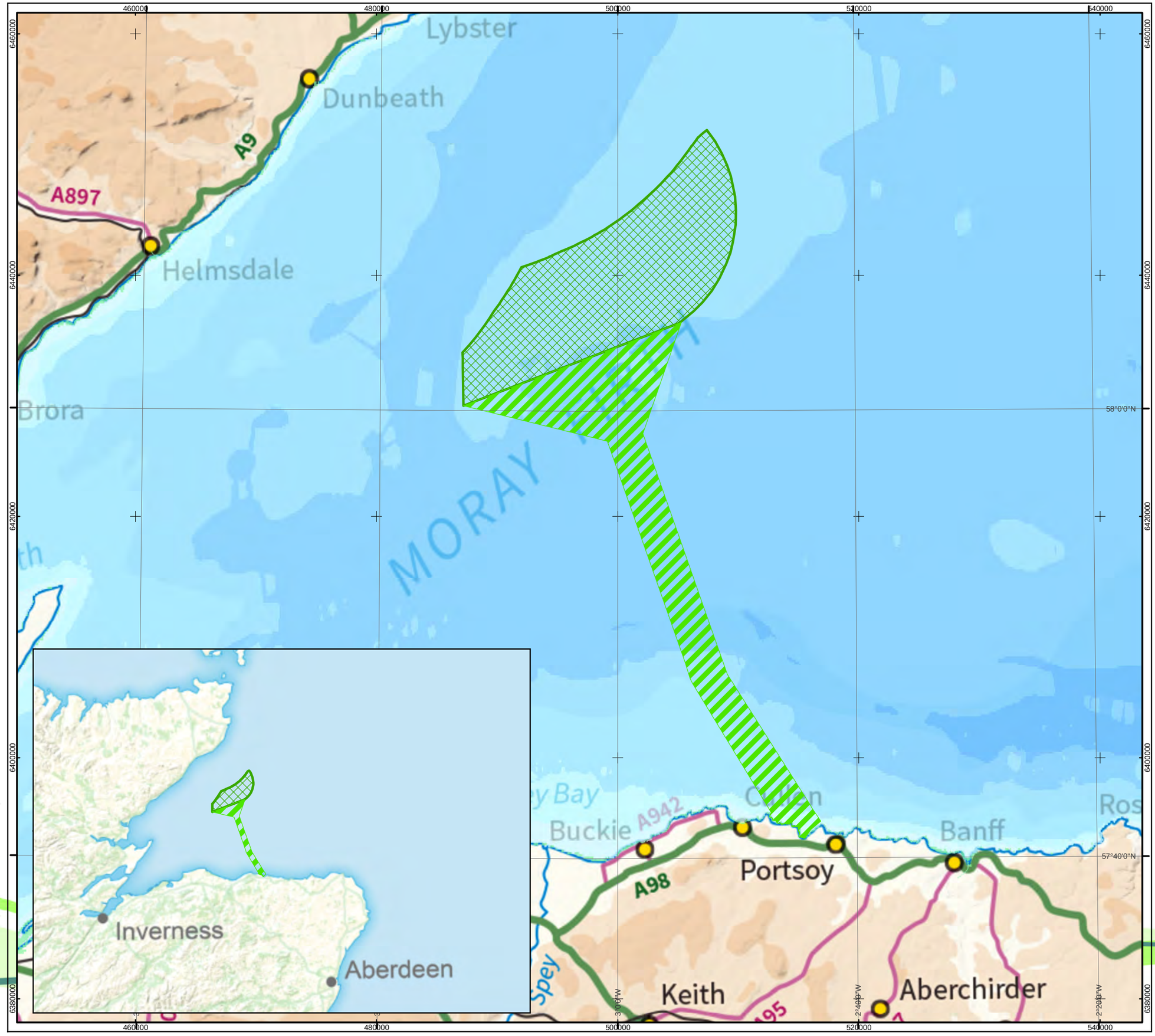

MORAY WEST OFFSHORE WINDFARM

KEY

- Offshore Export Cable Corridor
- Moray West Site

Bathymetry (Metres)

- <=500
- <=100
- <=50
- <=20
- <=10
- >=0

Horizontal Scale: 1:300,000 A3 Chart

0 5,000 10,000 Meters

N

Geodetic Parameters:	WGS84 UTM Zone 30N
Produced: RC Reviewed: GB Approved: FG	
Date: 04/09/2017	Revision: B
REF: 8460005-PPW0160-GOE-MAP-001	

Figure 1.1.1. Moray West Site (Moray West Offshore Wind Farm and OfTI)

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MORAY WEST
OFFSHORE WINDFARM

KEY

- Moray Forth potential SPA (pSPA)
- Special Protection Areas
- Moray West Site
- Moray West Offshore Cable Export Route

Horizontal Scale: 1:700,000 A3 Chart

0 12,500 25,000 Meters

N

Geodetic Parameters:	WGS84 UTM Zone 30N
Produced: HAZ Reviewed: RC Approved: FG	
Date: 08/09/2017	Revision: A
REF: 8460005-PPW0160-GOE-MAP-002	

Figure 4.2.1 Special Protection Areas (SPAs)

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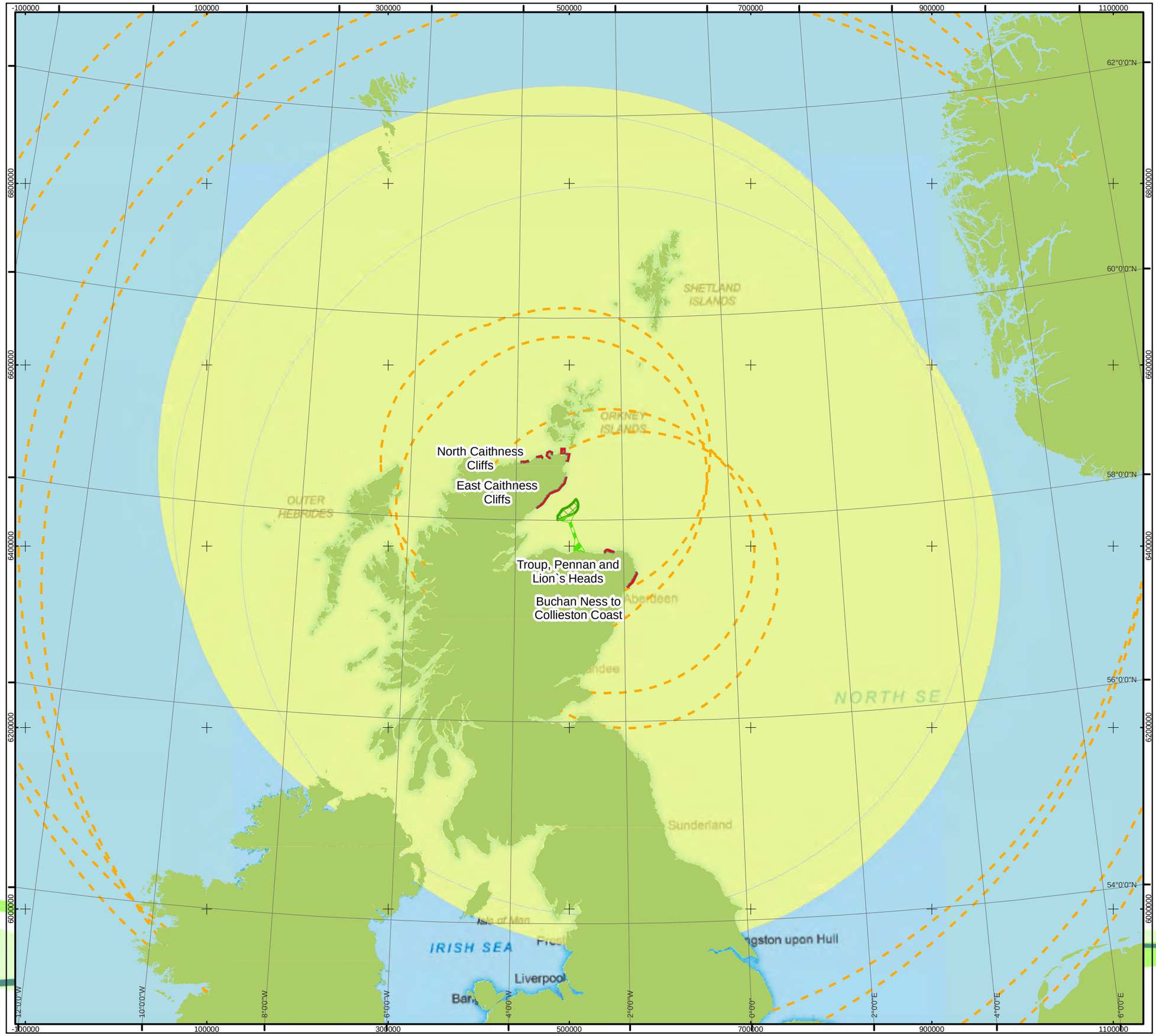

MORAY WEST
OFFSHORE WINDFARM

KEY

- Moray West Site
- Moray West Offshore Cable Export Route
- Special Protection Areas
- Mean-max foraging range ± 1 standard deviation (400 ± 245.8 km)
- Mean-max foraging range (400 km)

Horizontal Scale: 1:4,000,000 A3 Chart

0 66,000 132,000 Meters

N

Geodetic Parameters: WGS84 UTM Zone 30N

Produced: HAZ
Reviewed: RC
Approved: FG

Date: 08/09/2017 | Revision: A

REF: 8460005-PPW0160-GOE-MAP-003

Figure 4.2.2: Fulmar Foraging Ranges

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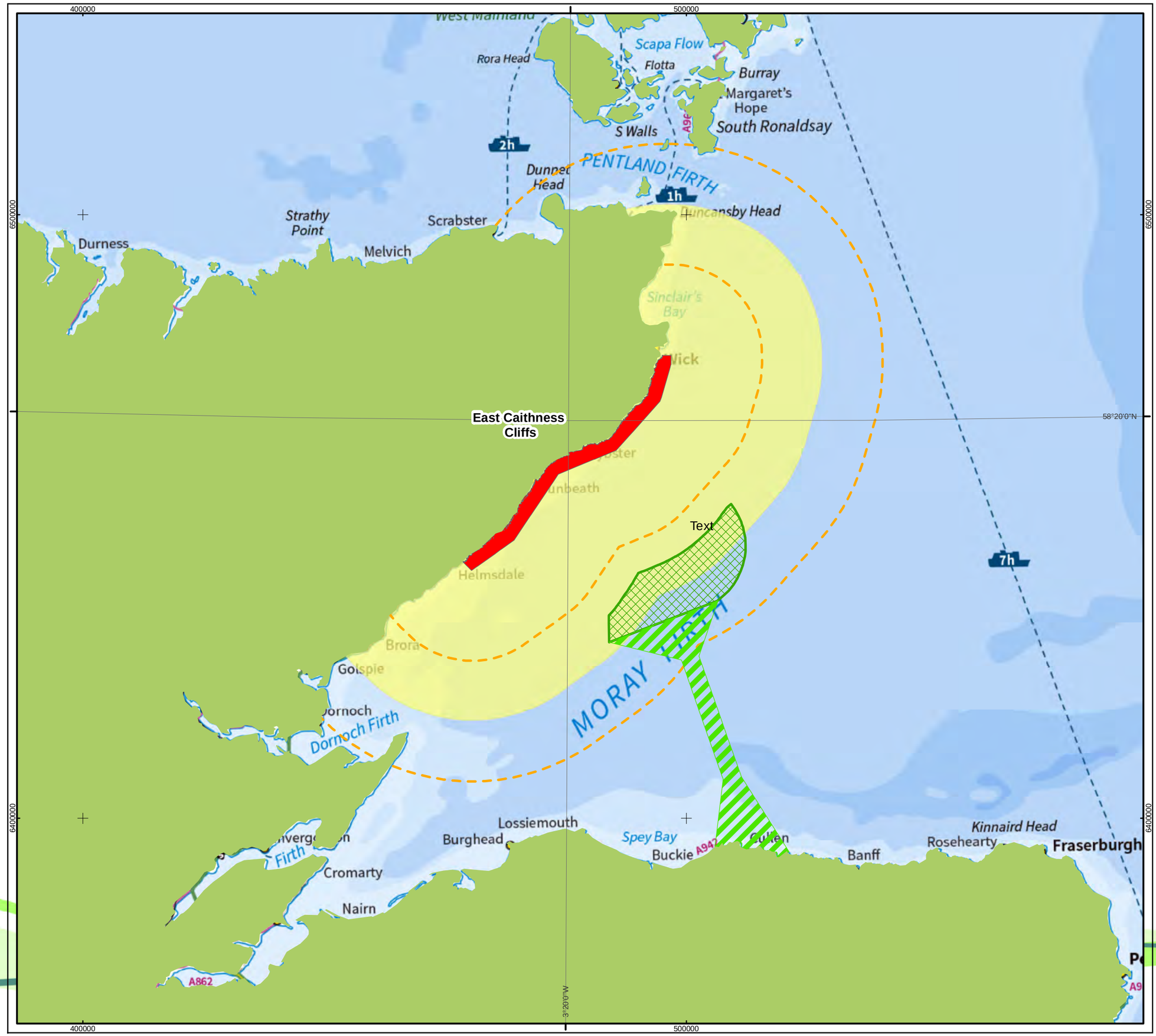

MORAY WEST
OFFSHORE WINDFARM

KEY

- Moray West Site
- Moray West Offshore Cable Export Route
- Mean-max foraging range (25km)
- Mean-max foraging range ± 1 standard deviation (25 ± 10km)
- Special Protection Areas (SPAs)

Horizontal Scale: 1:600,000 A3 Chart

0 12,500 25,000 Meters

N

Geodetic Parameters: WGS84 UTM Zone 30N

Produced: HAZ
Reviewed: RC
Approved: FG

Date: 07/09/2017 | Revision: B

REF: 8460005-PPW0160-GOE-MAP-004

Figure 4.2.3. Cormorant Foraging Ranges

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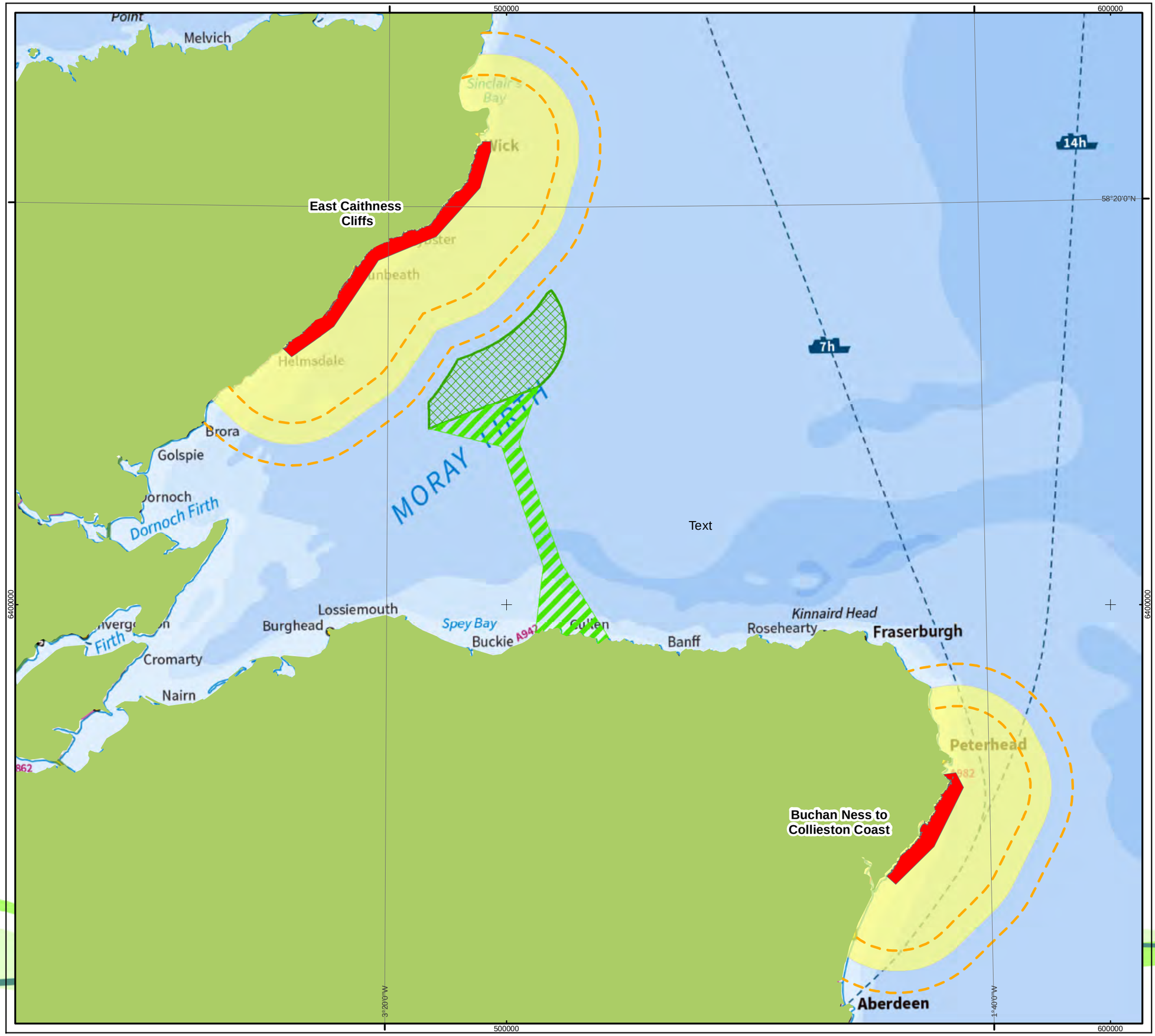


MORAY WEST
OFFSHORE WINDFARM

KEY

- Moray West Site
- Moray West Offshore Cable Export Route
- Mean-max foraging range (14.5km)
- Mean-max foraging range ± 1 standard deviation (14.5 ± 3.5km)
- Special Protection Areas (SPAs)

Horizontal Scale: 1:600,000 A3 Chart

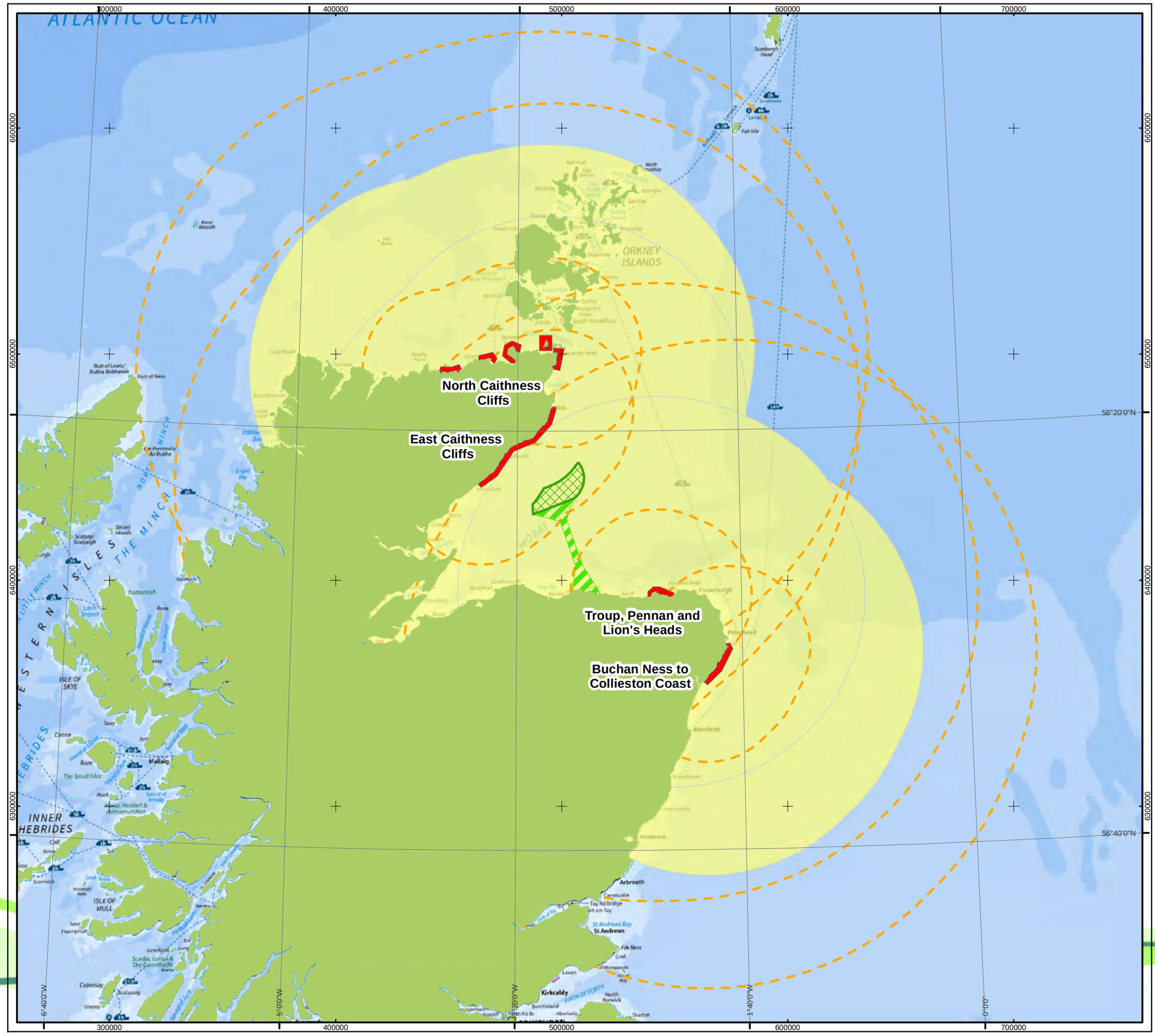
0 12,500 25,000 Meters

N

Geodetic Parameters:	WGS84 UTM Zone 30N
Produced: HAZ Reviewed: RC Approved: FG	
Date: 07/09/2017	Revision: B
REF: 8460005-PPW0160-GOE-MAP-005	

Figure 4.2.4. Shag Foraging Ranges

Moray Offshore Windfarm (West) Ltd



MORAY WEST
OFFSHORE WINDFARM

KEY

- Moray West Site
- Moray West Offshore Cable Export Route
- Mean-max foraging range (82.4km)
- Mean-max foraging range ± 1 standard deviation (82.4 ± 50.1km)
- Special Protection Areas (SPAs)

Horizontal Scale: 1:1,600,000 A3 Chart

0 25,000 50,000 Meters

N

Geodetic Parameters: WGS84 UTM Zone 30N

Produced: HAZ
Reviewed: RC
Approved: FG

Date: 07/09/2017 | Revision: B

REF: 8460005-PPW0160-GOE-MAP-006

Figure 4.2.5. Guillemot Foraging Ranges

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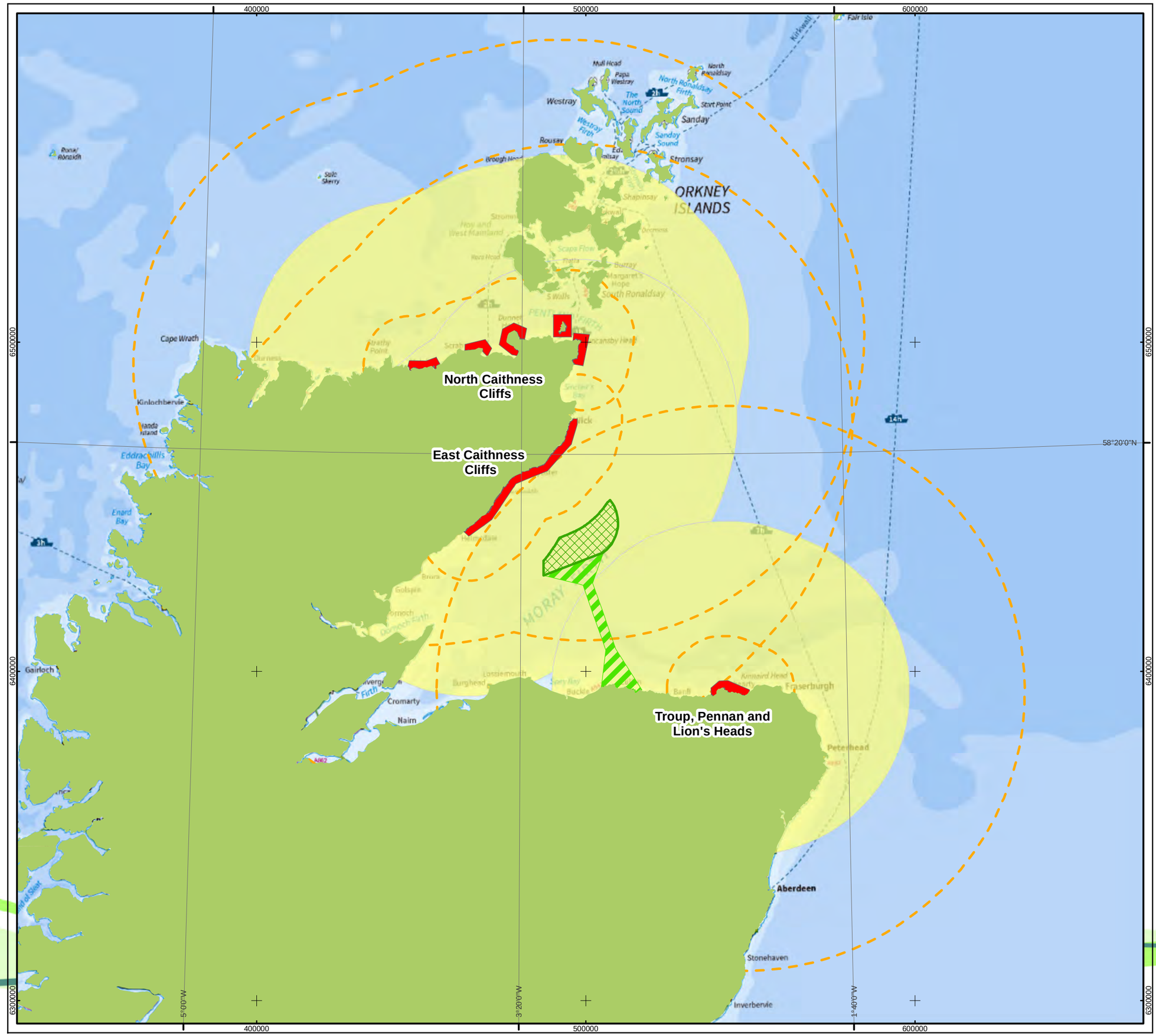

MORAY WEST
OFFSHORE WINDFARM

KEY

- Moray West Site
- Moray West Offshore Cable Export Route
- Mean-max foraging range (48.5km)
- Mean max foraging range ± 1 standard deviation (48.5 ± 35.0km)
- Special Protection Areas (SPAs)

Horizontal Scale: 1:1,100,000 A3 Chart

0 25,000 50,000 Meters

N

Geodetic Parameters: WGS84 UTM Zone 30N

Produced: HAZ
Reviewed: RC
Approved: FG

Date: 07/09/2017 | Revision: B

REF: 8460005-PPW0160-GOE-MAP-007

Figure 4.2.6. Razorbill Foraging Ranges

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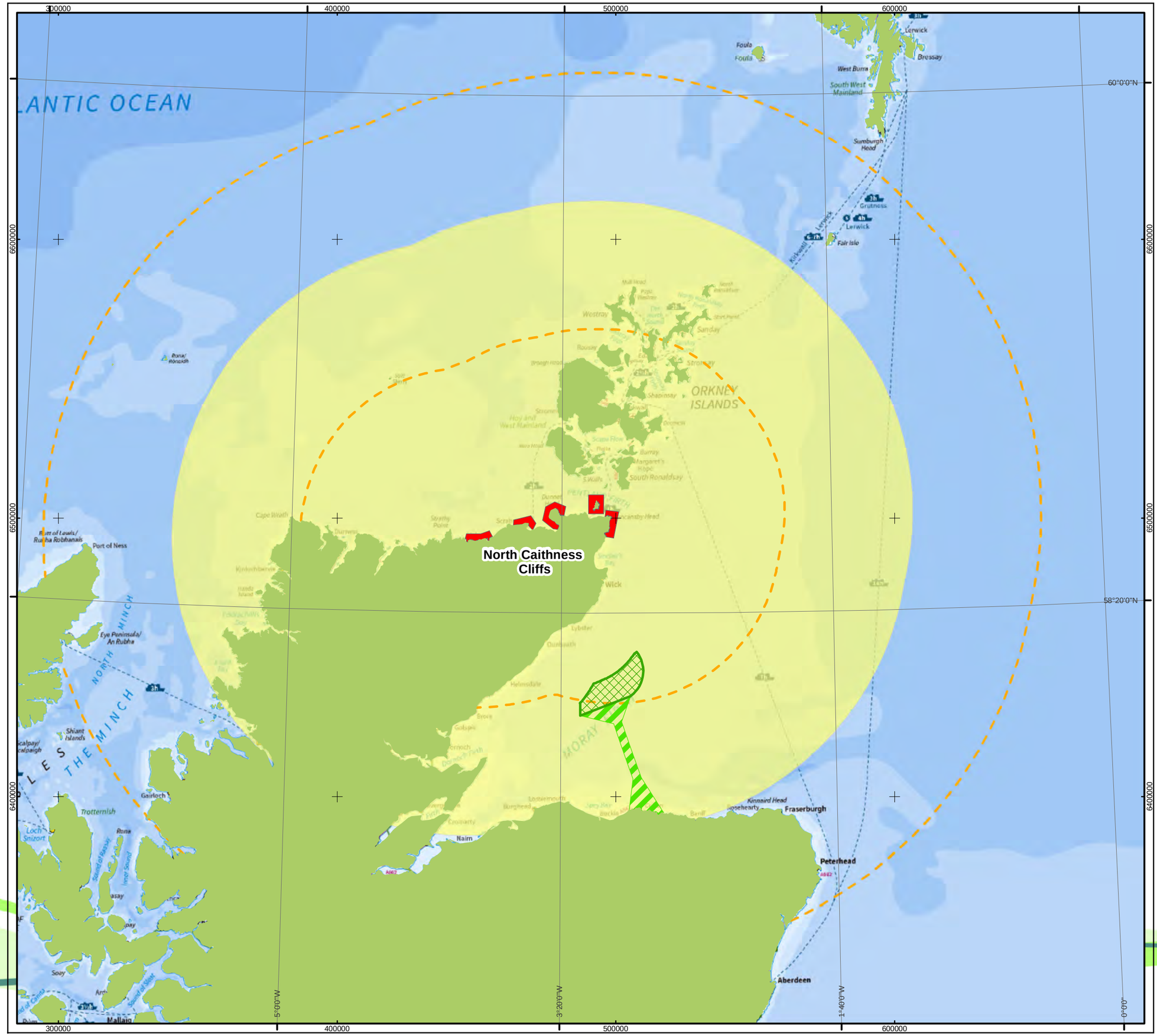

MORAY WEST
OFFSHORE WINDFARM

KEY

- Moray West Site
- Moray West Offshore Cable Export Route
- Mean-max foraging range (105.4km)
- Mean-max foraging range ± 1 standard deviation (105.4 ± 46.0km)
- Special Protection Areas (SPAs)

Horizontal Scale: 1:1,300,000 A3 Chart

0 25,000 50,000 Meters

N

Geodetic Parameters: WGS84 UTM Zone 30N

Produced: HAZ
Reviewed: RC
Approved: FG

Date: 07/09/2017 | Revision: B

REF: 8460005-PPW0160-GOE-MAP-008

Figure 4.2.7. Puffin Foraging Ranges

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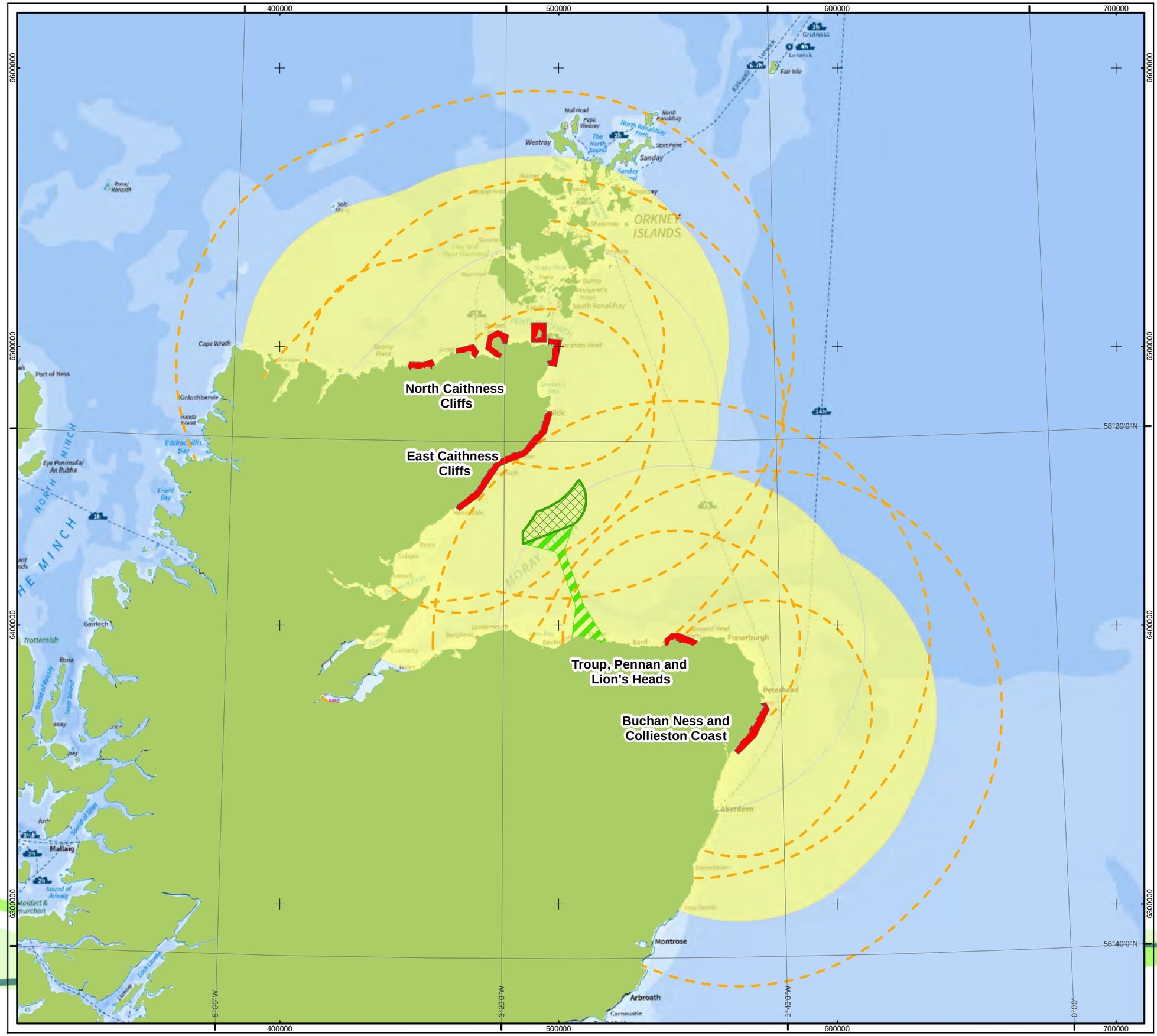

MORAY WEST OFFSHORE WINDFARM

KEY

- Moray West Site
- Moray West Offshore Cable Export Route
- Mean-max foraging range (60km)
- Mean-max foraging range ± 1 standard deviation (60 ± 23.3km)
- Special Protection Areas (SPAs)

Horizontal Scale: 1:1,300,000 A3 Chart

0 25,000 50,000 Meters

N

Geodetic Parameters: WGS84 UTM Zone 30N

Produced: HAZ
Reviewed: RC
Approved: FG

Date: 07/09/2017 | Revision: B

REF: 8460005-PPW0160-GOE-MAP-009

Figure 4.2.8. Kittiwake Foraging Ranges

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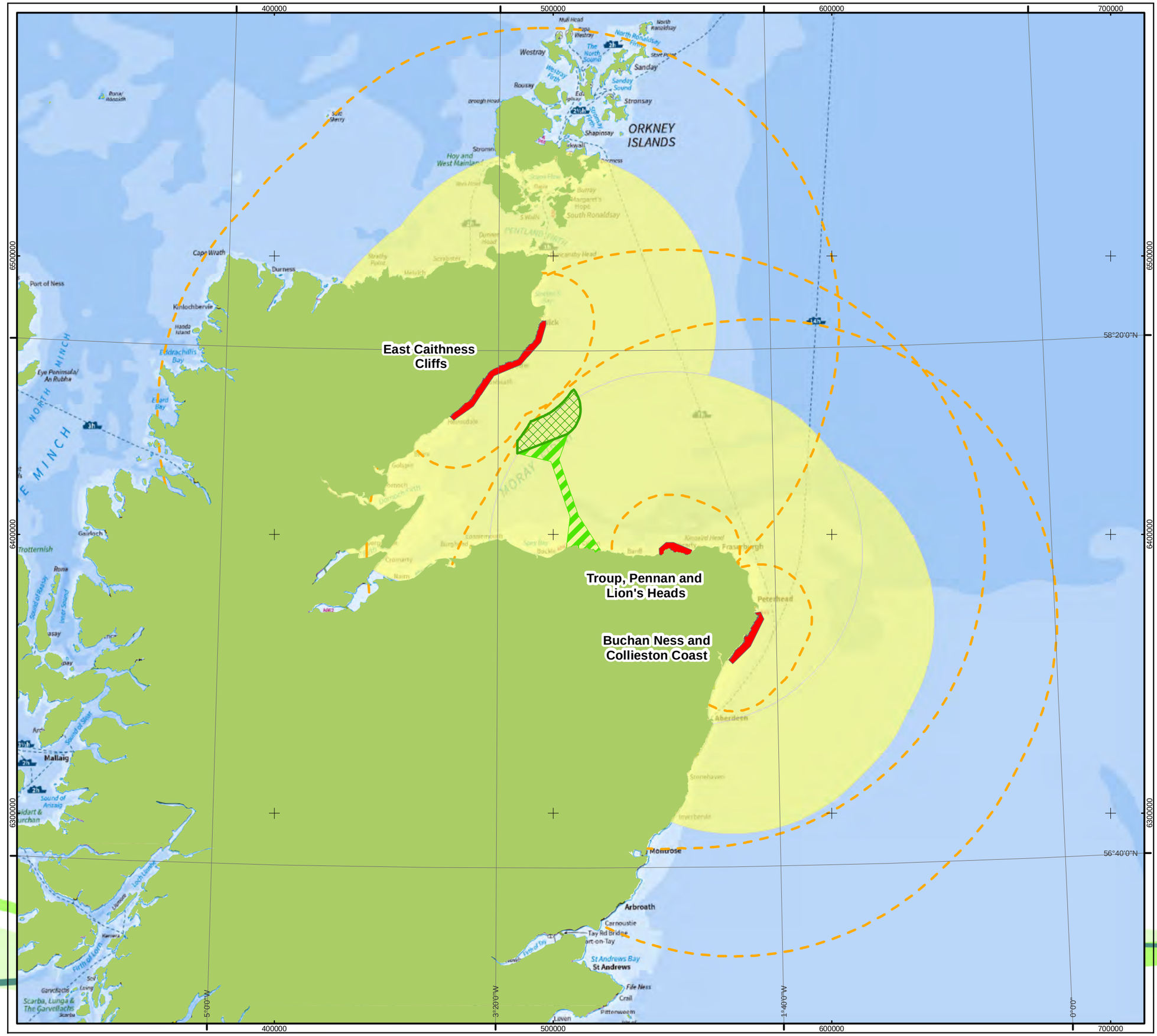

MORAY WEST
OFFSHORE WINDFARM

KEY

- Moray West Site
- Moray West Offshore Cable Export Route
- Mean-max foraging range (61.1km)
- Mean-max foraging range ± 1 standard deviation (61.1 ± 44.0km)
- Special Protection Areas (SPAs)

Horizontal Scale: 1:1,300,000 A3 Chart

0 25,000 50,000 Meters

N

Geodetic Parameters:	WGS84 UTM Zone 30N
Produced: HAZ Reviewed: RC Approved: FG	
Date: 07/09/2017	Revision: B
REF: 8460005-PPW0160-GOE-MAP-010	

Figure 4.2.9. Herring Gull Foraging Ranges

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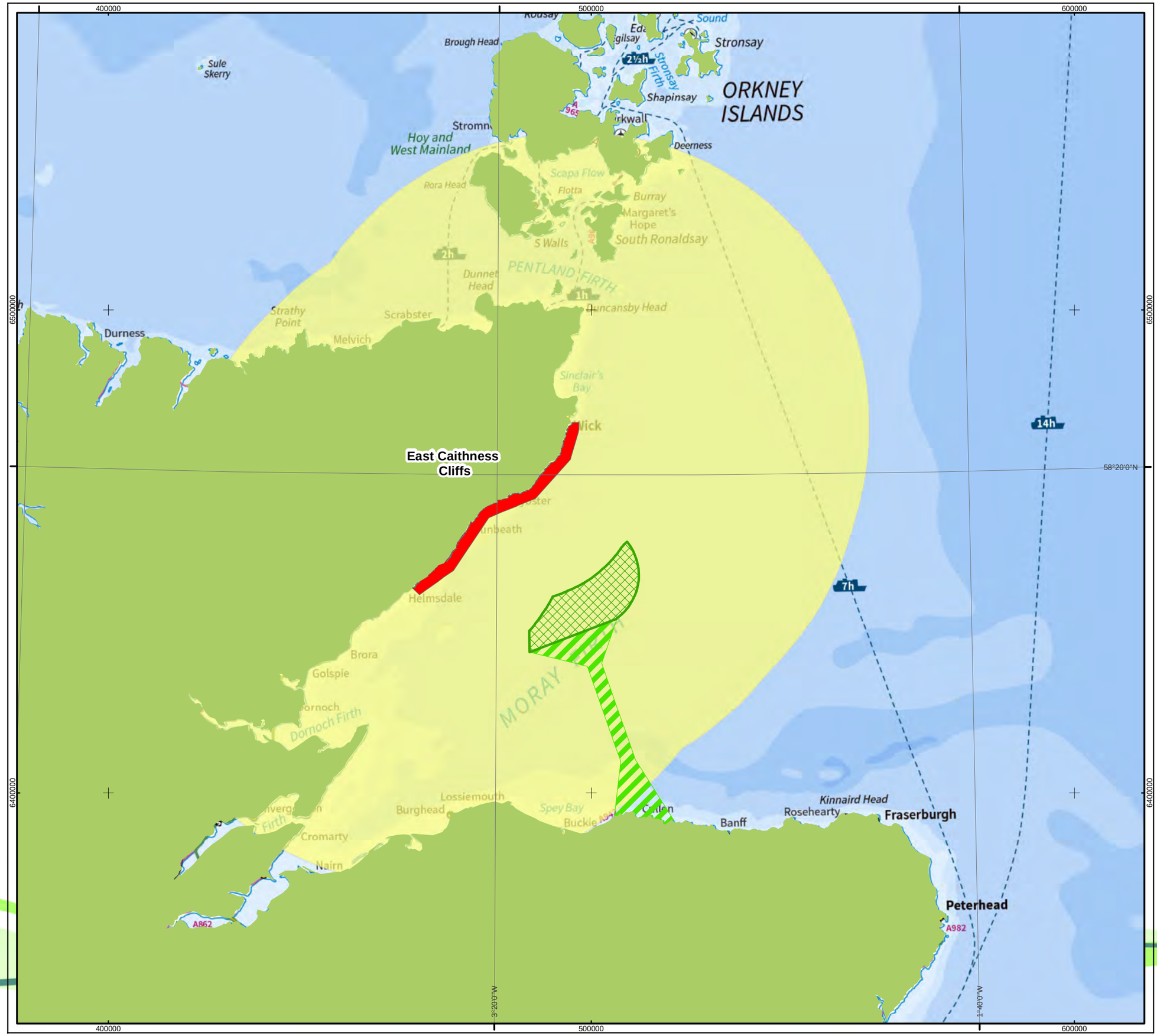

KEY

- Moray West Site
- Moray West Offshore Cable Export Route
- Foraging range (60km)
- Special Protection Areas (SPAs)

Horizontal Scale: 1:750,000 A3 Chart

0 12,500 25,000 Meters

N

Geodetic Parameters: WGS84 UTM Zone 30N

Produced: HAZ
Reviewed: RC
Approved: FG

Date: 07/09/2017 | Revision: B

REF: 8460005-PPW0160-GOE-MAP-011

Figure 4.2.10. Great Black-backed Gull Foraging Range

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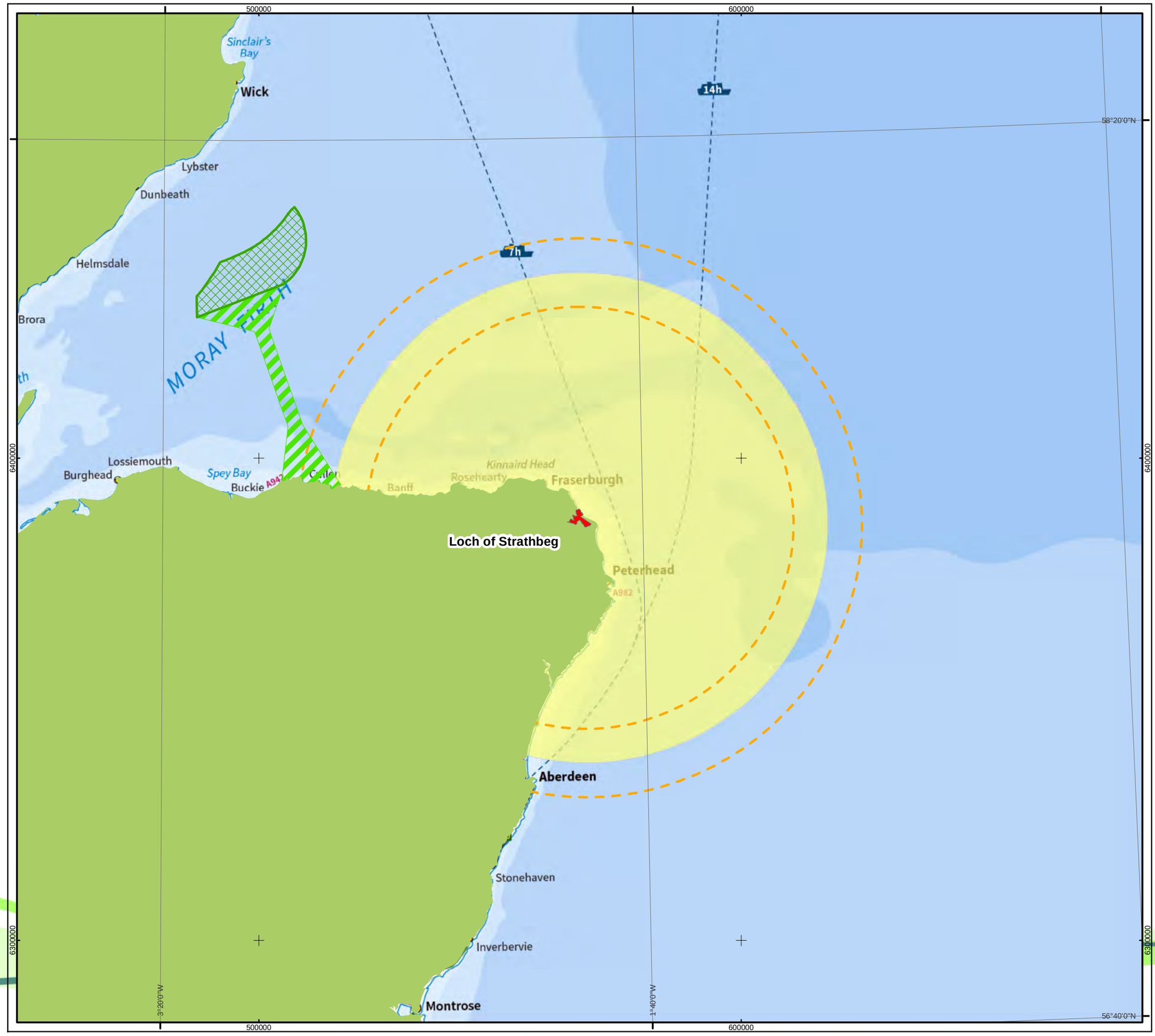

MORAY WEST
OFFSHORE WINDFARM

KEY

- Moray West Site
- Moray West Offshore Cable Export Route
- Mean-max foraging range (49km)
- Mean max foraging range ± 1 standard deviation (49.0 ± 7.1km)
- Special protection Areas (SPAs)

Horizontal Scale: 1:750,000 A3 Chart

0 12,500 25,000 Meters

N

Geodetic Parameters:	WGS84 UTM Zone 30N
Produced: HAZ Reviewed: RC Approved: FG	
Date: 07/09/2017	Revision: B
REF: 8460005-PPW0160-GOE-MAP-012	

Figure 4.2.11. Sandwich Tern Foraging Ranges

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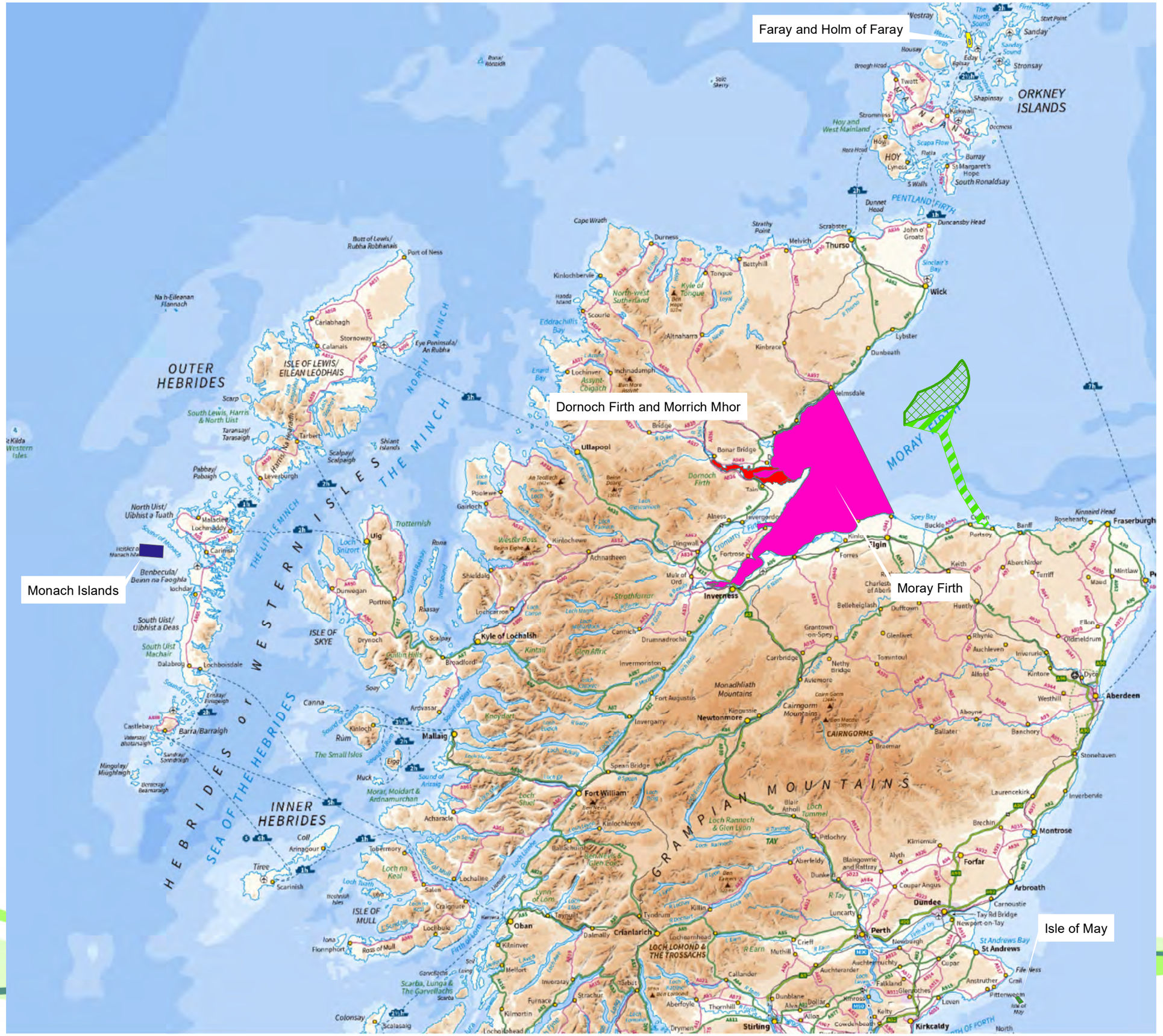
Faray and Holm of Faray
Dornoch Firth and Morrich Mhor
Monach Islands
Moray Firth
Isle of May
OUTER HEBRIDES
ISLE OF LEWIS/ EILEAN LEODHAIS
INNER HEBRIDES
ISLE OF SKYE
ISLE OF MULL
HEBRIDES OR WESTERN ISLES
SEA OF THE HEBRIDES
THE LITTLE MINCH
NORTH MINCH
ORKNEY ISLANDS
PENTLAND FIRTH
MORAY FIRTH
GRAMPIAN MOUNTAINS
CAIRNGORMS
Inverness
Aberdeen
Wick
Thurso
Ullapool
Fort William
Oban
Stornoway
Lochmaddy
Portree
Mallaig
Kyle of Lochalsh
Dornoch Firth
Scrabster
Kirkwall
Stromness
Lerwick
Fraserburgh
Peterhead
Montrose
Arbroath
Dundee
Perth
Stirling
Kirkcaldy
St Andrews
Elgin
Forres
Nairn
Banff
Buckie
Keith
Huntly
Inverurie
Stonehaven
Forfar
Brechin
Alford
Ballater
Braemar
Aviemore
Newtonmore
Kingussie
Carrbridge
Grantown-on-Spey
Dufftown
Tomintoul
Rhynie
Oldmeldrum
Ellon
Banchory
Laurencekirk
Inverbervie
Fort Augustus
Invergarry
Spean Bridge
Kinlochleven
Pitlochry
Aberfeldy
Blairgowrie and Rattray
Alyth
Kirriemuir
Couper Angus
Carnoustie
Arbroath
Tay Rd Bridge
Newport-on-Tay
Newburgh
Auchtermuchty
Cupar
Anstruther
Crail
Pittenweem
Leven
Kelty
Dunfermline
Alloa
Dollar
Callander
Crianlarich
Tyndrum
Killin
Aberfoyle
Dunblane
Thornhill
Drymen
Balloch
Helensburgh
Gairloch
Poolewe
Ullapool
Lochinver
Kinlochbervie
Durness
Cape Wrath
Tongue
Bettyhill
Melvich
Thurso
Wick
Lybster
Dunbeath
Helmsdale
Golspie
Brora
Dornoch
Tain
Alness
Invergordon
Dingwall
Strathpeffer
Muir of Ord
Beauly
Fortrose
Cromarty
Achnasheen
Kinlochewe
Shieldaig
Applecross
Torridon
Lochcarron
Kyle of Lochalsh
Broadford
Portree
Dunvegan
Uig
Lochmaddy
Benbecula/ Beinn na Faoghla
Lochboisdale
Castlebay
Barra/Barraigh
Eriskay/ Eisgeigh
Lochaline
Craignure
Tobermory
Salen
Fionnphort
Iona
Ross of Mull
Scarinish
Tiree
Arinagour
Coll
Colonsay
Scalasaig
Kilmartin
Furnace
Inveraray
Tarbert
Kilninver
Melfort
Oban
Dalmally
Lochearnhead
Callander
Aberfoyle
Dunblane
Alva
Doune
Dunkeld
Pitlochry
Kinloch Rannoch
Aberfeldy
Killin
Tyndrum
Crianlarich
Lochearnhead
Callander
Strathpeffer
Muir of Ord
Beauly
Fortrose
Cromarty
Nairn
Forres
Elgin
Lossiemouth
Buckie
Banff
Macduff
Fraserburgh
Rosehearty
Kinnaird Head
Peterhead
Boddam
Cruden Bay
Newburgh
Auchtermuchty
Cupar
Anstruther
Crail
Pittenweem
Leven
Kelty
Dunfermline
Alloa
Dollar
Callander
Crianlarich
Tyndrum
Killin
Aberfoyle
Dunblane
Alva
Doune
Dunkeld
Pitlochry
Kinloch Rannoch
Aberfeldy
Blairgowrie and Rattray
Alyth
Kirriemuir
Couper Angus
Carnoustie
Arbroath
Tay Rd Bridge
Newport-on-T

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MORAY WEST
OFFSHORE WINDFARM

KEY

- Moray West Site
- Offshore Export Cable Corridor
- Special Area of Conservation with Migratory Fish Features

Horizontal Scale: 1:700,000 A3 Chart

0 10,000 20,000 Meters

N

Geodetic Parameters:	WGS84 UTM Zone 30N
Produced: RC Reviewed: GB Approved: FG	
Date: 04/09/2017	Revision: C
REF: 8460005-PPW0160-GOE-MAP-014	

Figure 4.2.13: Location of SAC's with Migratory Fish Qualifying Features

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Appendix 2 – Environmental Baseline: European Sites and Ramsar and Qualifying Features

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Environmental Baseline

European Sites and Ramsars

Moray Firth pSPA

The Moray Firth proposed Special Protection Area (pSPA) comprises an area of 1762.36 square kilometres (km^2). The Moray basin is an extensive site stretching seaward from the Helmsdale coast in the north, to Portsoy in the east and it includes the Outer Dornoch and Cromarty Firths, Beauly and Inverness Firths, as well as part of the wider Moray Firth.

This area attracts the largest British non-breeding populations of long-tailed duck, velvet scoter and shag, as well as the second largest population of scaup and the largest Scottish non-breeding populations of common scoter and goldeneye. Important numbers of four other marine birds also spend winter in the Firth. In summer, the site continues to provide important feeding grounds for breeding shag, making local foraging trips from their breeding grounds along the sea cliffs.

East Caithness Cliffs SPA

The East Caithness Cliffs SPA is located on the east coast of Caithness and comprises most of the sea-cliff areas between Wick and Helmsdale. The cliffs are formed from Old Red Sandstone and are generally between 30-60 m high, rising to 150 m at Berriedale. Cliff ledges, stacks and geos provide ideal nesting sites for internationally important populations of seabirds, especially gulls and auks. The seabirds nesting on the East Caithness Cliffs feed outside the SPA in inshore waters as well as further away. The cliffs overlook the Moray Firth, an area that provides rich feeding areas for fish-eating seabirds.

North Caithness Cliffs SPA

The North Caithness Cliffs SPA is located on the north coast of Caithness in northern Scotland. The site comprises most of the sea-cliff areas between Red Point and Duncansby Head on the north mainland coast, and the western cliffs on the island of Stroma. The cliffs are formed from Old Red Sandstone and are generally between 30-60 m high, rising to 120 m at Dunnet Head. Cliff ledges, stacks and geos provide ideal nesting sites for important populations of seabirds, especially gulls and auks. The seabirds nesting on the North Caithness Cliffs feed outside the SPA in the surrounding waters of the Pentland Firth, as well as further afield.

Troup, Pennan and Lion's Head SPA

Troup, Pennan and Lion's Head SPA is a 9 km stretch of sea-cliffs along the Banff and Buchan coast of Aberdeenshire in north-east Scotland. As well as cliffs, the site also includes adjacent areas of grassland and heath, and several small sand or shingle beaches punctuate the otherwise rocky shore. The cliffs rise to 150 m and provide ideal nesting sites for seabirds, which feed in the rich waters offshore and outside the SPA. Different parts of the cliffs are used by different species of seabirds according to varying ecological requirements. The site is particularly important for its numbers of gulls and auks.

Buchan Ness and Collieston Coast SPA

Buchan Ness to Collieston Coast SPA is located on the coast of Aberdeenshire in north-east Scotland. It is a 15 km stretch of south-east facing cliff formed of granite, quartzite and other rocks running to the south of Peterhead, interrupted only by the sandy beach of Cruden Bay. The low, broken cliffs (generally less than 50 m high) show many erosion features such as stacks, arches, caves and blowholes. The varied coastal vegetation on the ledges and cliff tops includes maritime heath, grassland and brackish flushes. The site is of importance as a nesting area for a number of seabird species (gulls and auks). These birds feed outside the SPA in the nearby waters, as well as more distantly.

Moray and Nairn Coast SPA

The Moray and Nairn Coast SPA is located on the south coast of the Moray Firth in north-east Scotland. The site comprises the intertidal flats, saltmarsh and sand dunes of Findhorn Bay and Culbin Bar, and the alluvial deposits and associated woodland of the Lower River Spey and Spey Bay. It is of outstanding nature conservation and scientific importance for coastal and riverine habitats and supports a range of wetland birds throughout the year. In summer it supports nesting osprey *Pandion haliaetus*, whilst in winter it supports large numbers of Iceland/Greenland pink-footed goose *Anser brachyrhynchus*, Icelandic greylag goose *Anser* and other waterbirds, especially ducks, sea-ducks and waders. The geese feed away from the SPA on surrounding agricultural land during the day. The sea-ducks feed, loaf and roost over inundated intertidal areas within the site, but also away from the SPA in the open waters of the Moray Firth.

Moray and Nairn Coast SPA forms an integral ecological component of the Moray Basin Firths and Bays, of which it is the easternmost unit.

Dornoch Firth SPA

The Dornoch Firth is located in north-eastern Scotland and is one of the two northernmost estuaries in the Moray Basin ecosystem. The Dornoch Firth and Loch Fleet SPA is one of the best examples in northwest Europe of a large complex estuary which has been relatively unaffected by industrial development, whilst Loch Fleet itself is an example of a shallow, bar-built estuary. Extensive sand-flats and mud-flats are backed by saltmarsh and sand dunes with transitions to dune heath and alder *Alnus glutinosa* woodland. The tidal flats support internationally important numbers of waterbirds on migration and in winter, and are the most northerly and substantial extent of intertidal habitat for wintering waterbirds in the UK, as well as Europe. The Firth is also of importance as a feeding area for locally breeding Osprey.

Dornoch Firth and Loch Fleet SPA forms an integral ecological component of Moray Basin Firths and Bays of which it forms the most northerly component area.

Cromary Firth SPA

Cromarty Firth is located in north-eastern Scotland and is one of the major firths on the east shore of the Moray Firth. It contains a range of high-quality coastal habitats including extensive intertidal mud-flats and shingle bordered locally by areas of saltmarsh, as well as reedbeds around Dingwall. The rich invertebrate fauna of the intertidal flats, with beds of eelgrass *Zostera* spp., glasswort *Salicornia* spp., and *Enteromorpha* algae, all provide important food sources for large numbers of wintering and migrating waterbirds (swans, geese, ducks and waders). With adjacent estuarine areas elsewhere in the Moray Firth, it is the most northerly major wintering area for wildfowl and waders in Europe. The Firth is also of importance as a feeding area for locally breeding osprey as well as for breeding terns.

Cromarty Firth SPA forms an integral ecological component of Moray Basin Firths and Bays.

Inner Moray Firth SPA

The Inner Moray Firth is located to the north of Inverness in Scotland and is one of the major arms of the Moray Firth. It comprises the Beauly Firth and Inverness Firth (including Munlochy Bay) which together form the easternmost estuarine component of the Moray Basin ecosystem. The site contains extensive intertidal flats and smaller areas of saltmarsh. The rich invertebrate fauna of the intertidal flats, with beds of eelgrass *Zostera* spp., Glasswort *Salicornia* spp., and *Enteromorpha* algae, all provide important food sources for large numbers of wintering and migrating waterbirds (geese, ducks and waders). With adjacent estuarine areas elsewhere in the Moray Firth, this site is the most northerly major wintering area

for wildfowl and waders in Europe. The Firth is also of importance as a feeding area for locally breeding Osprey well as for breeding terns.

The Inner Moray Firth SPA forms an integral ecological component of Moray Basin Firths and Bays.

Moray Firth SAC

The Moray Firth SAC was designated in March 2005 and covers an area of 15,1274 hectares (ha). The primary reason for designation is due to its population of Annex II species, bottlenose dolphin. The Moray Firth in north-east Scotland supports the only known resident population of bottlenose dolphin Tursiops truncatus in the North Sea. The population is estimated to be around 130 individuals (Wilson et al. 1999). Dolphins are present all year round, and, while they range widely in the Moray Firth, they appear to favour particular areas (JNCC, 2015a). The bottlenose population were last recorded as being in 'favourable recovered' condition in September 2010. The Moray Firth SAC is also designated for its Annex I habitat of 'Sandbanks which are slightly covered by sea water all the time'. The condition of the habitat is currently 'favourable maintained' as recorded in August 2004. The conservation objectives for the bottlenose dolphin are presented in Table A2.1.

Table A2.1 Conservation Objectives for the Bottlenose Dolphin Population of the Moray Firth SAC.

Moray Firth SAC – Conservation Objectives For Qualifying Species
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 each of the qualifying features; 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 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.

Dornoch Firth and Morrich More SAC

The Dornoch Firth and Morrich More SAC was designated in March 2005 and covers an area of 8,701 ha. The primary reason for designation is due to its Annex I habitats, which include 'estuaries', 'mudflats and sandflats not covered by seawater at low tide', 'Salicornia and other annuals colonizing mud and sand', 'Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)', 'embryonic shifting dunes', 'Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes)', 'Fixed dunes with herbaceous vegetation (grey dunes)', 'Decalcified fixed dunes with *Empetrum nigrum*', 'Atlantic decalcified fixed dunes (*Calluno-Ulicetea*)', 'Humid dune slacks', and 'Coastal dunes with *Juniperus* spp'. Otter and harbor seal are Annex II species that are listed as primary features. The Dornoch Firth is the most northerly large estuary in Britain and supports a significant proportion of the inner Moray Firth population of the Harbour seal. The seals, which utilise sand-bars 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 population (JNCC, 2015b). In August 2013, the population of harbor seal was recorded as being in 'unfavourable declining' condition. The Conservation Objectives for harbour seal are set out in Table A2.1.

Other Annex I habitats present as a qualifying feature, but not a primary reason for designation include 'Sandbanks which are slightly covered by sea water all the time' and 'Reefs'.

Faray and Holm of Faray SAC

The Faray and Holm of Faray SAC was designated in March 2005 and covers an area of 781 ha. The primary reason for designation is its Annex II species of grey seal. These two uninhabited islands in the northern part of Orkney support a well-established grey seal breeding colony. The seals tend to be found in areas where there is easy access from the shore, and freshwater pools on the islands appear to be particularly important. The islands support the second-largest breeding colony in the UK, contributing around 9% of annual UK pup production. (JNCC, 2015c). The condition of the population was last reported as 'favourable maintained' in November 2014. The conservation objectives that are applicable to this species are set out within Table A2.1.

Isle of May SAC

The Isle of May SAC was designated in March 2005 and covers an area of 357 ha. The primary reason for designation is due to its Annex II species of grey seal. The Isle of May, lying at the entrance to the Firth of Forth on the east coast of Scotland, supports a breeding colony of grey seals. The site is the largest east coast breeding colony of grey seals in Scotland and the fourth-largest breeding colony in the UK, contributing approximately 4.5% of annual UK pup production (JNCC, 2015d). The condition of the population was last reported as 'favourable maintained' in November 2014. The conservation objectives that are applicable to this species are set out within Table A2.1. The Annex I habitat of 'Reef' is also a qualifying feature, but not a primary reason for selection.

Monach Islands SAC

The Monach Islands SAC was designated in March 2005 and covers an area of 3,647 ha. The primary reason for designation is due to its Annex I habitat comprising 'Machairs' and its Annex II species of grey seal. In addition to these, the Annex I habitats of 'Shifting dunes along the shoreline with Ammophila arenaria (white dunes)' and 'Fixed coastal dunes with herbaceous vegetation (grey dunes)' are present, but are not primary reasons for designation. The Monach Islands, off the Outer Hebrides, offer a wide area of largely undisturbed habitat for breeding grey seal, and there is easy access to the grassy swards and dune systems of the islands. These islands hold the largest breeding colony in the UK, contributing over 20% of annual UK pup production (JNCC, 2015e). The grey seal population is described as being of 'favourable maintained' condition (November, 2014) and the conservation objectives that are applicable to this species are set out within Table A2.1.

Berriedale and Langwell Waters SAC

The Berriedale and Langwell Waters SAC was designated in March 2005 and covers an area of 58 ha. The primary reason for designation is due to its Annex II species of Atlantic salmon. A description of this population of Atlantic salmon is presented in Table A2.9. The salmon population is described as being of 'favourable maintained' condition (July, 2011) and the conservation objectives that are applicable to this species are set out within Table A2.2.

Table A2.2 Conservation Objectives for the Atlantic Salmon Population of the Berriedale and Langwell Waters SAC.

Berriedale and Langwell Waters SAC – Conservation Objectives For Qualifying Species
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 each of the qualifying features; and To ensure for the qualifying species that the following are maintained in the long term: • Population of the species, including range of genetic types for salmon, 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.

River Borgie SAC

The River Borgie SAC was designated in March 2005 and covers an area of 34 ha. The primary reason for designation is due to its Annex II species of freshwater pearl mussel. The Annex II species of Atlantic salmon and otter are also listed as qualifying features, although not as primary reasons for designation. A description of this population of Atlantic salmon is presented in Table A2.9. The salmon population is described as being of 'favourable recovered' condition (October, 2011) and the conservation objectives that are applicable to this species are set out within Table A2.3.

Table A2.3 Conservation Objectives for the Atlantic Salmon Population of the River Borgie SAC.

River Borgie SAC – Conservation Objectives For Qualifying Species
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 each of the qualifying features; and To ensure for the qualifying species that the following are maintained in the long term: • Population of the species, including range of genetic types for salmon, 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; • Distribution and viability of freshwater pearl mussel host species; and • Structure, function and supporting processes of habitats supporting freshwater pearl mussel host species.

River Naver SAC

The River Naver SAC was designated in March 2005 and covers an area of 1044 ha. The primary reason for designation is due to its Annex II species of freshwater pearl mussel and Atlantic salmon. A description

of this population of Atlantic salmon is presented in Table A2.9. The salmon population is described as being of 'favourable recovered' condition (August, 2011) and the conservation objectives that are applicable to this species are set out within Table A2.3.

River Thurso SAC

The River Thurso SAC was designated in March 2005 and covers an area of 348 ha. The primary reason for designation is due to its Annex II species of Atlantic salmon. A description of this population of Atlantic salmon is presented in Table A2.9. The salmon population is described as being of 'unfavourable recovering' condition (October, 2011) and the conservation objectives that are applicable to this species are set out within Table A2.2.

River Oykel SAC

The River Oykel SAC was designated in March 2005 and covers an area of 921 ha. The primary reason for designation is due to its Annex II species of freshwater pearl mussel. The Annex II species of Atlantic salmon is also a qualifying feature, although not a primary reason for designation. A description of this population of Atlantic salmon is presented in Table A2.9. The salmon population is described as being of 'favourable recovered' condition (July, 2011) and the conservation objectives that are applicable to this species are set out within Table A2.3.

River Moriston SAC

The River Moriston SAC was designated in March 2005 and covers an area of 194 ha. The primary reason for designation is due to its Annex II species of freshwater pearl mussel. The Annex II species of Atlantic salmon is also a qualifying feature, although not a primary reason for designation. A description of this population of Atlantic salmon is presented in Table A2.9. The salmon population is described as being of 'unfavourable no change' condition (July, 2011) and the conservation objectives that are applicable to this species are set out within Table A2.3.

River Spey SAC

The River Spey SAC was designated in March 2005 and covers an area of 5760 ha. The primary reason for designation is due to its Annex II species of freshwater pearl mussel, Atlantic salmon, sea lamprey and otter. A description of this population of Atlantic salmon is presented in Table A2.9. The salmon population is described as being of 'unfavourable recovering' condition (September, 2011) and the conservation objectives that are applicable to this species are set out within Table A2.2. The River Spey represents the sea lamprey in the northern part of its range in the UK. It is absent from rivers north of the Great Glen, and the River Spey is virtually at the northern limit for this species. Recent surveys show that sea lamprey larvae are widely distributed throughout the middle and lower reaches of the river, where the particularly fast-flowing waters of the River Spey provide ideal spawning conditions for this species. In addition, as an unpolluted and relatively little modified system, the River Spey matches the other key habitat requirements of the sea lamprey in terms of good water quality, clean gravels and marginal silts and an unhindered migration route to the sea (JNCC, 2015f). The conservation objectives for sea lamprey are set out in Table A2.3 and the population condition is described as 'favourable maintained' (September 2011).

Qualifying Features

Through EIA Scoping of the Moray West Offshore Wind Farm (Marine Scotland, 2016), the following ecological aspects have been identified as requiring consideration within the HRA process in relation to European sites and qualifying features of interest:

- Ornithology;
- Marine mammals; and
- Migratory fish.

This section presents a summary of the baseline environmental characterisation of these three key ecological aspects in relation to the Moray West Offshore Wind Farm and Moray West OfTI. Baseline characterisation is informed through site specific surveys, desk studies and review of other published literature and publicly available datasets. These sources of information are referenced within the individual baseline descriptions presented below.

Ornithology

The following guidance and published work has informed the baseline characterisation of the ornithological interests:

- A review of assessment methodologies for offshore wind farms (Maclean et al., 2009);
- Assessing vulnerability of marine bird populations to offshore wind farms (Furness et al., 2013);
- Biologically appropriate, species-specific, geographically non-breeding season population estimates for seabirds (Furness, 2015);
- Seabird foraging ranges as a preliminary tool for identifying candidate Marine Protected Areas (Thaxter et al., 2012);
- Using a collision risk model to assess bird collision risk for offshore wind farms (Band 2012);
- Developing an avian collision risk model to incorporate variability and uncertainty. (Masden, 2015);
- The avoidance rates of collision between birds and offshore turbines (Cook et al., 2014);
- Joint Response from the Statutory Nature Conservation Bodies to the Marine Scotland Science Avoidance Rate Review (JNCC et al., 2014);
- JNCC et al. (2017). Interim Displacement Advice Note Advice on how to present assessment information on the extent and potential consequences of seabird displacement from Offshore Wind Farm developments;
- Assessing the risk of offshore wind farm development to migratory birds designated as features of UK SPAs Special Protection Areas (Wright et al., 2012);
- Developing guidelines on the use of Population Viability Analysis for investigating bird impacts due to offshore wind farms (Wildfowl and Wetland Trust (WWT) Consulting, 2012);
- Moray West (2016). Environmental Impact Assessment. Scoping Report. Western Development Area. Offshore Wind Farm Infrastructure: Offshore Wind Turbines, Foundations / Substructures and Inter-Array Cables May 2016;
- Moray East (2012). Environmental Statement. Technical Appendix 4.5 A - Ornithology. Telford, Stevenson, MacColl Wind Farms and associated Transmission Infrastructure Environmental Statement;
- SOSS-05: Assessing the risk of offshore wind farm development to migratory birds designated as features of UK Special Protection Areas (and other Annex 1 species); and
- Wade et al. (2016). Incorporating data uncertainty when estimating potential vulnerability of Scottish seabirds to marine renewable energy developments.

The waters of the Outer Moray Firth and the nearshore waters off the Moray and Aberdeenshire coasts are important feeding areas for seabirds and seaduck (Tasker, 1996). Of the seabirds, fulmars are widely distributed in the offshore export cable corridor throughout the year, whilst gannet, kittiwake and auk numbers peak during the summer or autumn. The surrounding coastal waters are of particular year-round importance for shags and herring gulls (Department of Trade and Industry (DTI), 2004; DECC, 2009).

An extensive ornithological dataset exists for the Moray Firth with this further indicating importance of the area for seabirds in both the breeding season and non-breeding season as evident from SPA designations in and around the Moray Firth area. Because of the mix of birds present, it is probable that the Moray West Offshore Wind Farm and OfTI areas are used at different times by birds (i) overwintering in the area; (ii) foraging from nearby breeding coastal colonies; and (iii) on post-breeding dispersal, migration and pre-breeding return.

As well as true pelagic seabirds (e.g. gannet, fulmars and auks), other species that spend part of their annual life cycle at sea (e.g. divers, gulls and seaducks) may also be present in particular months.

Site Specific Surveys

Digital aerial video surveys have been undertaken monthly, over a period of 12 months between April 2016 and March 2017. The surveys consisted of a series of parallel transects, each spacing 2.531 km apart, aligned in a south-east to north-west orientation within the Moray West Site and 4 km buffer. The survey was designed to allow for a 10.21% coverage of the survey area. Surveys were undertaken at a height of 550 m above sea level and data collected at a 2 cm resolution. Figure A2.1 provides an overview of the proposed transect survey design (the transects at the eastern and western boundaries of the survey area have been increased to 4 km in line with the size of the buffer).

The following data was collected:

- Date and time of each bird recorded;
- Global Positioning System (GPS) coordinate location of each bird recorded, ± error in the location;
- Survey transect number;
- Species Identification (structured approach to, and confidence in identification is needed);
- Bird age, gender and moult status (where possible);
- Whether the individual is in flight or on the sea surface;
- Behaviour in flight (e.g. part of a flock, carrying fish, diving);
- Flight height (± an appropriate error and confidence);
- Flight orientation (in compass degrees to true North); and
- Sea state (at the time of the image being collected.

Historical Moray Firth Surveys

As mentioned above, there is an extensive amount of ornithology data for the Moray Firth which has previously been detailed in the Moray East Environmental Statement. Technical Appendix 7.3 G - Habitat Regulations Appraisal: Marine Mammals. Telford, Stevenson, MacColl Wind Farms and associated Transmission Infrastructure Environmental Statement (Moray East, 2012). Further data that was reported in the Moray West Offshore Wind Farm Scoping Report (Moray West, 2016) included great back-backed gull and herring gull tagging work as well as regional strategic monitoring (commissioned by Marine

Scotland Science (MSS)). Table A2.4 provides an overview of the existing seabird datasets relevant to the Moray West HRA.

Table A2.4 Ornithological Datasets in the Moray Firth with Contextual Relevance to the Moray West HRA

Dataset / Technical Report	Main Content	Geographical Coverage	Source	Date
Moray East boat-based surveys	Data from 28 boat-based surveys including population estimates and densities for key ornithological receptors	Moray East Site plus 4 km buffer	Moray East	Apr 2010 – Mar 2012
Moray East aerial surveys	Six aerial surveys collecting relative abundance estimates of birds from relevant breeding colonies	Wide strip from the East Caithness Cliffs (ECC) and North Caithness Cliffs (NCC) SPAs to the Moray Coast	Moray East	May – July 2011
Tracking data for fulmar, kittiwake, guillemot and razorbill from the southern part of the ECC SPA	GPS data collected from a range of species at the ECC SPA	Moray Firth	Moray East	2011 breeding season
Migration surveys (during Moray East and BOWL boat-based surveys and at four coastal vantage points)	Additional data on migrating swans and geese flying through the Moray East Site	Moray Firth	Moray East	Autumn 2010 and Spring 2011
BOWL boat-based surveys	Data from boat-based surveys including population estimates, densities and behavioural data	BOWL site plus a 4 km buffer	BOWL	Oct 2009 – Sep 2011
Beatrice Demonstrator monthly vantage point watches (Talisman)	-	Moray Firth	Talisman	2005 – 2008
Aerial surveys (HiDef, WWT)	-	Wide area in Moray Firth including the entire Zone plus 4 km buffer	-	Breeding season 2009 and winter 2009/2010
Tracking of large gulls (great black-backed gull and herring gull) at ECC SPA	Tracking of 11 great black-backed gulls and 10 herring gulls	Moray Firth	MORL	May – Jun 2014
Marine Scotland seabirds strategic surveys	-	East Coast Scotland	MSS	2014 – 2015

Dataset / Technical Report	Main Content	Geographical Coverage	Source	Date
BOWL pre-construction aerial surveys	-	Area between the ECC SPA and the BOWL site plus 10 km buffer	-	May – Aug 2015
Seabird 2000 census	Population counts for relevant breeding colonies	UK	-	1998-2002
East Caithness Cliffs SPA colony monitoring (SNH)	-	East Caithness Cliffs SPA	-	2015

The geographical extent of the above data sets in relation to Moray West is present in Figure A2.2.

A total of six digital aerial surveys were carried out by between May and July 2011. The survey area covered a strip between the ECC and NCC SPAs in the north, to the Troup, Pennan and Lion's Head SPA in the Moray Coast in the south. The survey aircraft was flown along transects 2 km apart from each other, aligned in a north-northeast to south-southeast direction, and images were captured every 250 m along each transect line. Relative abundance estimates from the aerial surveys are included in Table A2.5 below. These data describe the relative abundance of birds across the survey area.

Table A2.5 Relative Abundance Estimates from the 2011 Digital Imaging Surveys

Species	Abundance Estimate
Guillemot	69,485
Razorbill	58,846
Puffin	11,780
Fulmar	21,241
Great black-backed gull	950
Kittiwake	47,765

Seven aerial surveys were undertaken over the Moray Firth Round 3 zone in 2009 (May, June, August, November and December) and 2010 (two in February). The surveys covered the entire Moray Firth Round 3 zone plus a 4 km buffer. The key findings from these data as a whole were:

- The most frequently recorded bird species / species groups in this area were auks, with high numbers of fulmar, kittiwake and other gulls also recorded;
- Other bird species recorded within the Moray Firth site included gannet, along with very low numbers of divers, Leach's petrel, Arctic skua, great skua, and unidentified terns; and
- Seasonal variations in bird numbers present within the Moray Firth Site included: increasing numbers of fulmar in November compared to other months; highest numbers of gannet and kittiwake in June and August, with low numbers during the winter; and higher numbers of auks during May and June compared to the winter.

A seabird tracking study was undertaken in 2011 by the Marine Biology and Ecology Research Centre, University of Plymouth at the ECC SPA. GPS loggers were attached to four key species of seabirds (fulmar, kittiwake, guillemot and razorbill). Full details of the methodology and results can be found in Technical

Appendix 4.5 C of the Moray East ES (Moray East, 2012). The large majority of the guillemots, razorbill and kittiwakes tracks were recorded within the inner part of the Moray Firth, with a small number commuting through the western part of the Moray West Offshore Wind Farm and OfTI areas. Fulmars travelled over a much wider area compared with the other three species, heading to more offshore foraging grounds.

A total of 28 boat-based surveys were carried out between April 2010 and March 2012. The survey area covered the Moray West Site plus a 4 km buffer (part of which overlaps with the Export Cable Corridor (see Technical Appendix 4.5 A of the Moray East ES (Moray East, 2012) for full details on the boat-based survey methodology). A summary of the seasonal abundance of the key species recorded, are presented in Table A2.6.

Table A2.6 Abundance Estimates for Key Species at Moray East Offshore Wind Farm (Taken From 2010 to 2012 Boat–Based Survey Data)

Species	Breeding Season		Non-breeding Season	
	Site	Buffer	Site	Buffer
Fulmar	782	750	197	189
Gannet	100	86	23	20
Great skua	101	62	n/a	n/a
Kittiwake	1,963	1,532	261	204
Herring gull	7	18	41	47
Great black-backed gull	271	526	106	77
Arctic tern	229	1,903	n/a	n/a
Guillemot	6,732	6,943	990	1,021
Razorbill	1,661	1,674	892	899
Puffin	1,916	1,971	450	263

Herring gulls and great black-backed gulls were tracked at ECC SPA during May and June 2014 (Archibald *et al*. 2014). Eleven great black-backed gulls and 10 herring gulls were caught on the nest and fitted with a 26 g remotely downloadable GPS / accelerometer tag. The results of this study showed that great back-backed gulls foraged mainly across inshore areas (maximum distance recorded from the nest was around 20 km although the vast majority of trips shorter than this). Herring gulls were also largely coastal, but foraged further to the south-east compared with great back-backed gulls, to waters north of the Cromarty.

Further contextual information on seabird density in the Moray Firth can be taken from an analysis of 26 years of European seabirds at sea (ESAS) surveys undertaken by JNCC (Kober *et al*., 2010); these are summarised in A2.7.

Table A2.7 Summary of JNCC ESAS Survey Data Analysis For The Moray Firth (Kober *et al*., 2010)

Species	Season	Density/km^2
Fulmar	Breeding	5 – 16
	Winter	3 - 7

Gannet	Breeding	0.9 – 2.9
	Winter	0.4 – 1.0
Cormorant	Breeding	0.03 – 0.3
	Winter	0 – 0.2
Shag	Breeding	0 – 5.7
	Winter	0 – 8.0
Arctic skua	Breeding	0.02 – 0.2
	Winter	0.01 – 1.1
Great skua	Breeding	0.1 – 0.2
	Winter	0.01 – 0.3
Kittiwake	Breeding	0.1 – 185.0
	Winter	0.1 – 20.5
Black-headed gull	Winter	0.01 – 3.0
Great black-backed gull	Breeding	0.01 – 0.8
	Winter	0.01 – 1.2
Lesser black-backed gull	Breeding	0.1 – 4.0
	Winter	0.1 – 4.0
Herring gull	Breeding	0.1 – 44.8
	Winter	0.1 – 9.2
Arctic tern	Breeding	0.01 – 0.9
Guillemot	Breeding	0.1 – 713.4
	Autumn	0.1 – 254.8
	Winter	0.1 – 62.7
Razorbill	Breeding	0.1 – 22.0
	Autumn	0.1 – 30.5
	Winter	0.1 – 15.8
Puffin	Breeding	0.1 – 14.8
	Winter	0.1 – 3.8

Determining a Robust Baseline for Moray West

Digital aerial surveys of the proposed Moray West site have recently been completed. Whilst this year of site-specific survey data provides a characterisation of the bird fauna of the Moray West Site across all seasons, it provides more limited information on the variability of bird densities over a wider temporal span than is normally the case for offshore wind farm impact assessments (given that it is a 12-month data set).

It is considered that recent, site-specific data are the most relevant for the purposes of HRA. The intention is, therefore, to focus primarily on the most recent site-specific data for the purpose of impact assessment. To better understand the variability in bird densities at the Moray West Site and the factors

driving that variability, Moray West proposes to undertake an analysis of historical data for which there is a wealth of in this area as identified above.

An initial review has indicated there are survey data available that can be usefully analysed to supplement the recent site-specific aerial surveys (2016-17) of the Moray West Site.

The proposed approach to the use of these data for informing impact assessment is summarised in Table A2.8.

Table A2.8 Proposed Approach To The Use Of Data Within the Impact Assessment

Characteristic	Data and Approach
Abundance / Density	Site-specific aerial surveys (2016-17) will form the primary data-set on the abundance and density of seabirds within the wind farm area and buffer. Previously collected (historical) seabird survey data will be analysed to provide an historical context to inform an understanding of the likely variability in abundance of key species at the wind farm site. The approach to this analysis is set out below. Where the recent data is considered to be representative of the site (i.e. comfortably within the ranges observed historically) the values for abundance and density observed during those recent surveys will be used to inform collision risk and displacement assessment. If the recent data appear to be exceptional, then the historical data will be further examined to identify a suitably precautionary assumption for the purposes of impact assessment.
Flight Heights	Site-specific aerial surveys (2016-17) will form the primary data-set for flight heights. Historical boat-based survey data will also be interrogated for information on the flights heights of key species. These data will inform the collision risk assessment.
Connectivity	Tracking data will provide information on potential connectivity between breeding colonies and the wind farm site.

The second stage of the process focuses, on the estimation of abundance and density from existing survey datasets to provide an historical context against which the results of the 2016-17 surveys can be set.

Boat-based surveys will be analysed using distance sampling (Buckland *et al.*, 2001) to estimate abundance in each survey area using distance (Thomas *et al.*, 2009, Thomas *et al.*, 2010). The expected outcome of this design-based analysis is an estimated population, with confidence intervals for a defined survey block.

A model-based approach will be used for digital aerial surveys. Each relevant survey dataset will be modelled to produce a density surface map which can be used to calculate the density of a species within a given region along with confidence intervals. Seasonality can be included as a factor in the model, or data from different seasons can be analysed separately.

In addition an evaluation will be made as to whether model predictions can be enhanced through the use of co-variates, which the literature search indicates could, potentially include:

- Static features: depth, distance to breeding colony, seabed slope or roughness, seabed habitat type; and
- Dynamic features: SST, chlorophyll, fronts.

The intention is to tabulate the resulting abundance / density estimates (and confidence limits) by species and season. The results of the most recent survey programme (2016-17) will then be compared to these

data to determine their representativeness. Assuming that the results of the recent surveys are considered to be representative, it is proposed that these data are used for the purposes of risk assessment (i.e. collision risk modelling and displacement analysis).

Marine Mammals

Desk Based Study and Literature Review

The following data sources have been used to describe the baseline conditions for marine mammals within and surrounding Moray West:

- Marine Scotland's National Marine Plan interactive (NMPi) mapping http://marine.gov.scot/maps/nmpi - for data on cetaceans and seals distribution and information on population consequences of disturbance (PCOD);
- Atlas of Cetacean distribution in north-west European waters (2003) http://jncc.defra.gov.uk/page-2713 - Joint Cetacean Database maps depicting cetacean occurrence (distribution and/or sightings) within the study area, including the Moray Firth;
- Data from the Joint Cetacean Protocol (JCP) Phase III http://jncc.defra.gov.uk/pdf/JNCC_Report_517_FINAL_web.pdf [Accessed May 2017];
- Small Cetaceans in the European Atlantic and North Sea (SCANS) survey data – SCANS II http://biology.st-andrews.ac.uk/scans2/inner-finalReport.html and SCANS III https://synergy.st-andrews.ac.uk/scans3/;
- Seal management areas are determined by the Special Committee on Seals (SCOS): http://www.smru.st-andrews.ac.uk/documents/SCOS.pdf;
- UK seal usage of the sea maps http://www.smru.st-andrews.ac.uk/smrudownloader/ [Accessed May 2017];
- Seal density data from SCOS http://www.smru.st-andrews.ac.uk/files/2017/04/SCOS-2016.pdf [Accessed May 2017];
- Guidance on cetacean management units from: http://jncc.defra.gov.uk/pdf/Report_547_webv2.pdf;
- information on the draft Southern Trench Marine Protection Area (MPA) is available from: http://www.snh.gov.uk/protecting-scotlands-nature/protected-areas/national-designations/marine-protected-areas-%28mpa%29/scottish-mpa-network-advice/;
- MORL (2016). Environmental Impact Assessment. Scoping Report. Western Development Area. Offshore Wind Farm Infrastructure: Offshore Wind Turbines, Foundations / Substructures and Inter-Array Cables May 2016; and
- MORL (2012). Environmental Statement. Technical Appendix 7.3 G - Habitat Regulations Appraisal: Marine Mammals. Telford, Stevenson, MacColl Wind Farms and associated Transmission Infrastructure Environmental Statement.

According to the UK Cetacean Atlas (Reid et al., 2003), there are a total of nine species of cetacean that are known to visit the Moray Firth. These are humpback whale (*Megaptera novaeangliae*), Minke whale (*Balaenoptera acutorostrata*), fin whale (*Balaenoptera physalus*), bottlenose dolphin (*Tursiops truncatus*), white-beaked dolphin (*Lagenorhynchus albirostris*), Risso's dolphin (*Grampus griseus*), killer whale (*Orcinus orca*), long-finned pilot whale (*Globicephala melas*) and harbour porpoise (*Phocoena phocoena*).

Within the UK the only marine mammals that form part of the qualifying features for SACs are grey seal (*Halichoerus grypus*), harbour (or common) seal (*Phoca vitulina*) and bottlenose dolphin. In addition to the current suite of designated SACs for these species, there are proposals to designate six additional SACs

around the UK for harbour porpoise and one of these proposals is the Inner Hebrides and Minches candidate SAC (cSAC), which has now been submitted to the European Commission for consideration.

Moray West is located within the Coastal East Scotland (CES) Management Unit for cetaceans which covers the inner Moray Firth area, as well as the Greater North Sea (GNS) Management Unit which covers the Outer Moray Firth.

Moray West is located within the Moray Firth Seal Management Area and within a conservation area for harbour seals (Marine Scotland, 2017). Designated seal haul-out sites are locations on land where seals come ashore to rest, moult or breed. There are no seal haul-out sites that will be directly affected by Moray West with the closest being located approximately 22 km to the north west at Dunbeath-Helmsdale, Lothmore, Brora, Loch Fleet and Findhorn (see Figure A2.3) (Marine Scotland, 2017). The nearest grey seal pupping sites (breeding colonies) are to the north west of Moray West, on the coastline between Dunbeath and Helmsdale and Wick to Lybster at a distance of 20.5 km and 20.0 km respectively (see Figure A2.4).

UK wide seal usage at sea mapping is available from the Sea Mammal Research Unit (SMRU). This data shows the average number of seals in each 5km by 5km grid square at any point in time (Jones *et al.*, 2015). For Moray West, the average number of grey seal is between 1 and 10 individuals. For harbour seal it is 0.01 to 5 individuals. More fine-scale at sea usage maps for harbour seal are available for the north of Scotland, but does not include the Moray Firth. Telemetry data collected from the movement of tagged seals between 2003 and 2015 has been used by (SMRU) to produce fine-scale 'usage' maps. These have then been scaled to population levels using data collected in aerial survey counts at haul-out sites, to produce estimates of mean density (Jones *et al.*, 2016).

Based upon 18 years of data collection, the Moray Firth is reported to have a persistently high density of harbour porpoise during the summer months but not during the winter (Heinänen and Skov, 2015). Mapping shows this area of high density to be present to the north of Moray West but the main areas used by harbour porpoise are on the west coast of Scotland and to the south, in England. The JCP and SCANS data show similar results of a harbour porpoise hotspot in the Moray Firth. SCANS III estimates of abundance for harbour porpoise and bottlenose dolphin are available; harbour porpoise abundance and density (animals/km^2) estimates were 6,147 individuals and 0.152 (overall density average of 0.351). Bottlenose dolphin abundance and density (animals/km^2) estimates were 151 individuals and 0.004 (overall density average of 0.016).

The location of all SACs with marine mammal qualifying features that are potentially connected to the Moray West proposal are illustrated in Figure 4.2.12. Further more detailed baseline information on marine mammals is presented within the Moray East Environmental Statement and supporting Technical Appendices (Moray East, 2012) and in the Moray West Scoping Report (Moray West, 2016).

Site Specific Surveys

To date, no specific marine mammal surveys have been undertaken at the Moray West Site, however site specific surveys were previously completed as part of the consent application for the Moray East Site (Moray East, 2012). Surveys included boat-based surveys over the period April 2010 to March 2012 and these are reported within Technical Appendix 4.4 A Marine Mammal Baseline of the previous Environmental Statement (Moray East, 2012). The digital aerial video surveys undertaken monthly between April 2016 and March 2017 for the ornithological assessment have also recorded marine mammals and provide a source of data (not yet analysed).

Passive acoustic monitoring (PAM) studies have been funded by Marine Scotland and will provide further site specific data in the near future, as will incidental observations made during boat based bird surveys and during aerial surveys (by HiDef) that are due to take place for Moray West. This additional data will be used to further inform any future RIAA.

BOWL and MORL 2015 and 2016 MMMP Results

In 2014 BOWL and MORL agreed, as part of their consents, to undertake a joint regional Marine Mammal Monitoring Programme (MMMP) and a proposed methodology and programme was drawn up and agreed with MS-LOT. This MMMP comprises of harbour seal and bottlenose dolphin monitoring that will be undertaken pre, during and post construction.

As Beatrice is currently under construction, some of this programme of works has been completed and was reported in 2015 (Graham et al., 2015) and 2016 (Graham et al., 2016). During 2014 and 2015, Harbour seal work has focused upon the breeding population in Loch Fleet National Nature Reserve (NNR). A total of 54 females were seen with a pup at Loch Fleet in 2014 and the fecundity rate was estimated to be 0.83. The median pupping date was the 19th June, later than for the preceding seven years from 2007 to 2013. In 2014, a total of 183 individuals were identified at Loch Fleet: 92 females, 76 males and 15 individuals of unknown sex. The mean count of adult harbour seals at Loch Fleet was 93 (± 4) during pupping and 123 (± 8) during the moult. Counts at Loch Fleet have been increasing since the mid-1990s. In 2015, a total of 179 individuals were identified at Loch Fleet: 101 females, 75 males and 3 individuals of unknown sex. This included 55 reproductive females that were seen with a pup at Loch Fleet, providing a direct estimate for the 2015 fecundity rate of 0.81. The median pupping date in 2015 was the 21st June, later than the preceding nine years from 2006. In September 2014 and February 2015, 25 harbour seals were captured at Loch Fleet and fitted with GPS/GSM tags, which are providing information on foraging distribution and diving behaviour.

Bottlenose dolphin photo-identification surveys were focused in the Moray Firth SAC. Seven calves were seen with known females in the SAC in 2014 and the fecundity rate was estimated to be 0.26. In 2014, a total of 41 well-marked individuals were seen in the SAC: 20 females, 14 males and 7 individuals of unknown sex. The estimated number of dolphins using the SAC in the summer of 2014 was 78. In 2015, a total of 53 well-marked individuals were seen in the SAC: 30 females, 16 males and 7 individuals of unknown sex. The estimated number of dolphins using the SAC in the summer of 2015 was 98. There was no evidence of a trend in the estimated abundance of dolphins using the SAC from 1990 to 2015. Data from across the population's range suggests that the east coast of Scotland dolphin population is increasing, with annual estimates of 101 in 1990 and 195 in 2015. Over 2014 and 2015 PAM with CPODs was used to determine baseline levels of occurrence in favoured areas. Dolphin occurrence was highest at the Sutors and Chanonry and lower at sites along the south coast. Dolphin detections varied seasonally but were generally highest from May to August.

Species Accounts

Within the Scoping Opinion for Moray West (Marine Scotland, 2016) SNH and JNCC identified that the key species to address for the Moray West Offshore Wind Farm were harbour seal, bottlenose dolphin, harbour porpoise, minke whale and grey seal. As this report addresses the requirements of HRA Screening, a species account is presented for all except minke whale (not an SAC qualifying feature).

For each species, the account has been broken down into the following subsections:

- Ecology and habitat;
- Abundance and distribution; and
- Protected sites.

Harbour Seal

Ecology and Habitat

Adult harbour seals typically weigh 80-100 kg and are slightly smaller than grey seals. Males are slightly larger than females. Like grey seals, harbour seals are long-lived with individuals living up to 20-30 years. Harbour seals normally feed within 40-50 km around their haul out sites. They take a wide variety of prey

including sandeels, gadoids, herring and sprat, flatfish, octopus and squid. Diet varies seasonally and from region to region. Because of their smaller size, harbour seals eat less food than grey seals; 3-5 kg per adult seal per day depending on the prey species (SCOS, 2016). Harbour seals give birth to their pups in June and July and moult in August.

Approximately 30% of European harbour seals are found in the UK; this proportion has declined from approximately 40% in 2002. Harbour seals are widespread around the west coast of Scotland and throughout the Hebrides and Northern Isles. On the east coast, their distribution is more restricted with concentrations in the major estuaries of the Thames, The Wash and the Moray Firth. Scotland holds approximately 79% of the UK harbour seal population.

Abundance and Distribution

According to Duck *et al.* (2016), in the Moray Firth, 705 harbour seals were counted in the area surveyed annually (Helmsdale to Findhorn) in 2015, compared with 693 counted in 2014. These are the two lowest counts for this area, just over 20% lower than the mean count between 2002 and 2013 (909).

SNH and JNCC have requested that the population of the Moray Firth seal MU should be used as the reference population for HRA as this is taken to be equivalent to the SAC population. In 2016, it was estimated that the total population for the UK in 2015 was 43,300 harbour seals (SCOS, 2016), with a count of 745 individuals within the Moray Firth seal Management Unit (MU) in 2015. This, scaled to account for the proportion of animals at sea at the time of the count, equates to a population estimate of 1,034 harbour seals in the MU, which accounts for 2.39% of the total UK population or 2.93% of the Scottish population. The current estimated total number of harbour seals in Scotland of 20,427 is 31% less than the total of 29,600 for the previous complete survey carried out in 1996/97.

Both the Dornoch Firth and Morrich More SAC and the Loch Fleet NNR have been counted annually during the August moult counts. These data show that the Loch Fleet NNR counts have increased from 59 animals in 2002 to 144 animals in 2015 (average p.a. increase of 8.94%). If the 2015 count of 144 is scaled to include the proportion of seals in the water at the time of the count, the abundance of harbour seals in Loch Fleet during the 2015 August moult is estimated as 200 animals. Unlike the Loch Fleet site, the annual moult count at the Dornoch Firth and Morrich More SAC has fluctuated annually from 220 in 2002 to a maximum of 290 in 2003 and a minimum of 111 in 2014. Over the period between 2002 and 2015 the counts show an average per annum 0.38% decline in counts. If the 2015 count of 120 is scaled to include the proportion of seals in the water at the time of the count, the abundance of harbour seals in the Dornoch Firth and Morrich More SAC during the 2015 August moult is estimated as 167 animals.

Overall, the UK population has increased since the late 2000s and is close to the 1990s level. However, there are significant differences in the population dynamics between regions. As reported in SCOS 2008 to 2015, there have been general declines in counts of harbour seals in several regions around Scotland, particularly in the Northern Isles and East Coast management units, but the declines are not universal with some populations either stable or increasing. From Moray East 2012, the results of the presence-absence Generalised Additive Model (GAM) indicated that seals from the Moray Firth population were likely to be dispersed widely across the Moray Firth, particularly over offshore sandbanks.

Harbour seals in Scotland by 1km squares from surveys in August 2007-2009 indicate a count of less than 1,000 individuals. The harbour seal population over much of the east coast and the Northern Isles has shown a marked decline in recent years which has thought to be attributed to a number of factors such as competition with grey seals, reduced prey availability, disease, increased predation from killer whales, shooting, elevated biotoxin loading, reduced fecundity and corkscrew injuries.

Protected Sites

As harbour seal generally forage within 50 km of their haul out sites (Sharples et al., 2012), all SACs within this distance are considered to have connectivity with Moray West. The only SAC within 50 km with harbour seal as a qualifying interest (Annex II species that are a primary reason for selection of this site) is the Dornoch Firth and Morrich More SAC (Figure 4.2.12) and SNH / JNCC have advised, during scoping, that there is connectivity between Moray West and this SAC.

Bottlenose Dolphin

Ecology and Habitat

The bottlenose dolphins found in the Moray Firth SAC are part of a Scottish east coast population of approximately 200 animals that ranges south past Aberdeen to the Firths of Tay and Forth. Analysis of photo-identification data collected since 1989 within and outside the Moray Firth SAC estimate a low probability of dolphins temporarily emigrating outside the study area, which is consistent with this being a highly resident population, although the portion of the population that are regularly seen outside of the SAC has been increasing in recent years (Cheney *et al.*, 2013). Dolphins in the Moray Firth and Firth of Tay are also seen throughout the year, with most sightings between May and December in the Moray Firth and from May to October in the Firth of Tay (Thompson et al. 2011). 2009). Bottlenose dolphins are a social dolphin, commonly forming groups of 2-25 individuals with larger schools occurring in offshore areas (Reid et al. 2003). Bottlenose dolphins in Scotland have been found to feed primarily on gadoids such as cod, saithe and whiting as well as Atlantic salmon and cephalopods.

Abundance and Distribution

Bottlenose dolphins in the CES Management Unit are primarily located in the coastal waters, with very few individuals recorded in the GNS Management Unit. Individuals recorded in the GNS Management Unit are thought to be associated with the CES group. The abundance counts for the CES are for a resident population estimated to contain 195 bottlenose dolphins (Cheney et al. 2013), with zero for the GNS.

Protected Sites

As bottlenose dolphin within the Moray Firth are known to move down the east coast as far as the Firth of Forth and are a qualifying feature of the Moray Firth SAC, this site is of relevance. SNH and JNCC have advised that there is connectivity between Moray West and this designated site.

Harbour Porpoise

Ecology and Habitat

The harbour porpoise is the smallest cetacean in the north-east Atlantic, reaching up to approximately 2m, and is abundant in the waters off north-west Scotland (SMRU, 2010). Around the UK, mating and calving is estimated to take place between May and September, peaking in June and July. In terms of diet, in Scottish waters, porpoise tend to feed on two to four main species, for example whiting and sandeel. Harbour porpoise is a characteristically shy species, and generally do not approach vessels or other anthropogenic activities (SMRU, 2010).

Much work has been undertaken to determine the preferred habitat of the harbour porpoise, in order to inform areas for potential designation, and this is summarised within 'Protected Sites' below. As their name suggests, however, the species is frequently found in estuaries, harbours, bays and fjords. This also explains why they are generally the most frequently-recorded species around the west coast of Scotland.

Abundance and Distribution

The North Sea Management Unit for harbour porpoise contains an estimated abundance of 227,298 animals for which 110,433 individuals (approximately 49%) are in the UK (IAMMWG 2015). Passive

acoustic monitoring indicates that harbour porpoise can be found throughout the Moray Firth (Moray East ES, 2012, Appendix 4.4A Marine Mammals Baseline). Predicted density surfaces from previous work indicate a widespread offshore distribution with considerable spatial variability in at-sea density. Using the SCANS II data, predicted harbour porpoise densities range between 0.305 and 0.373 porpoise/km^2 within Moray West (Hammond et al. 2013)

Passive acoustic monitoring indicated that harbour porpoise can be found throughout the Moray Firth. Harbour porpoise habitat models utilising a number of survey data (Appendix 4.4 A of Moray East, 2012), showed a preference for intermediate depths with increasing levels of sand and gravel, such as the Smith Bank.

SNH and JNCC have confirmed that on the basis of the data collected so far, harbour porpoise are likely to be the most abundant marine mammal species recorded in Moray West.

Protected Sites

The Inner Hebrides and Minches cSAC is currently under review by the European Commission, but this cSAC is considered to be too far from the Moray Firth and comprise a different population of harbour porpoise to those that are encountered in the Moray Firth (as indicated by IAMMWG, 2015 and other data). As such it is considered that there is no connectivity to this cSAC.

Grey Seal

Ecology and Habitat

Approximately 38% of the world's grey seals breed in the UK and 88% of these breed at colonies in Scotland with the main concentrations in the Outer Hebrides and in Orkney. The grey seal is the larger of the UK's two resident seal species, with adult males reaching over 300kg in weight, and females around 200kg (SCOS, 2016). Males and females can live up to 20 and 30 years, respectively, with breeding ages from ten and five years, again, respectively. Grey seals tend to forage mainly on small demersal fish species, such as sandeel, whitefish and flatfish, which they find in open sea conditions, before returning to haul-out sites to rest, moult and breed. Most foraging activity occurs within 100km of haul-out sites, and in waters up to 100m in depth (SCOS, 2011), although longer trips between different haul-out sites can be up to several hundred kilometres. Foraging trips can last anywhere between 1 and 30 days. Compared with other times of the year, grey seals in the UK spend longer hauled out during their annual moult (between December and April) and during their breeding season (between August and December). In north and west Scotland, pupping occurs mainly between September and late November.

Abundance and Distribution

The population estimate for the Moray Firth Seal Management Unit for the 2009 pup production was 119,400 for the UK and 105,072 (88%) for Scotland. The most recent surveys of the Scottish grey seal breeding sites flown in 2014, produced a pup production estimate of 60,500 pups and it was estimated that there was approximately 139,800 UK grey seals at that time (1+ aged population).

Protected Sites

From radio tagging and telemetry research, the foraging distances and movements of grey seal are known to vary extensively, with short distance movements regularly taking place between haul out sites and local foraging areas, as well as long distance movements often taking place with individuals travelling at speeds of up to 75km – 100 km per day (McConnell *et al.*, 1999). For this HRA screening exercise, the foraging distance of grey seal from their haul out sites is considered to extend up to 200 km in distance, and any SAC within this distance with grey seal as a qualifying feature is considered to have connectivity to the Moray West site (unless proven otherwise). There are no SAC designations for this species in the Moray Firth and one within 200 km that are designated for grey seal (closest being the Faray and Holm of Faray SAC in Northern Orkney, approximately 112 km from the Moray West Offshore Wind Farm (and 126 km

from the OfTI). The next closest are the Isle of May (Firth of Forth) at 205 km form the Moray Firth Site and Monach Islands (Outer Hebrides) at 264 km from the Moray West Site. SNH and JNCC have, during scoping, confirmed that they do not advise connectivity between Moray West and any grey seal SACs.

Migratory Fish

Within the MS-LOT Scoping Opinion (Marine Scotland, 2016), SNH stated that they had reviewed the advice given at the application stage for the Moray East Site in relation to diadromous fish and freshwater pearl mussels (*Margaritifera margaritifera*) as qualifying interests of SACs. SNH had concluded that on the basis of that advice, and because an extensive monitoring programme in support of the National Research and Monitoring Strategy for Diadromous Fish had been committed to by Moray East, SNH wished 'to discuss whether SAC fish interests could be scoped out of assessment'.

However, Marine Scotland Science (MSS) requested, within their scoping response, that inclusion of an updated authoritative view on the likely distribution of the various life stages of the diadromous fish species, including salmon, sea trout and eels, in the development locality, whether they are likely to be close to the coast or offshore, and the extent to which they are likely to be in the immediate vicinity of the development, and swimming depths, based as far as possible on real information for the locality or elsewhere was required. In the case of salmon and sea trout this should include updated information on the likely origin / destination of fish using the area. Updated information, bringing in the latest knowledge, on the likely impacts of underwater noise on diadromous fish and their behaviour, and appropriate mitigation to minimise impacts of pile driving noise during construction should be provided. There would need to be consideration of what further research and monitoring relating to diadromous fish with respect to the Moray West Site will be appropriate. MSS also stated that because of the long range movements of salmon, developments could have the potential to impact on salmon populations associated with rivers substantial distances from development sites. It was suggested that the ES should review first what information is available on where salmon in the area are likely to be from, or destined for, before the selection is made. This statement would also be applicable to the HRA and selection of SACs.

Desk Based Study and Literature Review

The following data sources have been used to describe the baseline conditions for migratory fish within and surrounding Moray West:

- D Armstrong, D-C Hunter, R J Fryer, P Rycroft & J E Orpwood (2015). Scottish Marine and Freshwater Science. Volume 6 Number 9. Behavioural Responses of Atlantic Salmon to Mains Frequency Magnetic Fields;
- Gill, A. B. and Bartlett, M. (2010). Literature review on the potential effects of electromagnetic fields and subsea noise from marine renewable energy developments on Atlantic salmon, sea trout and European eel. Scottish Natural Heritage, Commissioned Report No. 401. Available online from: http://www.snh.org.uk/pdfs/publications/commissioned_reports/401.pdf.
- Godfrey, J.D., Stewart, D.C., Middlemas, S.J. & Armstrong, J.D. (2014). Depth use and movements of homing Atlantic salmon (*Salmo salar*) in Scottish coastal waters in relation to marine renewable energy development. Scottish Marine and Freshwater Science Vol 05, No 18.;
- Harding, H., Bruintjes, R., Radford, A. and Simpson, S. (2016). Measurement of Hearing in the Atlantic salmon (*Salmo salar*) using Auditory Evoked Potentials, and effects of Pile Driving Playback on salmon Behaviour and Physiology Scottish Marine and Freshwater Science Report Vol 7 No 11;

- Malcolm, I., Godfrey, J. and Youngson, A.F. (2010). Review of migratory routes and behaviour of Atlantic salmon, sea trout and European eel in Scotland's coastal environment: implications for the development of marine renewables. Scottish Marine and Freshwater Science Report, 1(14). http://www.scotland.gov.uk/Resource/Doc/295194/0111162.pdf;
- Moray West (2016). Environmental Impact Assessment. Scoping Report. Western Development Area. Offshore Wind Farm Infrastructure: Offshore Wind Turbines, Foundations / Substructures and Inter-Array Cables May 2016;
- Moray West (2017a). Moray West Offshore Transmission Infrastructure. Scoping Report. June 2017;
- Moray West (2017b). Moray West Onshore Transmission Infrastructure. Scoping Report. June 2017; and
- Shearer, W.M. (1992). The Atlantic Salmon. Natural History, Exploitation and Future Management. Fishing News Books.

Section 6.2 of the Moray West OfTI Scoping Report (Moray West, 2017a) and Section 5.2 of the Moray West OnTI Scoping Report (Moray West, 2017b) set out the baseline conditions for the migratory fish interests that are present in relation to the Moray West Offshore Wind Farm and the OfTI. Diadromous fish species such as Atlantic salmon (*Salmo salar*) and European eel (*Anguilla anguilla*) may be present in the area, particularly adult salmon migrating to the nearby SACs, or salmon smolts migrating from the SACs into the open sea. The following SACs (Figure 4.2.13) were identified during scoping as potentially being impacted upon by Moray West:

- **Berriedale and Langwell Waters SAC** – Atlantic salmon;
- **River Borgie SAC** – Atlantic salmon and freshwater pearl mussel;
- **River Dee SAC** - Atlantic salmon and freshwater pearl mussel;
- **River Naver SAC** - Atlantic salmon and freshwater pearl mussel;
- **River Thurso SAC** – Atlantic salmon;
- **River Oykel SAC** - Atlantic salmon and freshwater pearl mussel;
- **River Moriston SAC** - Atlantic salmon and freshwater pearl mussel; and
- **River Spey SAC** – Atlantic salmon, sea lamprey (*Petromyzon marinus*) and freshwater pearl mussel.

Freshwater pearl mussels are reliant on salmonids for successful juvenile recruitment and population sustainability so there is connectivity between these species. This needs to be considered in parallel with the test for no LSE on SAC's for Atlantic salmon. The qualifying features of brook lamprey, freshwater pearl mussel and habitats are not considered to have connectivity to Moray West (due to their wholly freshwater lifecycles as well as there being no SACs within the Scoping Study Area of the OnTI). Otter associated with SACs are also not considered to have connectivity, due to no SACs being located within the Scoping Study Area. These species are scoped out of any future HRA on this basis.

Site Specific Studies

Site-specific surveys have been completed for the Moray East Site for benthic ecology, fish and shell fish in order to characterize the general fish populations that are present within the Moray East Site. No specific surveys were completed however for migratory fish species and during these surveys no sea lamprey or Atlantic salmon were caught. Specific surveys have been undertaken for sandeels and cod.

BOWL has also undertaken site-specific surveys at the Beatrice Offshore Wind Farm, including benthic surveys and several pre-construction surveys. Benthic surveys at this site have included beam trawling, drop down video (DDV) and grab sampling. Species specific surveying has included sandeels, cod and herring larvae studies.

Scientists from Marine Scotland are working with the Beatrice Offshore Windfarm Ltd, in association with Glasgow University and local migratory fish interests, to monitor Atlantic Salmon smolt (Salmo salar) and seatrout smolt (Salmo trutta) as they migrate from the Cromarty Firth to their feeding grounds (https://blogs.gov.scot/marine-scotland/2016/07/15/tracking-atlantic-salmon-and-seatrout-smolts/). As part of a programme, the fish are being tagged in rivers feeding the Cromarty Firth and Marine Scotland has installed 40 acoustic receivers on a line from Burghead to Tarbat Ness to pick up signals from the tagged fish as they swim past. Additional receivers in the Cromarty Firth will separately monitor smolt movement and survival in the Firth. The aim of the survey is to determine whether or not the smolts natural migration route indicates that it may bring them into contact with any of the Renewable projects in the Moray Firth.

No other specific surveys have been completed for Atlantic salmon or sea lamprey.

Species Accounts

The only species of migratory fish that are listed as qualifying features for SACs are Atlantic salmon, Twaite shad (*Alosa fallax*), Allis shad (*Alosa alosa*), river lamprey, brook lamprey and sea lamprey. As mentioned in Section 4.2.2, brook lamprey are not connected to the Moray West Site due to their wholly freshwater lifecycle. River lamprey are not associated with any of the SACs that have been defined in Section 4.2.2 and Table 4.2.5 as having connectivity to the Moray West Site, so this species is screened out from any further HRA process. For the same reason, Twaite shad and Allis shad are also screened out, with MSS confirming in their scoping response that there are few records of these species in the Moray Firth. Species that are potentially present within the Moray West Site that may be connected to SAC populations are therefore identified as Atlantic salmon and sea lamprey.

Atlantic Salmon

The life history of Atlantic salmon is well documented. Adult salmon migrate from the sea to their home rivers to spawn. The main feeding grounds for Scottish salmon stock is within the waters around Greenland. Adult salmon have already spent anywhere between one year (grilse) and up to five years (multi-sea-winter (MSW)) when they return to spawn. The individual salmon ascent the rivers, where they pair up and spawn. Eggs are usually laid within a nest (redd) which is created in areas of gravel and cobble substrate within stretches of fast flowing, well oxygenated water. When temperature and other environmental factors are suitable, alevins hatch from the eggs and live within the interstices of the gravel and cobble. From here, they grow to become fry, emerging from the gravels to feed within the water column. The fry then develop into parr where they then spend between one year and four years within the river system. The parr eventually become smolts as they metamorphose to allow migration to the saltwater of the sea. At a certain time of the year when conditions are suitable, these smolts leave the river system, migrating downstream and out into the estuaries and coastal waters. They then make their way to their feeding grounds near Greenland.

Atlantic salmon are only found within rivers that do not contain impassable barriers. The species is known for its leaping capabilities that allow adults to surpass certain obstructions such as waterfalls. Some adult salmon are capable of returning to sea once they have spawned and live to return to spawn another time. Others die within the river system after spawning.

Within Scotland, most rivers with access to the sea and no insurmountable barriers support populations of Atlantic salmon. There are specific, key seasonal periods associated with the lifecycle of Atlantic salmon. Adult salmon migrate to rivers from the sea all year round but often have a main run period between October and February. Individuals can spawn between mid-October and late February (Shearer, 1992). Eggs usually hatch during June and July, while smolts often migrate to sea during April, May or June (usually with the main smolt run taking place within a short time period of weeks).

For the SACs identified in Section 4.2.2, the information presented in Table A2.9 is applicable.

Table A2.9 SAC Specific Information for Atlantic Salmon

SAC	Condition Status (Assessment Date) / Specific Information on Atlantic Salmon Population*
Berriedale and Langwell Waters	Favourable Maintained (July 2011)
	Small but high quality population. The rivers have two separate catchments, but share a short length of river just before they meet the sea. Whilst they are comparatively small rivers and support only a small proportion of the Scottish salmon resource, their long history of low management intervention means that they score highly for naturalness. Recent records indicate that the full range of Atlantic salmon life-history types return to the river, with grilse, spring and summer salmon all being caught.
River Borgie	Favourable Recovered (October 2011)
	Qualifying feature, but not a primary reason for site selection.
River Dee	Favourable Maintained (July 2011)
	Supports a high quality population. The high proportion of the river accessible to salmon has resulted in it supporting the full range of life-history types found in Scotland, with sub-populations of spring, summer salmon and grilse all being present. The headwaters which drain the southern Cairngorm and northern Grampian mountains are particularly important for multi sea-winter spring salmon, but there has been a significant decline in their abundance in recent years. The extensive areas accessible to salmon means the River Dee supports a significant proportion of the Scottish salmon resource. In recent years it has contributed about 4 or 5% of all salmon caught in Scotland.
River Naver	Favourable Recovered (August 2011)
	Supports a high quality population. Northerly extent of the species' range. The northern location of the River Naver and the cooler ambient water temperature results in the Atlantic salmon producing a higher proportion of slower-growing parr which smolt at an older age. These fish often return as multi sea-winter salmon (which have spent more than one year at sea). The full range of Atlantic salmon life-history types return to the system, with grilse, spring and summer salmon all being present. The site also scores highly for being relatively free from flow modifications, allowing unhindered migration.
River Thurso	Unfavourable Recovering (October 2011)
	The river supports a higher proportion of multi sea-winter salmon Salmo salar than is found in many rivers further south in the species' range. This is aided by the northerly location of the river and the cooler ambient water temperature, resulting in slower-growing juveniles which smolt at an older age, and tend to return as older multi sea-

	winter salmon. In addition to these multi sea-winter fish, grilse also return to the River Thurso, meaning that the river supports the full range of salmon life-history types.
River Oykel	Favourable Recovered (July 2011)
	Qualifying feature, but not a primary reason for site selection.
River Moriston	Unfavourable No Change (July 2011)
	Qualifying feature, but not a primary reason for site selection.
River Spey	Unfavourable Recovering (September 2011)
	Supports one of the largest Scottish populations. Adults spawn throughout virtually the whole length of the river, and good quality nursery habitat is found in abundance in the main river and numerous tributaries. The salmon population includes fish of all ages including migrating smolts and returning adults, possibly reflecting genetic differences within the Spey stock.

✪ Extracted information from JNCC website (accessed June 2017).
http://jncc.defra.gov.uk/ProtectedSites/SACselection/species.asp?FeatureIntCode=S1106

Smolt migration routes towards their feeding grounds at Greenland are thought to follow a migration route northwards off the western coast of Scotland along the continental shelf edge and out to the Norwegian Sea, apparently making use of the dominant ocean currents. Post-smolts from the east coast of Scotland are thought to migrate in near-shore waters but this movement is poorly understood. As part of the MASTS programme a salmon smolt tracking program using acoustic tags has been proposed for the Berriedale Water (Youngson *et al.*, 2015), but no further information is currently available.

National level research undertaken recently (Malcolm, *et al.*, 2015) reports that smolt emigration within the sea takes place within the coastal waters and a 'sensitive window' for development can be identified for Scotland between days 103 - 145, where large numbers of migrating salmon smolts could be expected in the coastal zone. There is however, no information on the amount of time that smolts will spend in the coastal zone.

The National Research and Monitoring Strategy for Diadromous Fish (NRMSD) has been set up by Marine Scotland to identify, assist with prioritising and gathering data to fill current gaps in knowledge regarding salmon migration movements and behaviour. Moray East are already committed to input to this programme if the consented Moray East Site is progressed.

Sea lamprey

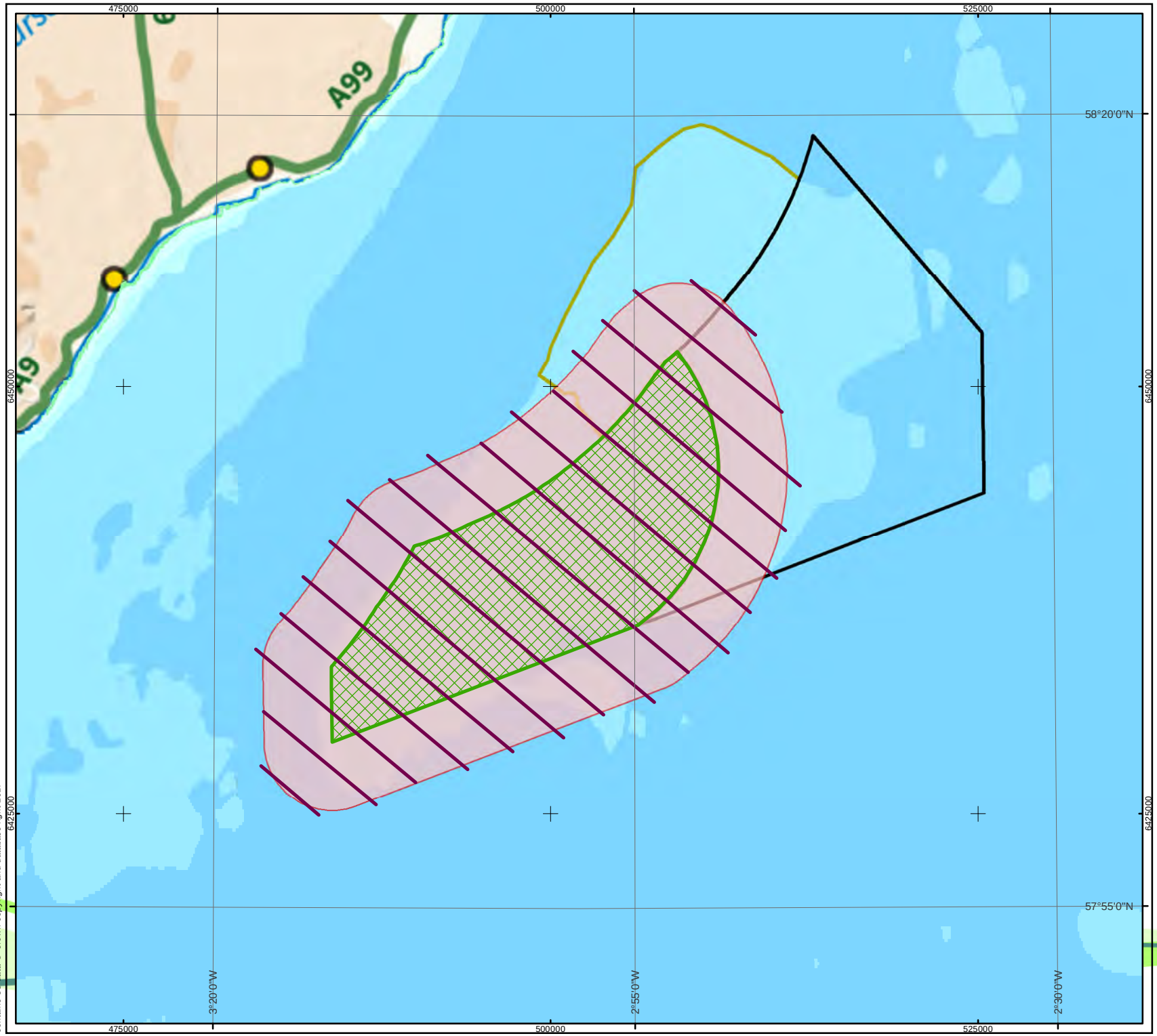
There are no records of sea lamprey being recorded within the Moray West Site during site-specific surveys or from a desk based study, however there is potential for this species to pass through or be present within the Moray West Site.

Adult sea lamprey are the largest of the three lamprey species found within the UK and are generally found within inshore and estuarine waters although they can travel considerable distances out to sea (Igoe *et al.*, 2004). Sea lamprey are bottom living and after spending one or two years within the sea, the adults migrate upstream into river systems (during the night) where they spawn within nests (created by the male) that are located in reaches of faster flowing, good quality water. Migration upstream usually occurs between March and June (but can start as early as September), with spawning taking place in May and June. The adult sea lamprey die once spawning has taken place. Once eggs hatch and the ammocoete emerge, the young inhabit area of river bed comprised of sandy / silty / muddy substrate where they filter feed on microorganisms. After a period of between four to five years of freshwater life, the ammocoetes metamorphose and migrate downstream to the sea. This migration downstream to sea usually occurs in

late autumn or early winter. Within the sea, the species becomes a hematophagous feeder (feeds off blood). Sea lampreys generally feed on other fish species, often becoming parasitic.

Sea lamprey are considered to be at the northern limit of their range within the Moray Firth. There is little information available on the migration movements within and the use of the Moray Firth by sea lamprey and it is considered that construction noise and electromagnetic fields (EMF) from installed inter-array and export cables may potentially have a LSE on the SAC population.

Research indicates that sea lamprey respond to sound at frequencies of between 20 Hz and 100 Hz (Lenhardt & Sismour 1995) they do not possess a swim bladder and are less sensitive to sound than fish that do possess a swim bladder (Maes et al. 2004).



MORAY WEST
OFFSHORE WINDFARM

KEY

- Moray West Aerial Surveys 2016-17
- Aerial Survey Transects
- Moray West Site

Offshore wind farms

- Beatrice
- Moray East

Bathymetry (metres)

- >10000
- <=10000
- <=5000
- <=1000
- <=500
- <=100
- <=50
- <=20
- <=10
- >=0

Horizontal Scale: 1:300,000
0 4,000 8,000 Meters
A4 Chart
N

Geodetic Parameters: WGS84 UTM Zone 30N

Produced: HAZ
Reviewed: SM
Approved: RC

Date: 04/09/2017 | Revision: A

REF: 8460005-PPW0160-GOE-MAP-015

Figure A2.1
Moray West Aerial Surveys

Moray Offshore
Windfarm (West) Ltd

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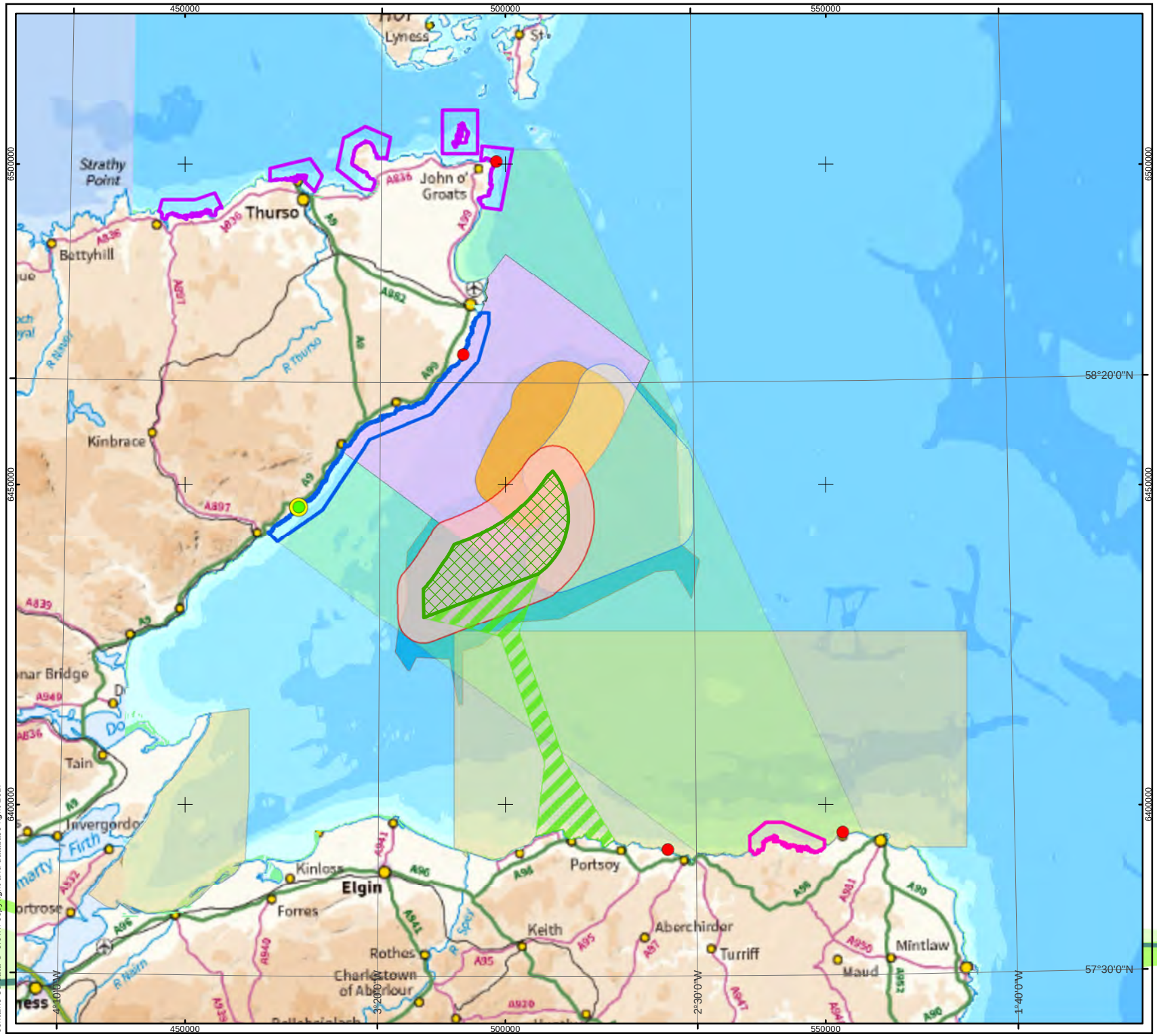

MORAY WEST
OFFSHORE WINDFARM

KEY

- Moray West Site
- Moray West Offshore Export Cable Corridor
- Moray West Aerial Surveys 2016-17
- Autumn 2010 and Spring 2011 Migration Surveys
- 2011 Tagging Surveys (Fulmar, Kittiwake, Guillemot and Razorbill)
- 2014 Great Black-backed Gull and Herring Gull Tagging

Special Protection Area

- North Caithness Cliffs SPA
- East Caithness Cliffs SPA
- Troup, Pennan and Lion's Head SPA

Ornithological Surveys

- MORL Boat-based Surveys 2010-12 (4 km Boundary)
- BOWL Boat-based Surveys 2009-11
- BOWL Pre-construction Aerial Survey 2015
- Moray East 2011 Aerial Surveys
- Marine Scotland Strategic Seabird Surveys 2014-15
- TCE 2009 Aerial Surveys (HiDef)

Bathymetry (metres)

- <=500
- <=100
- <=50
- <=20
- <=10
- >=0

Horizontal Scale: 1:800,000 (0 – 10,000 – 20,000 Meters)

A4 Chart

N

Geodetic Parameters: WGS84 UTM Zone 30N

Produced: HAZ
Reviewed: SM
Approved: RC

Date: 04/09/2017 | Revision: C

REF: 8460005-PPW0160-GOE-MAP-016

Figure A2.2
Existing Datasets

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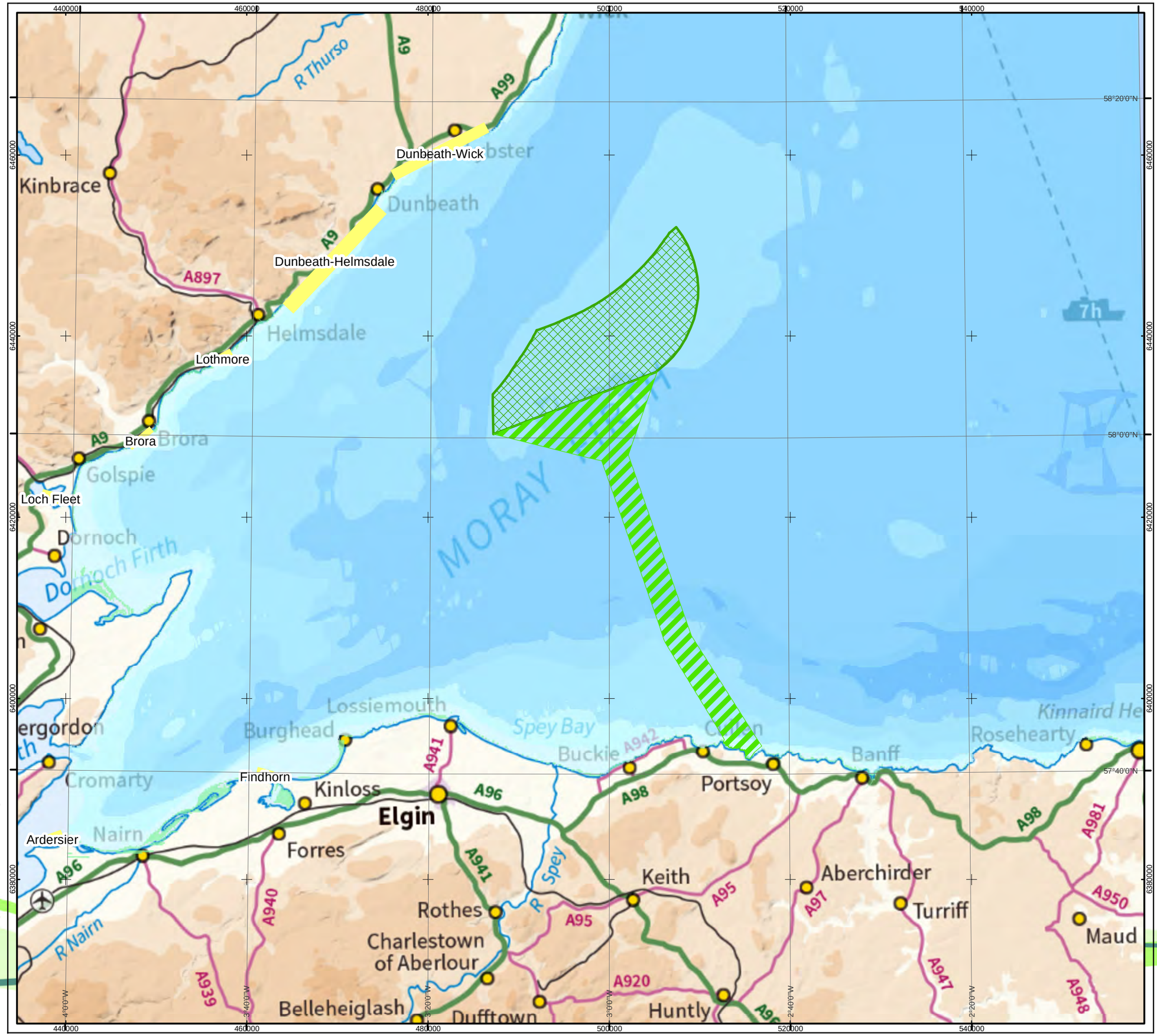

KEY

- Moray West Site
- Offshore Export Cable Corridor
- Harbour Seal Haul Outs

Bathymetry (Metres)

- <=500
- <=100
- <=50
- <=20
- <=10
- >=0

Horizontal Scale: 1:400,000 — A3 Chart — N

0 5,000 10,000 Meters

Geodetic Parameters: WGS84 UTM Zone 30N

Produced: RC
Reviewed: GB
Approved: FG

Date: 04/09/2017 | Revision: C

REF: 8460005-PPW0160-GOE-MAP-017

Figure A2.3: Harbour Seal Haul Out Sites

Moray Offshore Windfarm (West) Ltd

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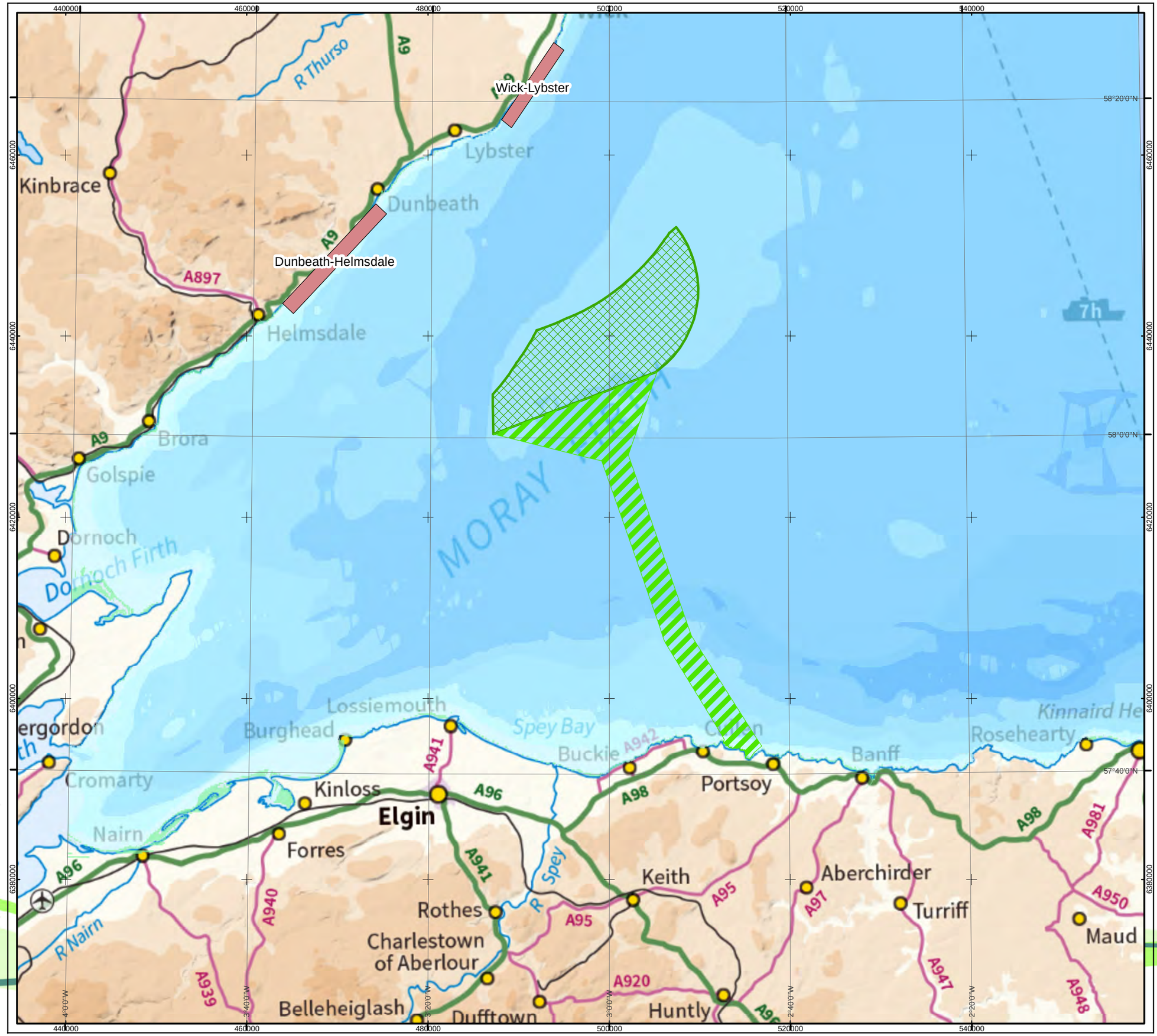

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KEY

- Moray West Site
- Offshore Export Cable Corridor
- Grey Seal Pupping Sites

Bathymetry (Metres)

- <=500
- <=100
- <=50
- <=20
- <=10
- >=0

Horizontal Scale: 1:400,000 — A3 Chart — N

0 5,000 10,000 Meters

Geodetic Parameters: WGS84 UTM Zone 30N

Produced: RC
Reviewed: GB
Approved: FG

Date: 04/09/2017 | Revision: C

REF: 8460005-PPW0160-GOE-MAP-018

Figure A2.4: Grey Seal Pupping Sites.

Moray Offshore Windfarm (West) Ltd

MORAY WEST
OFFSHORE WINDFARM

Contact

Moray Offshore Windfarm (West) Limited
4th Floor, 40 Princes Street
Edinburgh EH2 2BY
Tel: 0131 556 7602

MORAY WEST
OFFSHORE WINDFARM

HRA Screening Opinion

Moray Offshore Windfarm (West) Limited

Appendix 4.2a

marinescotland
MS.MarineRenewables@gov.scot

Scottish Government
Riaghaltas na h-Alba
gov.scot

Gayle Boyle
Moray Offshore Windfarm (West) Limited
4th Floor
40 Princes Street
Edinburgh
EH2 2BY

Date: 19th October 2017

Dear Ms Boyle

THE CONSERVATION (NATURAL HABITATS, &C.) REGULATIONS 1994
THE OFFSHORE MARINE CONSERVATION (NATURAL HABITATS, &C.) REGULATIONS 2007

OFFSHORE HABITATS REGULATIONS APPRAISAL SCREENING OPINION ON THE MORAY WEST OFFSHORE WIND FARM, TO BE LOCATED IN THE OUTER MORAY FIRTH APPROXIMATELY 22 KM SOUTH OF THE CAITHNESS COASTLINE.

Thank you for your email dated 8th September 2017 requesting a screening opinion on the Habitats Regulations Appraisal ("HRA") for proposed installation of the Moray West Offshore Wind Farm ("Moray West"), to be located in the Moray Firth, approximately 22 km south of the Caithness coastline. It will be comprised of an offshore array of Wind Turbines Generators ("WTGs"), connected to one another by subsea inter-array cables, which will in turn connect the WTGs to the Offshore Transmission Infrastructure ("OfTI"). The site has connectivity with multiple European and Ramsar sites as addressed in table 4.4.1 of the Moray West Offshore Habitats Regulations Appraisal document received with the screening opinion request.

The OfTI will be comprised of one or two Offshore Substation Platform(s) ("OSP"(s)) (joined by an interconnector cable if two are required) and up to two offshore export cable circuits that carry the power to an onshore landfall location joined to the Onshore Transmission Infrastructure ("OnTI"). Each OfTI circuit is likely to be comprised of three core cables in a trefoil arrangement with a typical voltage of 132 to 400 kilovolts (kV) and may also include a fibre optic communication link either embedded within the cables or as separate, smaller cables running alongside in the same trench.

Consultation
The Scottish Ministers have, consulted with Scottish Natural Heritage ("SNH"), the Royal Society for the Protection of Birds ("RSPB") and the Whale and Dolphin Conservation society ("WDC"). All have responded to the consultation and their advice is included at Appendix 1.

In summary, SNH are unable to provide advice on which Special Protection Areas ("SPAs")/ qualifying interests are required to be taken to the next stage of HRA as baseline characterisation and modelling discussions are currently on-going with a further report due the week of 23rd October 2017. SNH as an interim refer you to the final short list of species identified in the Moray East appropriate assessment (see caveat to this in their advice). With regards to Special Areas of Conservation ("SACs") SNH has advised that the Dornoch Firth and Morrich More SAC - harbour

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seals, and Moray Firth SAC - bottlenose dolphins and subtidal sandbanks. should be screened in. SNH advise that there is no requirement to consider diadromous fish as part of the HRA, impacts should be considered in the EIA report.

RSPB highlighted their concern with the lack of a full two years of site specific survey data.

WDC agreed with the potential impacts that have been 'scoped in' for Likely Significant Effect (LSE) in Table 5.3.1 of the document.

In-combination assessment
Scottish Ministers advise that for bottlenose dolphin the following projects should be considered in a quantitative way:

- Beatrice
- Moray East
- Neart na Gaoithe
- Inch Cape
- Seagreen

For the Forth and Tay sites the worst case of the 2014 consents or the 2017 proposals should be considered in the in-combination assessment. It will be appropriate include other projects qualitatively.

SNH have advised separately that sequential piling represents the worst case, so that it is not necessary to model concurrent piling at the different sites or within the Moray West site.

Conclusions
The Scottish Ministers have considered whether the proposed works would have a likely significant effect on the surrounding SACs. Based on the advice outlined above, the Scottish Ministers are of the opinion that the following sites/qualifying interests should be taken forward to the next stage of HRA and information must be provided to inform the appropriate assessment which Scottish Ministers will be required to undertake:

- **Dornoch Firth and Morrich More SAC – harbour seals**
- **Moray Firth SAC, - bottlenose dolphin, subtidal sandbanks**

Scottish Ministers agree with the SNH advice that diadromous fish do not need to be considered through the HRA process. Once further advice has been received from SNH on the ornithological interests, confirmation will be provide on which SPAs/qualifying interests will be required to be taken forward to the next stage of HRA.

Yours sincerely,

Gayle Holland
Marine Scotland Licensing Operations Team

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Appendix 1

Consultee response to the request for a HRA Screening Opinion

Stakeholders Comment

SNH Advice

MORAY WEST OFFSHORE WIND FARM
SNH ADVICE ON HABITATS REGULATIONS APPRAISAL SCREENING REPORT FOR THE MORAY WEST OFFSHORE WIND FARM PROPOSAL

Thank you for your consultation of the 14 September 2017 requesting our advice on the Habitats Regulations Appraisal (HRA) screening report for the Moray West offshore wind farm (OSWF) development proposal.

Introduction
We have now had chance to review the HRA screening document and we have the following comments to make:

- The layout and content of the report make it difficult to follow and to understand the conclusions reached by the developer as to which species / sites are being taken forward to the next stage.
- We disagree with some of the conclusions reached and provide further advice below.
- We are unable at this point to provide final advice in respect of ornithological interests; this is due to ongoing discussions about the baseline characterisation and modelling. We are aware of a further request for a meeting and a further report is due the week of the 23rd October which may help inform which SPAs / features need to be taken to the next stage of HRA.
- As an interim measure we would refer you to the final short list of species taken forward in the appropriate assessment for the Moray East proposal. Please note this is with the caveat that we wish to understand more of the baseline characterisation before we can confirm if any additional species / sites require to be considered or if any sites / features from this list do not require to be considered further.

SNH advice
We provide advice below in respect of those species / sites for which we can conclude at this stage if they require further consideration as part of the HRA for the proposed Moray West application. At this stage we are unable to provide any advice on which ornithological European sites / features should be screened into the HRA. We cannot make an informed judgement on this without an agreed baseline of species recorded on the development site. This requires further information from the developer as was discussed at the meeting held on 24 August 2017.

Notwithstanding our comments above, please find below comments in respect of the other receptors which have been considered:

1. Diadromous Fish

Please note that SNH advises that with regard to this proposal that there is no requirement to consider diadromous fish as part of the HRA. We do however advise that impacts to diadromous fish should be considered within the EIA report. In our view, we do not feel that it is possible to undertake site-specific HRA for migratory Atlantic salmon or other migratory fish because we cannot apportion impacts correctly to individual SACs. This is due to the current lack of information on SAC diadromous fish populations upon which to inform decisions on site integrity. As our knowledge improves and assessment methods develop this position may change. Potential

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impacts to migratory fish and therefore as a consequence freshwater pearl mussel (FWPM) should, in our view therefore be considered under EIA rather than HRA.

We would anticipate that assessment under EIA would also include the export cable and landfall with any potential effects addressed through appropriate mitigation as part of a construction method statement.

2. Marine Mammals

- Harbour Porpoise

We agree with the decision not to consider harbour porpoise further within the HRA with there being no likely significant effect with any of the candidate SACs. We do not however agree with the reasons. When considering harbour porpoise we advise that it does not need to be considered further, our reason for this advice is as follows:

I. The development does not lie within a cSAC
II. The appropriate management unit for harbour porpoise to consider is the North Sea.
III. This development does not have any direct or indirect impact overlapping with the Southern North Sea cSAC.

We also advise that consideration of harbour porpoise should still be included within the EIA Report as well as with the provision of information for any European Protected Species (EPS) licencing requirement.

- Grey Seal

We advise that there is no connectivity to grey seal SACs and this species therefore needs no further consideration within HRA. We would only consider grey seal SACs where there was an impact pathway from a proposal within 20km of a breeding colony.

- Dornoch Firth and Morrich More SAC - Harbour seal

We agree that the there is a likely significant effect for harbour seal and this site should be included within the HRA for harbour seal.

- Moray Frith - Bottlenose Dolphins

As identified, the Moray Firth SAC and bottlenose dolphin feature should be considered with the HRA. As part of the HRA, consideration will need to be given to in combination effects with the Forth and Tay offshore wind proposals. Recent advice provided by SNH in respect of the Forth and Tay proposals and the methods for considering underwater noise impacts are pertinent and we advise that the Forth and Tay discussions should also be held with Moray West.

3. Coastal Habitats

- Moray Firth SAC - Subtidal Sandbanks

The report correctly identifies the physical processes modelling and assessment work as the key tool in understanding any likely impact that the proposal may have on the physical processes within the wider Moray Firth, including any hydrodynamic changes that may affect the subtidal sandbank feature of the Moray Firth SAC. Given the potential connectivity, and pending the modelling assessment, we are unable to rule out a Likely Significant Effect (LSE).

We therefore do not agree that this impact should be addressed under EIA, rather the Moray Firth SAC subtidal sandbank feature should at this point in time, be screened in. We are content that the Dornoch Firth & Morrich More SAC and the Culbin Bar SAC are sufficiently far away for there

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not to be any discernable connectivity in terms of physical processes and so both of these sites can be screened out.

We hope these comments are helpful. Please note I have been temporarily promoted in SNH for the next six months and will not be working on marine renewables during this period. If further information or advice is required please contact the Marine Energy mailbox in the first instance: MARINEENERGY@snh.gov.uk

RSPB Advice

Thank you for inviting comments on the HRA screening report for the proposed Moray West project.

We have no comment on the approach to screening, however we do wish to highlight the potential risks and our concern with the lack of a full two years site specific survey to support the environmental assessment. The alternative proposal to analyse existing historic and contextual survey data is welcomed, although the requirement for 2 full years' worth of site specific data is a long established UK minimum standard for site characterisation of offshore wind projects.

The Moray West proposal may have significant effects on SPAs within the region both in isolation and in-combination, therefore any conclusions of the effects on site integrity need to be based on adequate and robust environmental data. It is imperative that the site characterisation and environmental baseline is supported by site specific survey data that is equivalent to 2 full years of site survey effort. We would recommend this 'equivalence' is demonstrated and accepted prior to the application and future determination.

WDC Advice

WDC comments on the Moray West Offshore Habitats Regulations Appraisal Screening Report.

Thank you for the opportunity to provide comments on the Moray West Offshore Habitats Regulations Appraisal (HRA) Screening Report. Given our area of interest, we have only focused on the marine mammal sections.

We understand that the Moray West Offshore Wind Farm will be located approximately 22 kilometres from the Scottish coast on the Smith Bank in the Outer Moray Firth. The Offshore Transmission Infrastructure will be located within the Outer Moray Firth and comprise of one or two offshore substation platforms. The export cables will make landfall on the Moray/Aberdeenshire coast. The Onshore Transmission Infrastructure will comprise onshore transition bays near the landfall where the offshore and onshore circuits join together. The location of the onshore work has yet to be determined and will be covered in the onshore Environmental Impact Assessment and onshore HRA. The development is anticipated to consist of up to 90 wind turbines with a potential generation capacity of up to 850 MW.

WDC are endeavouring to assist with the environmentally sustainable development of marine renewable energy in Scotland. Whilst welcoming the Scottish Governments' commitment to renewable energy generation, particularly noting the potential consequences of climate change for cetaceans, we have concerns about current levels of uncertainty and the possible negative impacts these developments, both individually and cumulatively, may have on cetaceans (whales, dolphins and porpoises) and seals in Scottish waters.

In summary

Overall, we are happy with the HRA screening document and agree with the potential impacts that have been 'scoped in' for Likely Significant Effect (LSE) in Table 5.3.1.

Harbour porpoise

We understand that there are no harbour porpoise SACs in the Moray Firth and that connectivity between the Moray Firth and the candidate SACs is low. However, considering the number of harbour porpoises observed in the development area during the surveys, we would like to see the potential impacts on harbour porpoises given more consideration. Harbour porpoise are very sensitive to noise from pile driving and if pile driving is conducted during development of Moray West there is the potential for an impact on the population.

Harbour seals

In recent years, connectivity between harbour seals in the Moray Firth and Orkney has been shown from tagged data. Due to the significantly declining population in Orkney, harbour seals in the Moray Firth should be given the same level of protection from disturbance and displacement as harbour seals in Orkney.

We hope you find these comments useful and would be happy to discuss any of these comments further.

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MORAY WEST
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HRA Screening Consultation Responses

Moray Offshore Windfarm (West) Limited

Appendix 4.2b

WDC Scottish Dolphin Centre, Spey Bay, Moray, IV32 7PJ
T +44 [redacted] F +44 (0)1343 829 065 E Fiona.read@whales.org W whales.org
WDC is a company limited by guarantee. Registered in England No. 2737421. Registered Scottish Charity No. SC040231.

Jessica Drew
Marine Scotland – Licensing Operations Team
Scottish Government
Marine Laboratory
PO Box 101
375 Victoria Road
Aberdeen, AB11 9DB

ms.marinelicensing@scotland.gsi.gov.uk

12th October 2017

Dear Jessica Drew,

WDC comments on the Moray West Offshore Habitats Regulations Appraisal Screening Report

Thank you for the opportunity to provide comments on the Moray West Offshore Habitats Regulations Appraisal (HRA) Screening Report. Given our area of interest, we have only focused on the marine mammal sections.

We understand that the Moray West Offshore Wind Farm will be located approximately 22 kilometres from the Scottish coast on the Smith Bank in the Outer Moray Firth. The Offshore Transmission Infrastructure will be located within the Outer Moray Firth and comprise of one or two offshore substation platforms. The export cables will make landfall on the Moray/Aberdeenshire coast. The Onshore Transmission Infrastructure will comprise onshore transition bays near the landfall where the offshore and onshore circuits join together. The location of the onshore work has yet to be determined and will be covered in the onshore Environmental Impact Assessment and onshore HRA. The development is anticipated to consist of up to 90 wind turbines with a potential generation capacity of up to 850 MW.

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In summary

Overall, we are happy with the HRA screening document and agree with the potential impacts that have been 'scoped in' for Likely Significant Effect (LSE) in Table 5.3.1.

Harbour porpoise

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WDC Scottish Dolphin Centre, Spey Bay, Moray, IV32 7PJ
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number of harbour porpoises observed in the development area during the surveys, we would like to see the potential impacts on harbour porpoises given more consideration. Harbour porpoise are very sensitive to noise from pile driving and if pile driving is conducted during development of Moray West there is the potential for an impact on the population.

Harbour seals

In recent years, connectivity between harbour seals in the Moray Firth and Orkney has been shown from tagged data. Due to the significantly declining population in Orkney, harbour seals in the Moray Firth should be given the same level of protection from disturbance and displacement as harbour seals in Orkney.

We hope you find these comments useful and would be happy to discuss any of these comments further.

Yours Sincerely,

[redacted]

F

Policy Officer

Scottish Natural Heritage
Dualchas Nàdair na h-Alba
All of nature for all of Scotland
Nàdar air fad airson Alba air fad

Marine Scotland
Marine Laboratory
PO Box 101
375 Victoria Road
Aberdeen
AB11 9DB

For the attention of: Jessica Drew

By email only:

MS.MarineRenewables@gov.scot
jessica.drew@gov.scot

Your ref: Moray West Offshore Wind Farm - Offshore Habitats Regulations Appraisal (HRA) Screening Report

Our ref: CNS/REN/OSWF/Moray West/CPA147544

Date: 12 October 2017

Dear Sirs,

MORAY WEST OFFSHORE WIND FARM

SNH ADVICE ON HABITATS REGULATIONS APPRAISAL SCREENING REPORT FOR THE MORAY WEST OFFSHORE WIND FARM PROPOSAL

Thank you for your consultation of the 14 September 2017 requesting our advice on the Habitats Regulations Appraisal (HRA) screening report for the Moray West offshore wind farm (OSWF) development proposal.

Introduction
We have now had chance to review the HRA screening document and we have the following comments to make:

- The layout and content of the report make it difficult to follow and to understand the conclusions reached by the developer as to which species / sites are being taken forward to the next stage.
- We disagree with some of the conclusions reached and provide further advice below.
- We are unable at this point to provide final advice in respect of ornithological interests; this is due to ongoing discussions about the baseline characterisation and modelling. We are aware of a further request for a meeting and a further report is due the week of the 23rd October which may help inform which SPAs / features need to be taken to the next stage of HRA.
- As an interim measure we would refer you to the final short list of species taken forward in the appropriate assessment for the Moray East proposal. Please note this is with the caveat that we wish to understand more of the baseline characterisation before we can confirm if any additional species / sites require to be considered or if any sites / features from this list do not require to be considered further.

SNH advice
We provide advice below in respect of those species / sites for which we can conclude at this stage if they require further consideration as part of the HRA for the proposed Moray West application. At this stage we are unable to provide any advice on which ornithological

European sites / features should be screened into the HRA. We cannot make an informed judgement on this without an agreed baseline of species recorded on the development site. This requires further information from the developer as was discussed at the meeting held on 24 August 2017.

Notwithstanding our comments above, please find below comments in respect of the other receptors which have been considered:

1. Diadromous Fish

Please note that SNH advises that with regard to this proposal that there is no requirement to consider diadromous fish as part of the HRA. We do however advise that impacts to diadromous fish should be considered within the EIA report. In our view, we do not feel that it is possible to undertake site-specific HRA for migratory Atlantic salmon or other migratory fish because we cannot apportion impacts correctly to individual SACs. This is due to the current lack of information on SAC diadromous fish populations upon which to inform decisions on site integrity. As our knowledge improves and assessment methods develop this position may change. Potential impacts to migratory fish and therefore as a consequence freshwater pearl mussel (FWPM) should, in our view therefore be considered under EIA rather than HRA.

We would anticipate that assessment under EIA would also include the export cable and landfall with any potential effects addressed through appropriate mitigation as part of a construction method statement.

2. Marine Mammals

- Harbour Porpoise

We agree with the decision not to consider harbour porpoise further within the HRA with there being no likely significant effect with any of the candidate SACs. We do not however agree with the reasons. When considering harbour porpoise we advise that it does not need to be considered further, our reason for this advice is as follows:

I. The development does not lie within a cSAC
II. The appropriate management unit for harbour porpoise to consider is the North Sea.
III. This development does not have any direct or indirect impact overlapping with the Southern North Sea cSAC.

We also advise that consideration of harbour porpoise should still be included within the EIA Report as well as with the provision of information for any European Protected Species (EPS) licencing requirement.

- Grey Seal

We advise that there is no connectivity to grey seal SACs and this species therefore needs no further consideration within HRA. We would only consider grey seal SACs where there was an impact pathway from a proposal within 20km of a breeding colony.

- Dornoch Firth and Morrich More SAC - Harbour seal

We agree that the there is a likely significant effect for harbour seal and this site should be included within the HRA for harbour seal.

- Moray Frith - Bottlenose Dolphins

As identified, the Moray Firth SAC and bottlenose dolphin feature should be considered with the HRA. As part of the HRA, consideration will need to be given to in combination

effects with the Forth and Tay offshore wind proposals. Recent advice provided by SNH in respect of the Forth and Tay proposals and the methods for considering underwater noise impacts are pertinent and we advise that the Forth and Tay discussions should also be held with Moray West.

3. Coastal Habitats

- Moray Firth SAC - Subtidal Sandbanks

The report correctly identifies the physical processes modelling and assessment work as the key tool in understanding any likely impact that the proposal may have on the physical processes within the wider Moray Firth, including any hydrodynamic changes that may affect the subtidal sandbank feature of the Moray Firth SAC. Given the potential connectivity, and pending the modelling assessment, we are unable to rule out a Likely Significant Effect (LSE).

We therefore do not agree that this impact should be addressed under EIA, rather the Moray Firth SAC subtidal sandbank feature should at this point in time, be screened in. We are content that the Dornoch Firth & Morrich More SAC and the Culbin Bar SAC are sufficiently far away for there not to be any discernable connectivity in terms of physical processes and so both of these sites can be screened out.

We hope these comments are helpful. Please note I have been temporarily promoted in SNH for the next six months and will not be working on marine renewables during this period. If further information or advice is required please contact the Marine Energy mailbox in the first instance: MARINEENERGY@snh.gov.uk

Yours faithfully,

KAREN TAYLOR
Marine Renewable Energy Casework Adviser

CC Sarah MacNab - GoBe consultants for Moray West

Roberts R (Rhianna)

From: Drew J (Jessica)
Sent: 13 October 2017 07:38
To: 'Nathan, Charles'
Cc: 'McCluskie, Aly'; 'Erica Knott'; 'Catriona Gall'
Subject: RE: Moray West Offshore Wind Farm - Offshore Habitats Regulations Appraisal (HRA) Screening Report

Good morning Charles,

Many thanks for forwarding your response to my request.

Kind regards,

Jessica

From: Nathan, Charles [mailto:Charles.Nathan@rspb.org.uk]
Sent: 12 October 2017 17:31
To: Drew J (Jessica)
Cc: McCluskie, Aly; Erica Knott; Catriona Gall
Subject: FW: Moray West Offshore Wind Farm - Offshore Habitats Regulations Appraisal (HRA) Screening Report

Dear Ms Drew,

Thank you for inviting comments on the HRA screening report for the proposed Moray West project.

We have no comment on the approach to screening, however we do wish to highlight the potential risks and our concern with the lack of a full two years site specific survey to support the environmental assessment. The alternative proposal to analyse existing historic and contextual survey data is welcomed, although the requirement for 2 full years' worth of site specific data is a long established UK minimum standard for site characterisation of offshore wind projects.

The Moray West proposal may have significant effects on SPAs within the region both in isolation and in-combination, therefore any conclusions of the effects on site integrity need to be based on adequate and robust environmental data. It is imperative that the site characterisation and environmental baseline is supported by site specific survey data that is equivalent to 2 full years of site survey effort. We would recommend this 'equivalence' is demonstrated and accepted prior to the application and future determination.

Best regards,
Charles

Charles Nathan MRTPI
Senior Conservation Planner

(Please note my working week: Tue - Fri)

Scotland Headquarters 2 Lochside View, Edinburgh Park, Edinburgh, EH12 9DH
Tel 0131 317 4196
Mobile [redacted]

rspb.org.uk

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RSPB Scotland is part of the RSPB, the UK's largest nature conservation charity, inspiring everyone to give nature a home. Together with our partners, we protect threatened birds and wildlife so our towns, coast and countryside will teem with life once again. We play a leading role in BirdLife International, a worldwide partnership of nature conservation organisations.

The Royal Society for the Protection of Birds (RSPB) is a registered charity: England and Wales no. 207076, Scotland no. SC037654

From: Jessica.Drew@gov.scot [mailto:Jessica.Drew@gov.scot]
Sent: 14 September 2017 15:35
To: MARINEENERGY@snh.gov.uk; sarah.dolman@whales.org; fiona.read@whales.org; planning, scotland <scotland.planning@rspb.org.uk>
Cc: Erica.Knott@snh.gov.uk; Karen.Taylor@snh.gov.uk; Nicola.Bain@gov.scot; Sophie.Humphries@gov.scot
Subject: Moray West Offshore Wind Farm - Offshore Habitats Regulations Appraisal (HRA) Screening Report

Dear Sir/Madam,

Please find attached the offshore HRA Screening report for Moray West Offshore Wind farm.

We would appreciate any comments you may have on the attached document. If you wish to submit any comments, please do so to MS.MarineRenewables@gov.scot before the **12th October 2017**.

Yours faithfully,

Jessica Drew
Marine Renewables Casework Manager
Marine Scotland Licensing Operations Team

Scottish Government
Marine Laboratory
375 Victoria Road
Aberdeen
AB11 9DB

PLEASE NOTE NEW TELEPHONE NUMBER

Direct Line: +44 (0)131 244 4023

e. jessica.drew@gov.scot / MS.MarineRenewables@gov.scot

w: http://www.gov.scot/marinescotland

MORAY WEST
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Approach to Cumulative Impact Assessment

Position Paper

Appendix 4.3

Moray Offshore Windfarm (West) Limited

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1 Proposed Approach and Methodology to Cumulative Impacts Assessment

The current Environmental Impact Assessment (EIA) Regulations[1] require that a description of the likely significant cumulative effects of a project should be considered. This document sets out the approach that will be adopted for the Cumulative Impact Assessment (CIA) requirement of the EIA process that is applicable to the Moray West Offshore Wind Farm and Offshore Transmission Infrastructure (OfTI) (referred to as 'the Development').

For the CIA, each EIA technical chapter of the Offshore EIA Report will include a section covering cumulative effects, which considers the effects arising from the Development cumulatively with other relevant plans, projects and activities. This approach is preferred to the production of a standalone chapter within the EIA Report, or a standalone CIA Report, as these would result in assessment repetition (e.g. of baseline descriptions). Keeping all key receptor assessments together in one place provides completeness for ease of reading and considering.

This assessment will be undertaken in accordance with the following standard guidance:

- Chartered Institute of Ecology and Environmental Management (CIEEM) (2010) Guidelines for Ecological Impact Assessment in Britain and Ireland. Marine and Coastal. Final Version 5. August 2010;
- European Commission (EC) (1999). Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions;
- Scottish Natural Heritage (SNH) (2005). Cumulative Effects of Wind Farms. Version 2 Revised 13.04.05;
- SNH (2012). Assessing the Cumulative Impact of Onshore Wind Energy Developments;
- Renewable UK (2013). Cumulative Impact Assessment Guidelines. Guiding Principles for Cumulative Impacts Assessment in Offshore Wind Farms. June 2013; and
- British Standards Institution (BSI) (2015). PD 6900:2015. Environmental impact assessment for offshore renewable energy projects – Guide.
- King, S., Maclean, I.M.D., Norman, T., and Prior, A. (2009). Developing Guidance on Ornithological Cumulative Impact Assessment for Offshore Wind Farm Developers. COWRIE.

If considered appropriate, the CIA will also take into consideration the content of The Planning Inspectorate (PINS) Advice Note Seventeen: Cumulative effects assessment relevant to nationally significant infrastructure projects (The Planning Inspectorate, 2015). Furthermore, the assessment will also have regard to the methods outlined within the Moray Firth Offshore Wind Developers Group (MFOWDG) discussion document 'Moray Firth Offshore Wind Developers Group Cumulative Impact Assessment Discussion Document' (Moray East, 2012) unless agreed otherwise with MS-LOT and appropriate stakeholders.

1.1 Proposed Approach

The key issues requiring consideration when undertaking a CIA relate to defining appropriate analytical boundaries in time and space, identifying and predicting future resource use and impacts, and evaluating the significance of cumulative effects that are predicted to take place. These key issues are reflected in the three stage approach to CIA outlined below:

[1] For the marine environment and as relevant to the Moray West Project these are the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017, the Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 and the Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended)

- **Screening Exercise** – establishing screening definitions, defining CIA extents for specific EIA topics and creation of an initial list of plans, projects and activities based on defined range criteria for receptors (provided in this document);
- **Stakeholder Consultation** – agreement of key receptors, range criteria and final list of plans, projects and activities to be included in the CIA; and
- **Assessment of Potential Cumulative Effects** – completion of a CIA for each environmental technical area and receptors.

1.2 Proposed Methodology

1.2.1 Screening Exercise

The screening exercise is being led by GoBe Consultants, supported by specialist EIA technical consultants.

The aim of the screening exercise is to define those EIA topics/receptors where there may be cumulative effects and identify the ranges at which projects and activities may have a cumulative effect on receptors such as species and habitats. Following this, the screening exercise then seeks to identify a list of all projects and activities that are deemed to require consideration within the CIA. These plans, projects and activities, including information on project name, status of the development, scale / capacity, known planned construction programme, data confidence, and distance from the Development at its closest point are presented in Table 2.1.1. These include:

- Projects that are not currently in the planning system but are likely to enter the planning system in the near future (e.g. areas for lease (AfL) or projects at feasibility / early design stages);
- Projects currently within the marine planning system at scoping stage or for which an application has been submitted but which are not yet consented;
- Projects that are consented and are yet to be constructed or are under construction; and
- Projects that are currently operational but that were not operational when baseline data was collected, or operational projects that have an ongoing impact.

For projects currently under construction, the standard approach is to include these within the CIA and not consider them as part of the baseline as their effects are not yet fully established. However, there are exceptions to this approach where the effects of projects in construction have already been recorded in baseline data gathering. For example, with regard to this Development, the Beatrice Offshore Wind Farm, which is currently under construction, has already been recorded in the baseline for the EIA topics of Seascape, Landscape and Visual Impact Assessment (SLVIA) and Shipping and Navigation and therefore are now considered to form part of the baseline.

A review of the potential receptors for assessment of cumulative effects was undertaken as part of the Offshore Scoping Report and further guidance has been provided within the Offshore Wind Farm Scoping Opinion received in August 2016, and within the OfTI Scoping Opinion received in August 2017.

1.2.1.1 Project Screening Definitions and Extents

For the identification of routes (or pathways) that may cause potential cumulative effects, project specific definitions were applied, as set out in Table 1.2.1. These were then used to identify the environmental technical areas requiring consideration in the CIA, and the spatial and temporal extents of potential cumulative effects for each environmental technical area (Table 1.2.2) in order to identify which plans, projects and activities require inclusion in the CIA (as presented in Table 2.2.1). More detailed justification of the screening distances for each environmental technical area will be provided within specific CIA sections of the EIA Technical Chapters.

Table 1.2.1: Project Specific Screening Definitions

Table 1.2.1: Project Specific Screening Definitions	
Term	**Definition**
Conceptual overlap	For a cumulative effect to occur it must be established that a cumulative impact has the potential to directly or indirectly affect the receptor(s) in question. In EIA terms this is described as an impact-receptor-pathway, and is hereafter referred to as a conceptual overlap. An example of a conceptual overlap can be seen where increased suspended sediment concentrations from a nearby project (impact) affect fish and shellfish (receptor) that are also potentially affected by the Development. Conversely, a conceptual overlap cannot be demonstrated between activities such as the operation of a subsea cable and aircraft navigation. It is in cases such as this second example where projects, plans and activities have been screened out.
Physical overlap	The impacts on one receptor from Moray West and one or more other plans, projects or activities overlap i.e. sediment plumes interact, or noise contours from piling, while not overlapping directly, impact on the general range of a mobile species such as harbour porpoise.
Temporal or sequential overlap	The specific impacts on a receptor have to interact temporally, or sequentially, for there to be a cumulative effect. For those impacts only active during construction, e.g. piling noise, it is necessary to determine the potential overlap of construction, or sequential construction periods, with other plans, projects and activities in order to assess the likelihood of any overlap.

Table 1.2.2: Offshore Search Area Extents

Table 1.2.2: Offshore Search Area Extents.	
Environmental Technical Area	**Range Criteria for Plans / Projects / Activities**
Physical Processes and Water Quality	Within one tidal ellipse distance or wave change regime. Out with this tidal range, there is considered to be no connectivity between the physical or biological environments.
Benthic and Intertidal Ecology	Within one tidal ellipse (limited to projects within the Moray Firth). Dependent to an extent on Physical Processes, Water Quality and noise modelling.
Fish and Shellfish	Within one tidal ellipse (limited to projects within the Moray Firth but dependent to an extent upon Physical Processes and Water Quality). Within key spawning areas or migration routes (within the Moray Firth). Within relevant noise contours (dependent on noise modelling).
Marine Mammals	Within the relevant management unit for each key species. For example, for seals this is the Moray Firth seal management area; for bottlenose dolphins this is the East Coast management unit. For harbour porpoise and minke whales, whose management units extend over very large areas beyond the Moray Firth, it is proposed that quantitative assessment of cumulative impacts is focused on offshore wind farm projects in the Moray Firth, and that cumulative impacts with other wind farm will be considered qualitatively.
Ornithology	Within species-specific key foraging ranges, breeding areas or migration routes. Out with these ranges or routes, there is considered to be no connectivity between physical or biological environments.

Table 1.2.2: Offshore Search Area Extents.	
Environmental Technical Area	**Range Criteria for Plans / Projects / Activities**
	For the breeding season, the CIA will consider projects within mean-max foraging range (Thaxter *et al.,* 2012) or where specific tracking data exists from the Special Protection Area (SPA) colony under consideration. Non-breeding connectivity is informed by the definition of Biologically Defined Minimum Population Scales (BDMPS) as presented in Furness (2015). Non-breeding seasons are when the largest cumulative study areas could occur, potentially covering the North Sea for species such as gannet and kittiwake. For auks species (guillemot, razorbill and puffin) which are known to remain in relative close proximity to breeding colonies, it is considered appropriate that non-breeding cumulative assessments are restricted to the Moray Firth. It is proposed that quantitative assessment of cumulative impacts is focused on offshore wind farm projects in the Moray Firth, and that cumulative impacts with other wind farm will be considered qualitatively.
Commercial Fisheries	Extent of the relevant fishing grounds.
Shipping and Navigation	Based on shipping lane widths and sea space around Moray West.
Military, Aviation and Communications	Distance at which disturbance from Moray West would interact with that of an 'other development'.
Marine Archaeology and Cultural Heritage	Archaeological object specific.
Seascape, Landscape and Visual Impact (SLVIA)	Extent of the Zone of Theoretical Visibility (ZTV). The visual relationship with onshore as well as offshore wind energy developments will also be taken into consideration.
Other Human Activities	Extent of infrastructure / other activity limits plus any safety zones (e.g. maximum of 500m from extents of limits), within the Moray Firth.

1.2.1.2 Plans, Projects and Activities Requiring Assessment

A proposed list of plans, projects and activities identified as requiring consideration in the CIA is provided in Table 2.1.1. These plans, projects and activities encompass the following marine areas:

- Offshore wind farm infrastructure;
- Other marine energy developments;
- Oil infrastructure and decommissioning activities;
- Existing commercial fisheries, including aquaculture;
- MoD operations (where known);
- Cable and/or pipelines;
- Aviation activities;
- Shipping activities;

- Port and harbour developments;
- Dredging / aggregates; and
- Marine disposal.

1.2.2 Stakeholder Consultation

It is intended that stakeholder engagement will take place with the consenting authorities and their advisors (MS-LOT, SNH and via the Moray Firth Regional Advisory Group) in order to review, amend and agree suitable key receptor ranges and plans, projects and activities to be considered cumulatively. For this process, the proposed list of projects and activities will be reviewed, added to, or removed from so as to derive a final list of projects and activities to be included within the CIA. Refined screening of the plans, projects or activities will take place based on data confidence, whether there is a conceptual overlap, whether there is a spatial overlap and whether there is a temporal overlap.

1.2.3 Approach to the Assessment of Potential Cumulative Effects

For each plan, project and activity identified, all publicly available data and / or information will be gathered and reviewed in order to identify the proposed construction methods, construction programme and other timescales of interest and obtain an understanding of the elements of the project that may lead to cumulative impacts with Moray West. This will include reviewing the assessment of significant effects presented within supporting Environmental Statements / EIA Reports / Scoping Reports and, where available, other post-application survey validation / assessment reports. For each key receptor, an overall assessment of the Development combined with each individual project will then be presented and potential significance of effects identified as far as possible.

Where information is not present publicly e.g. for projects at scoping or earlier stages in the planning / EIA process, a high level qualitative assessment will be undertaken based on the level of information available at the time unless further project details can be acquired direct from the developers.

For the Firths of Forth and Tay offshore wind farms that are already consented but not under construction and have new applications being submitted (at scoping stage or later) for revised design envelopes (Inch Cape, Neart na Gaoithe, Seagreen), the worst case scenario from either the 2017 scoping reports or the previously consented parameters will be assessed for each EIA topic. This is in line with the approach set out in the Neart na Gaoithe Revised Design Scoping Opinion[2] from September 2017.

It is noted that within the Neart na Gaoithe Revised Design Scoping Opinion, there is also a request that where the worst case scenario is derived from the originally consented parameters, the 2017 scoping scenario will also need be assessed as the ongoing judicial review process may mean that the previously consented developments are no longer valid. However, given that the judicial review process is now concluded and the original consents remain valid, it is considered no longer necessary to assess the 2017 scoping scenario in addition to the consented worst case scenario described above.

Moray West will also seek to obtain confirmation of revised design parameters and realistic project development timelines from the Forth and Tay developers. In the absence of such confirmation, it will be necessary to refer to construction timelines assumed in the 2017 scoping scenarios. This is on the basis that it is assumed, given the projects without CfD are seeking to gain consent in time to be eligible for the Spring 2019 CfD round, that the construction programmes presented in the original project EIAs are no longer valid.

For the Moray East Offshore Wind Farm, the consented parameters of the Telford, Stevenson and MacColl projects will form the basis of the worst case (quantitative or qualitative) cumulative impact assessment. However, it is known that the consented parameters will be revised[3], with fewer turbines installed than

[2] http://www.gov.scot/Resource/0052/00524490.pdf
[3] http://www.4coffshore.com/windfarms/moray-east-selects-mhi-vestas-and-geosea-nid6597.html; http://www.offshorewind.biz/2017/10/30/mhi-vestas-9-5mw-preferred-for-moray-east-owf/

consented, and therefore it is proposed that additional assessment will be undertaken that considers the 'most likely' Moray East scheme, and that the outcomes of this assessment will be presented alongside those of the worst case assessment. It is currently anticipated and intended that this 'most likely' scenario will then be validated upon submission of the Moray East Consent Plans (namely the Development Specification and Layout Plan) in Q1/2 2018 (i.e. during the Moray West consent determination period).

For the Beatrice Offshore Wind Farm and the European Offshore Wind Deployment Centre ('Aberdeen Offshore Wind Farm') the actual build design parameters will be obtained (as stated in approved Consent Plans) and used in the baseline for SLVIA and Shipping and Navigation and in CIA for other topics instead of the consented parameters.

The inter-relationship between effects may also need to be assessed as part of the CIA. In addition, any areas of uncertainty will be fully outlined along with the reasons for uncertainty in the evaluation.

For quantitative assessment of projects, the assessment criteria used to determine the magnitude of impact, sensitivity of receptor, and overall significance of effect will follow the same methodology as that applied throughout EIA (and as described in the Moray West OfTI Scoping Report, May 2017). A combination of matrix and professional judgement will be applied to the evaluation of significance. Significance will either be adverse or beneficial and negligible, minor, moderate or major in nature. For qualitative assessment, a more high-level significance will be concluded using professional judgement.

Finally, for any cumulative effects that are identified to be significant, further assessment will be completed and mitigation and other measures developed in order to minimise / reduce cumulative effects to an acceptable level of significance.

1.2.4 Definition of Cumulative and In-combination

Cumulative impacts are defined as impacts that result from incremental changes caused by other past, present or reasonably foreseeable actions together with the project (CIEEM, 2010). The Renewable UK Guidance defines cumulative impacts *'as those that result from additive effects caused by other past, present or reasonably foreseeable actions together with the plan, programme or project itself and synergistic effects (in-combination) which arise from the reaction between effects of a development plan, programme or project on different aspects of the environment.'*

The terminology 'cumulative' is used within the EIA Regulations, while 'in-combination' is used within the Habitats Regulations[4]. The term 'combined' is referred to within the EIA Regulations (Schedule 1) but is used in the same manner as 'cumulative'. For the purposes of this CIA, the term 'cumulative' and 'combined' will be used in the same context, but 'in-combination' will only be used within the Habitats Regulations Appraisal (HRA) Report, which forms a separate report to the EIA CIA.

2 Screening List of Projects and Activities to be Considered in the Offshore Cumulative Effects Assessment

2.1 Introduction

Table 2.1.1 presents a list of projects and activities that are proposed for consideration within the cumulative impact assessment (CIA) of the Moray West EIA Report. Projects and activities have been identified on the basis that there is connectivity with Moray West, and therefore potential for cumulative effect, based on the range definitions and extents presented in Tables 1.2.1 and 1.2.2.

No 'plans' have been identified as being relevant to the CIA.

[4] As relevant to the Moray West Project these are the Conservation (Natural Habitats, &c.) Regulations 1994 and the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (or from 30th November 2017 the Conservation of Offshore Marine Habitats and Species Regulations 2017).

Table 2.1.1: Offshore Projects and Activities

Table 2.1.1. Offshore Projects and Activities			
Project or Activity	**Summary**	**Information Source**	**Technical Area of Relevance**
Offshore Wind Farm Projects			
Telford, Stevenson and MacColl Offshore Wind Farms	Consented Three adjacent consented projects (Telford, Stevenson and MacColl Offshore Wind Farms), developed by Moray Offshore Renewables Limited (MORL) (now Moray East), in the Moray Firth. The project consents allow a total capacity of up to 1,116 MW and up to 186 turbines across the Moray East Site. Construction will commence in March 2021 in line with the existing consents.	http://www.morayoffshorerenewables.com/Home.aspx.	All
Beatrice Offshore Wind Farm	Under Construction The Beatrice Offshore Wind Farm, to be developed by Beatrice Offshore Wind Limited (BOWL), will consist of up to 84 wind turbines, two OSPs and generate up to 588 MW. The project, in the Moray Firth, commenced construction in April 2017 and will be fully commissioned and operational in early 2019.	http://www.gov.scot/Topics/marine/Licensing/marine/scoping/Beatrice	All
Beatrice Wind Farm Demonstrator Project	Operational Two 5 MW wind turbines in the Moray Firth, operational since 2007. The site is 22 km from the Scottish coast and in 45 m of water. This project is a joint venture between Scottish and Southern Energy and Talisman Energy (UK) Limited and is due to be decommissioned in the near future.	http://www.hi-energy.org.uk/HI-energy-Explore/talisman-beatrice-project.htm	All

Table 2.1.1. Offshore Projects and Activities			
Project or Activity	**Summary**	**Information Source**	**Technical Area of Relevance**
Inch Cape Offshore Wind Farm	Consented In 2014 Inch Cape Offshore Limited (ICOL) gained offshore consents (Section 36 and Marine Licence) for the construction and operation of an offshore wind farm (up to 784 MW and no more than 110 turbines) and associated Offshore Transmission Works, situated in the Outer Firth of Tay off the east coast of Scotland.	http://www.inchcapewind.com/home and http://www.gov.scot/Topics/marine/Licensing/marine/scoping/InchCape	Marine Mammals Ornithology
Inch Cape Offshore Wind Farm Revised Design	Proposed Development of a revised offshore wind farm comprising up to 784 MW and up to 72 turbines. The alternative design comprises larger but fewer turbines. A Scoping Request for the proposal has recently been submitted (April 2017) and the project is expected to enter construction in 2020.	http://www.inchcapewind.com/home and http://www.gov.scot/Topics/marine/Licensing/marine/scoping/ICOLRevised-2017	Marine Mammals Ornithology
Neart na Gaoithe Offshore Wind Farm	Consented A project consisting of up to 75 wind turbines, with a total capacity of up to 450 MW. The project is being developed by Neart na Gaoithe Offshore Wind Limited (NnGOWL).	http://www.gov.scot/Topics/marine/Licensing/marine/scoping/Mainstream-NeartnaGaoithe	Marine Mammals Ornithology
Neart na Gaoithe Offshore Wind Farm Revised Design	Proposed A new consent application for a revised offshore wind farm comprising larger but less turbines and with greater spacing between turbines. There will be no more than 56 turbines with total capacity of 450 MW. A Scoping Request has recently been submitted for the revised proposal (May 2017).	http://www.neartnagaoithe.com/about.asp and http://www.gov.scot/Topics/marine/Licensing/marine/scoping/NnGRev2017	Marine Mammals Ornithology

Table 2.1.1. Offshore Projects and Activities			
Project or Activity	**Summary**	**Information Source**	**Technical Area of Relevance**
Seagreen Alpha and Bravo Offshore Wind Farms	Consented Two offshore wind farms, being developed by Seagreen Wind Energy Limited (SWEL), each consisting of up to 75 wind turbines and generating up to 525 MW.	http://www.seagreenwindenergy.com/	Marine Mammals Ornithology
Seagreen Phase I Wind Farm	Proposed A new consent application for a revised offshore wind farm in place of Seagreen Alpha and Bravo Offshore Wind Farms, which will comprise 70 to 120 turbines of up to 15 MW, with 1 km spacing between turbines. The revised proposal has recently submitted a Scoping Request (May 2017).	www.seagreenwindenergy.com and http://www.gov.scot/Topics/marine/Licensing/marine/scoping/SeagreenPhase1-2017/SeagreenPhase1-ScopingReport	Marine Mammals Ornithology
Aberdeen Offshore Wind Farm	Consented Consists of up to 11 wind turbines, generating up to 8.4 MW each, located immediately off Aberdeen. It is being developed by Aberdeen Offshore Wind Farm Limited (AOWFL) and construction will take place and be completed during 2017.	https://corporate.vattenfall.co.uk/projects/wind-energy-projects/european-offshore-wind-deployment-centre/	Marine Mammals Ornithology
Hywind Demo	Constructed Statoil's demonstration floating wind farm (moored floating spar type structure) off the Scottish coast. The consented project is located near Buchan Deep, approx. 25-30 km off the coast of Peterhead in Aberdeenshire. It consists of five wind turbines and is a 30 MW pilot project.	http://www.statoil.com/en/TechnologyInnovation/NewEnergy/RenewablePowerProduction/Offshore/HywindScotland/Pages/default.aspx?redirectShortUrl=http%3a%2f%2fwww.statoil.com%2fHywindScotland	Marine Mammals Ornithology

Table 2.1.1. Offshore Projects and Activities			
Project or Activity	**Summary**	**Information Source**	**Technical Area of Relevance**
Kincardine Floating Offshore Windfarm	Consented A pilot-scale offshore wind farm project utilising floating foundation technology. Proposed by Kincardine Offshore Wind Limited (KOWL), the project is located south-east of Aberdeen approximately 15km from the coastline.	http://www.gov.scot/Topics/marine/Licensing/marine/scoping/Kincardine.	Marine Mammals Ornithology
Forthwind Wind Farm Demonstrator Project – Phase 1	Consented A two turbine project located 1.5km offshore of Methil in the Firth of Forth with a capacity of up to 18MW.	http://www.gov.scot/Topics/marine/Licensing/marine/scoping/FW-Methil/s36consent	Marine Mammals Ornithology
Forthwind Wind Farm Demonstrator Project – Phase 2	Proposed Currently at the scoping stage, this Forthwind project will consist of up to 9 wind turbines with a total capacity of up to 65 MW located in the Firth of Forth.	www.gov.scot/Topics/marine/Licensing/marine/scoping/fowda	Marine Mammals Ornithology
ORE Catapult Levenmouth	Operational A 7 MW demonstration offshore wind turbine located at the Fife Energy Park off the East Fife coast. Looking at ways in which to drive cost efficiencies in offshore turbines. Operational since March 2014 with current operation proposed until 2019.	https://ore.catapult.org.uk/our-services/test-demonstration-assets/levenmouth-turbine/	Marine Mammals Ornithology
Dounreay Trì Floating Wind Demonstration Project	Under Construction (currently in administration) A commercial demonstration project, comprising two 5 MW wind turbine generators on a semi-submersible platform to be installed off the North coast of Scotland within a site approximately 9 km off Dounreay, Caithness. Construction started	http://www.hexicon.eu/dounreay-tri/ and http://www.gov.scot/Topics/marine/Licensing/marine/scoping/DTFWDP	Marine Mammals Ornithology

Table 2.1.1. Offshore Projects and Activities			
Project or Activity	**Summary**	**Information Source**	**Technical Area of Relevance**
	in March 2017 and commissioning is planned for September 2018.		
Other East Coast offshore wind farms (e.g. Blyth Offshore Demonstrator, Thanet, Teesside, Dogger Bank, Dudgeon, Hornsea projects, East Anglia projects, Kentish Flats, West of Duddon Sands, Scroby Sands, Sheringham Shoal, Greater Gabbard, Gunfleet Sands, Thanet Extension).	Various offshore wind farms currently seeking consent, consented or operational on the east coast of England.	Individual project specific websites / information.	Ornithology Marine Mammals (harbour porpoise, minke whale and white-beaked dolphin only)
Other North Sea offshore wind farms off Belgium, France, Denmark, the Netherlands and Germany.	Various offshore wind farms in the wider North Sea.		Marine Mammals (harbour porpoise, minke whale and white-beaked dolphin only)
Tidal Energy Projects			
MeyGen Pentland Firth	Operational Developed by Atlantis Resources, this is a 395 MW project comprising of various phases. The first Phase (1A) involves deployment of four 1.5 MW tidal turbines. Phases 1B (additional four 1.5 MW turbines) and 1C (additional 49 turbines of 73.5 MW capacity) are also consented.	http://www.gov.scot/Topics/marine/Licensing/marine/scoping/MeyGen https://www.atlantisresourcesltd.com/projects/meygen/	Marine Mammals (harbour porpoise, minke whale and white-beaked dolphin only)

Table 2.1.1. Offshore Projects and Activities			
Project or Activity	**Summary**	**Information Source**	**Technical Area of Relevance**
NOVA Innovation Tidal Turbine Array - Bluemull Sound	Operational A five turbine offshore tidal array off the coast of Shetland with maximum generating capacity of 500 kW.	http://www.gov.scot/Topics/marine/Licensing/marine/scoping/nova	Marine Mammals (harbour porpoise, minke whale and white-beaked dolphin only)
Churchill Barriers -	Proposed Construction of a tidal energy extraction scheme and a wave overtopping solution. At screening stage (April 2016).	http://www.gov.scot/Topics/marine/Licensing/marine/scoping/churchill-barriers	Marine Mammals (harbour porpoise, minke whale and white-beaked dolphin only)
Ness of Duncansby Tidal Array	Proposed ScottishPower Renewables (UK) Ltd proposed to develop a commercial tidal array at Ness of Duncansby in the Pentland Firth. The array would have a capacity of 95MW and comprise Andritz Hydro Hammerfest tidal turbines. Atlantis acquired the project in 2016.	https://www.atlantisresourcesltd.com/projects/duncansby/ and http://www.gov.scot/Topics/marine/Licensing/marine/scoping/duncansby	Marine Mammals (harbour porpoise, minke whale and white-beaked dolphin only)
Brims Tidal Array	Proposed Array of tidal turbines with a total capacity of up to 200MW. Two phases were proposed; Phase 1 up to 30MW and Phase 2 up to 170MW (15 turbines. Up to 200 turbines.	http://www.gov.scot/Topics/marine/Licensing/marine/scoping/BrimsArray	Marine Mammals (harbour porpoise, minke whale and white-beaked dolphin only)
Lashy Sound Tidal Array	Proposed Scotrenewables Tidal Power Limited proposal to develop a tidal array for up to 30MW of installed capacity. Two phases were proposed; Phase 1 up to 10MW (5 turbines) and Phase 2 up to 30MW (15 turbines).	http://www.gov.scot/Topics/marine/Licensing/marine/scoping/LashySound and http://www.scotrenewables.com/projects/lashy-sound	Marine Mammals (harbour porpoise, minke whale and white-beaked dolphin only)

Table 2.1.1. Offshore Projects and Activities			
Project or Activity	**Summary**	**Information Source**	**Technical Area of Relevance**
Oil and Gas Projects (Producing / Recently Producing Licences)			
P187 (Beatrice Oil Field) – Block 11/30a P1031 (Beatrice Oil Field) – Block 11/25a P982 (Beatrice Oil Field) - Block	Production Ceased The Beatrice Field commenced production in 1981 and is currently owned by Repsol Sinopec Resources UK Ltd and operated by Talisman. There are four platforms: Beatrice Alpha Drilling Platform (263m within Moray West Site boundary); Beatrice Alpha Production Platform (280 m within the boundary); Beatrice Bravo (1194 m outwith boundary); and Beatrice Charlie (204 m outwith the boundary). There is also a mid-line structure between Beatrice Alpha and the Jacky Platform which was installed in 2008. Decommissioning of the Beatrice Oil Field is currently anticipated to commence in 2017 and be completed by 2027 and is set out within the Decommissioning Report. It is understood that a decommissioning EIA is currently underway.	Oil and Gas Authority Offshore Interactive Map https://www.ogauthority.co.uk/data-centre/interactive-maps-and-tools/.	Other Human Activities Other technical areas also, depending upon confirmed decommissioning programme; current programme suggests structure removal activity will occur when Moray West is operational.
P1031 – Block 12/21a	Producing Owned by Repsol Sinopec Resources UK Ltd and operated under a Traditional Licence from Round 26, with an expiry date of August 2037.	Oil and Gas Authority Offshore Interactive Map https://www.ogauthority.co.uk/data-centre/interactive-maps-and-tools/.	Other Human Activities
P1392 (Jacky Oil Field) – Block 12/21c	Producing The Jacky Platform commenced production in 2009 and is currently owned and operated by Ithaca Energy. Preparatory works for decommissioning of the Jacky Platform commenced in the summer of 2016 with removal of the platform expected to take place in 2017	Oil and Gas Authority Offshore Interactive Map https://www.ogauthority.co.uk/data-centre/interactive-maps-and-tools/.	Other Human Activities

Table 2.1.1. Offshore Projects and Activities			
Project or Activity	**Summary**	**Information Source**	**Technical Area of Relevance**
	subject to receiving consent. The Jacky Platform is located 2870m outwith the boundary.		
Cables and Pipelines			
Caithness to Moray Interconnector	Under Construction Developed by Scottish and Southern Electricity Networks (SSEN) Transmission and will span the Moray Firth. Due to be installed by the end of 2017. The cable runs from Spitall Substation / Noss on the Caithness coastline to a landfall close to Portgordon on the Moray coastline. It will then connect to Blackhillock Substation. The cable will intersect the Moray West OfTI Site.	http://www.4coffshore.com/windfarms/interconnector-caithness-moray-icid2.html.	Other Human Activities
SHEFA-2 Telecom Cable	Operational Faroese telecommunications cable between the Faroes Islands and Banff, which is located offshore to the east of the Moray West OfTI Site	https://www.submarinecablemap.com/#/submarine-cable/shefa-2.	Other Human Activities
Other Coastal Developments			
Ports and Harbours			
Port of Ardersier	Consented Redevelopment of Former McDermott Fabrication Yard. Involves quay realignment, vibro piling, and dredging. A proportion of the dredged material is to be stored on site for future use as ballast material in gravity base foundations, another portion will be used to infill the “scalloped” area on Whiteness Head and the remainder will be disposed of at the Whiteness	http://www.gov.scot/Topics/marine/Licensing/marine/scoping/PortArdersierLtd.	Other Human Activities and Marine Mammals

Table 2.1.1. Offshore Projects and Activities			
Project or Activity	**Summary**	**Information Source**	**Technical Area of Relevance**
	Sands disposal site. A marine licence was granted in September 2016.		
Port of Nigg / Nigg Yard	Plan Stage Nigg Development Masterplan 2013 sets out a strategy for future development of the Port of Nigg over the next 15 to 12 years. Includes proposals for enhancing 334 hectares of the area for the marine renewables market and development of the oil terminal and fabrication yard. Most of the development appears to be onshore but there would be an increase in noise and vessel activity.	http://www.highland.gov.uk/downloads/file/1328/nigg_development_masterplan_-_march_2013.	Other Human Activities and Marine Mammals
Port of Cromarty Firth	Proposed Cromarty Firth Port Authority has plans for a Phase 4 port expansion project. The proposals include a new berth of 350m, a Ro-Ro facility and reclamation of additional land for lay down areas. A scoping opinion was provided in November 2015.	http://www.cfpa.co.uk/Port-Expansion/Phase-4.aspx	Other Human Activities and Marine Mammals
Coastal capital and maintenance dredging and sea disposal			
Burghead Disposal Site	Approximately 35.2km from the OfTI and 36.4km from the Moray West site.	Moray Council website http://www.moray.gov.uk/moray_standard/page_41056.html	Other Human Activities
Buckie Disposal Site	Approximately 2km from the OfTI and 36.9km from the Moray West site.	Moray Council website http://www.moray.gov.uk/moray_standard/page_41056.html	Other Human Activities
Helmsdale Disposal Site	Approximately 24.5km from the OfTI and 24.9km from the Moray West site.	The Highland Council website https://www.highland.gov.uk/directory_record/717679/helmsdale_bridge_car_park_shore_street_kw8_6jz/category/483/recycling_banks	Other Human Activities

Table 2.1.1. Offshore Projects and Activities			
Project or Activity	**Summary**	**Information Source**	**Technical Area of Relevance**
Macduff Disposal Site	Approximately 14.7km from the OfTI and 49.5km from the Moray West site.	Aberdeenshire Council website https://www.aberdeenshire.gov.uk/waste/recycling-centres-and-points/recycling-centres-and-points/	Other Human Activities
Lossiemouth Disposal Site	Approximately 21.2km from the OfTI and 27.3km from the Moray West site.	Moray Council website http://www.moray.gov.uk/moray_standard/page_41056.html	Other Human Activities
Military			
Military Practice Danger Areas at Moray Firth, Tain, Fort George and Binhill	No further information is currently available on activities.	https://marinescotland.atkinsgeospatial.com/nmpi/	Defence and Aviation

Notes:

Relinquished O&G licences are not included as these are no longer valid and there is no information to say they are being re-tendered.

No wave energy projects have been identified that have connectivity to Moray West and that need to be included within the CIA.

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MORAY WEST
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Phenology and Apportioning within the RIAA

Moray Offshore Windfarm (West) Limited

Appendix 4.4

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Acronyms	
Acronym	**Expanded Term**
RIAA	Report to Inform the Appropriate Assessment
SPAs	Special Protection Areas
BDMPS	Biologically Defined Minimum Population Scales
HRA	Habitats Regulation Appraisal
GPS	Global Positioning System
LSE	Likely Significant Effect
UD	Utilization Distributions
JNCC	Joint Nature Conservation Committee
SNH	Scottish Natural Heritage

1 Overview

This Appendix supports the Report to Inform the Appropriate Assessment (RIAA) for the Moray West Offshore Wind Farm. The RIAA assessed the possible impact that the Development will have on breeding seabird populations in protected areas i.e. Special Protection Areas (SPAs). This Appendix outlines the methodology and results for calculating apportioning values to be used to apportion impacts arising on seabirds from the Development to breeding populations of relevant species at SPAs with potential connectivity to the Moray West Offshore Wind Farm.

Connectivity is the occurrence of birds from a SPA at the Moray West Offshore Wind Farm. For features of the SPAs for which potential connectivity has been identified in the breeding season, the proportion of adult and immature birds present at the Moray West Offshore Wind Farm has been identified from age class data where available from site-specific surveys. For each of the features of the SPAs, the approach used to apportion impacts between adults and juveniles is outlined below. Of those adults, a proportion will be taking a sabbatical (adults which are not breeding in any one year) and the impacts assigned to this cohort can be removed when undertaking population modelling, as population size estimates of breeding colonies do not include sabbatical birds. How sabbaticals have been apportioned to adults for the purpose of population modelling is presented. In the non-breeding season, population data from Furness (2015) has been used to determine the proportion of adult birds from the SPAs with connectivity, present in the relevant Biologically Defined Minimum Population Scales (BDMPS) population. An outline of the methodology used and the results, concludes this appendix.

2 Connectivity between SPA seabird features and the Moray West Offshore Wind Farm in the breeding season

2.1 Overview

During the breeding season foraging birds may travel some distance from their breeding colonies. The information available on the distances that breeding birds will forage depends on the individual species. Typically, the mean-maximum foraging range (i.e. the mean of the maximum foraging trips recorded) as reported by Thaxter *et al.* (2012), has been applied in Habitats Regulation Appraisal (HRA) as a criterion for establishing whether there is likely to be connectivity (and hence risk of an impact) between a SPA breeding colony and a proposed wind farm development. Where the foraging ranges presented in Thaxter *et al.* (2012) are used in the Moray West Offshore Wind Farm HRA Screening Report (Moray West 2017a), the mean-maximum range with one standard deviation has been used (Table 2.1). The inclusion of one standard deviation to the mean-maximum range brings Moray West Offshore Wind Farm within foraging range of kittiwake and razorbill at North Caithness Cliffs SPA.

Whilst at-sea surveys can provide valuable information on where important aggregations of seabirds occur, such surveys cannot establish the provenance of individuals, and therefore establishing connectivity between the impacts of Moray West Offshore Wind Farm and a SPA breeding colony. Information from seabird tracking studies may be used to establish the likely colony origins of at-sea concentrations of seabirds. In some cases, targeted species-specific information is available from GPS/satellite tracking studies, such as, for example, the tracking by the University of Plymouth (for Moray Offshore Renewables Ltd) of breeding kittiwake, great black-backed gull, herring gull, guillemot and razorbill colonies associated with the East Caithness Cliffs SPA (Archibald *et al.,* 2015, Bicknell *et al.,* 2011). Such information is initially qualitatively reviewed below to establish the likely connectivity of a breeding seabird species from a SPA with the Moray West Offshore Wind Farm. The key SPA seabird features and SPAs against which impacts are likely from Moray West Offshore Wind Farm are then finally considered in this section.

2.2 Tracking Studies

2.2.1 GPS Tracking Study at East Caithness Cliffs in 2011

In 2011, a tracking study on seabirds breeding at colonies within the East Caithness Cliffs SPA attached GPS loggers during the incubation and early chick-rearing to breeding kittiwake, guillemot and razorbill. Tagged birds were left for a minimum of 36 hrs to allow them to complete one or more foraging trips prior to the retrieval of a tag in order to download the data. Tags with foraging data were retrieved from across 57 individuals of the three species (20 guillemots, 19 kittiwakes and 18 razorbills). All three species showed similar patterns of movement with birds recorded foraging in mainly inshore waters and with none recorded foraging in the Moray West Offshore Wind Farm. Small numbers of guillemots and kittiwakes commuted through the proposed site between foraging locations and the breeding colony (approximately 5% of guillemot and 10% of kittiwake flights (three flights of each species)). A low recovery rate of the tags from the 77 kittiwake, 31 razorbill and 92 guillemot tagged, suggests some device effects (Bicknell *et al.,* 2011).

2.2.2 GPS Tracking Study at East Caithness Cliffs in 2014

Herring gulls and great black-backed gulls were tracked at East Caithness Cliffs SPA during May and June 2014 (Archibald et al., 2015, cited in Moray West 2017a). Eleven great black-backed gulls and 10 herring gulls were caught on the nest and fitted with remotely downloadable GPS tags. Both species were recorded foraging in mainly inshore waters and none were recorded foraging in or commuting through the Moray West Site (Moray West 2017a).

2.2.3 Relevance of the Findings of Wakefield et al. (2017)

Wakefield *et al.* (2017) GPS-tracked a sample of four seabird species that included 464 kittiwake, 281 razorbills, 178 guillemots from respectively 20, 14 and 12 colonies in the UK. The sample of colonies were drawn from throughout the geographical, environmental and colony size range of the study species in Britain and Ireland. The sample of colonies did not include the four SPAs (East Caithness Cliffs SPA, North Caithness Cliffs SPA, Troup, Pennan and Lions Heads SPA and Buchan Ness to Collieston Coast SPA) that have been screened in by the Moray West Offshore Wind Farm HRA Screening Report as having connectivity and a route(s) to impact for which no Likely Significant Effect (LSE) cannot be concluded for one or more of their respective site features. The GPS tracking was carried out during May-July, 2010 – 2014, when the study species were either approaching the end of the incubation period or raising small chicks.

Using Poisson point process habitat use models, Wakefield *et al.* (2017) showed that distribution at sea is dependent on: (i) density-dependent competition among sympatric conspecifics (all species) and parapatric conspecifics (guillemots); (ii) habitat accessibility and coastal geometry, such that birds travel further from colonies with limited access to the sea; and (iii) regional habitat availability. Using these models, Wakefield *et al.* (2017) predicted space use by birds from unobserved colonies e.g. East Caithness Cliffs SPA for the auks, and thereby mapped the distribution at sea of each species at both the colony and regional level. This is presented in the form of percentage utilization distributions (UD), defined as a population's spatial probability distribution (Fieberg and Kochanny 2005).

Poisson point process habitat use models in Wakefield *et al.* (2017) suggest that the Moray West Offshore Wind Farm is located in an area delineating 25%, 5% and 50% at-sea utilization distribution of breeding kittiwake, guillemot and razorbill respectively within Britain and Ireland during late incubation/early chick-rearing estimated as functions of colony distance, coast geometry, intra-specific competition. On the basis of these findings alone, it is considered a robust assumption that the Moray West Offshore Wind Farm lies within the maximum foraging range of breeding kittiwake, guillemot and razorbill from East Caithness Cliffs SPA when successfully breeding i.e. a distance compatible with a two parent family able to bring enough food back to keep a chick alive.

2.3 The Key SPA Seabird Features and SPAs against which Impacts are Likely

The Moray West Offshore Wind Farm HRA Screening Report (Moray West 2017a) reviewed species foraging ranges and site specific information from GPS tracking studies where information was available, to ascertain the likelihood of connectivity between SPA seabird breeding colonies and the Moray West Site during the breeding season. On the basis of this analysis, it was considered that there was only likely to be connectivity (and hence risk of an impact) between the Moray West Offshore Wind Farm and one or more of four SPAs (East Caithness Cliffs SPA, North Caithness Cliffs SPA, Troup, Pennan and Lions Heads SPA and Buchan Ness to Collieston Coast SPA; Figure 2.1) for four or more of the eight seabird species (fulmar, cormorant, kittiwake, great black-backed gull, herring gull, guillemot, razorbill and puffin) that are qualifying feature at a given SPA. Site-specific digital aerial surveys of the Moray West Site (April 2016 to March 2017) recorded cormorant to be completely absent. Thus, this species does not influence a conclusion of no LSE for the SPAs of interest (Moray West 2017a). All other breeding seabird qualifying and assemblage features have mean-maximum (or maximum) foraging ranges that do not extend a sufficient distance to bring them into contact with the Moray West Site and, therefore, these species also do not influence a conclusion of no LSE on the SPAs of interest, during the breeding season.

In their advice on the HRA screening report for the Development, SNH were unable at that time to provide final advice in respect of ornithological interests (Marine Scotland 2017c). This has been due to ongoing discussions about the baseline characterisation and modelling (Marine Scotland 2017c). As an interim measure, Moray West was referred to the final short list of species identified in the Moray East Offshore Wind Farm Appropriate Assessment (i.e. great black-backed gull, herring gull, guillemot, razorbill and puffin). It is however noted that tracking studies from East Caithness Cliffs SPA in 2014 (Moray Offshore

Renewables Ltd 2016) found that none of the great black-backed gulls fitted with tags foraged within the boundary of the Moray West Site. Moreover the results of this study showed that great black-backed gulls foraged mainly across inshore areas with a maximum distance recorded from the nest of approximately 20 km although the vast majority of trips were shorter than this. It is therefore considered a reasonable assumption that there is no connectivity between great black-backed gull from East Caithness Cliffs SPA, or more distant SPAs, and the Moray West Site.

Tracking studies from East Caithness Cliffs in 2014 (Moray West 2017a) found that none of the herring gulls fitted with tags foraged within the boundary of the Moray West Site. Though the species foraging behaviour was largely coastal, they did forage further away from the coast than great black-backed gulls. In light of a mean-maximum range of 61.1 km also being reported by Thaxter *et al.* (2012) (Table 2.1), herring gull is retained on a precautionary basis as one of the four key species for which there is potential connectivity (and hence risk of an impact) between a key SPA breeding colony and the Moray West Site, based on the review of advice to Moray East e.g. Marine Scotland (2017b).

Table 2.1: Breeding Season Mean-Maximum Foraging Ranges

Species	**Mean-maximum foraging range (km) +/- one standard deviation (Thaxter *et al* 2012)**
Kittiwake	60 +/- 23.3
Herring Gull	61.1 +/- 44
Guillemot	84.2 +/- 50.1
Razorbill	48.5 +/- 35
Puffin	105.4 +/- 46

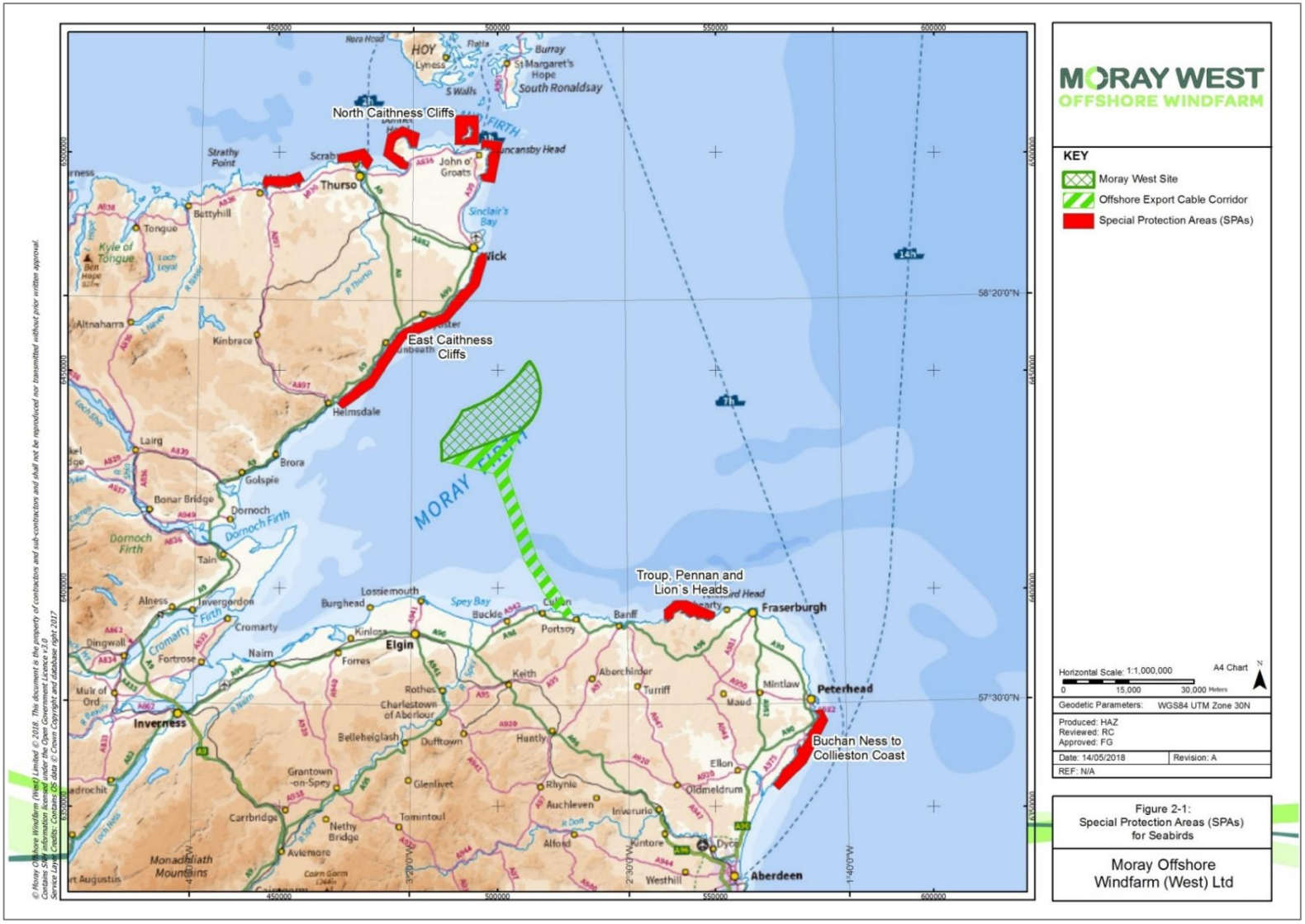

Figure 2.1 Special Protection Areas (SPAs) for breeding seabirds

3 Methods: Apportioning Estimated Effects from the Breeding Season

3.1 Introduction

For apportioning impacts associated with an offshore wind farm that may occur in the breeding season to seabirds from those SPAs within a species' foraging range of the proposed development, Scottish Ministers have advised recent projects to follow the two-step approach advised by SNH (e.g. Marine Scotland 2017a, b). This is the approach that has been followed in the assessment of impacts on seabirds from the Moray West Offshore Wind Farm.

The recommended two stage process is:

- (i) To apportion impacts between SPA and non-SPA breeding colonies within foraging range of the wind farm. This is done using Seabird 2000[1] data as this provides a common reference point and many of the non-SPA breeding colonies have not been counted since this time.
- (ii) The impacts assigned to the SPA component are further apportioned between the individual SPAs within foraging range. In this regard, the most recent counts are used, taken from JNCC's Seabird Monitoring Programme online database (http://jncc.defra.gov.uk/smp/).
- This second stage of the process is described within the RIAA assessing each respective breeding season impact on seabirds of the Moray West Site. The remainder of this section describes the methodology used to perform the first stage of the process.

3.1.1 Apportioning Impacts Between SPA and Non-SPA Breeding Colonies within Foraging Range of the Offshore Wind Farm

The current method for apportioning impacts between breeding colonies (SPA and other) within foraging range of the proposed offshore wind farm is SNH (2016) "*Interim Guidance on Apportioning Impacts from Marine Renewable Developments to Breeding Seabird Populations in Special Protection Areas*". This is an update to the guidance recommended to recent projects by Marine Scotland (2017a; b). As discussed in Section 2, connectivity to SPAs is largely based on determining seabird foraging ranges. The use of an empirically derived approach requires the use of robust site-specific field-derived data on foraging ranges and locations. This necessitates acquiring an adequate sample size of tagged birds from a colony selected from a random sample of breeding locations within the site. The tracking period should be representative of the breeding season and comparable for all sites. Moreover, it requires information from each tag and the length of each foraging day including the proportion of each day spent within the development area. Such tagging data for one or more SPA colonies with connectivity to the Moray West Site does not exist. Therefore, the theoretical approach of SNH (2016) is followed with this using published seabird foraging range information and generalised models.

The method is based on foraging range and three colony-specific weighting factors:

- (i) Colony size (with consistent count unit used between colonies for a species e.g. individuals, breeding pairs or apparently occupied sites);
- (ii) Distance of colony from the development site (using the geometric centre of both); and
- (iii) Sea area (the areal extent of the open sea within the foraging range of the relevant species).

To identify those breeding colonies (SPA and other) for which there may be connectivity between breeding birds and the Moray West Site, the mean-maximum foraging range (i.e. the mean average of the maximum foraging trips recorded) as published by Thaxter *et al.* (2012), has been applied. In order to

[1] Seabird 2000 was the third complete census of the entire breeding seabird population of Britain and Ireland. It took place during 1998 – 2002, being co-ordinated by JNCC in partnership with other organisations (http://jncc.defra.gov.uk/seabird2000).

bring Moray West Offshore Wind Farm within foraging range of kittiwake and razorbill at North Caithness Cliffs SPA, the mean-maximum range with one standard deviation has been used.

Large colonies will contribute more individuals to the number of seabirds found within the Moray West Site, all other factors being equal. To account for this, a weighting factor based on colony size is derived. For all colonies considered, colony size has been calculated from Seabird 2000 data with this providing a common reference point as all count data is contemporaneous. Seabird 2000 data is comprised of separate count sections with long stretches of coastline e.g. East Caithness Cliffs, made up of several count sections. For the purposes of this analysis each count section is treated as a separate colony. If a single SPA is made up of several count sections the combined SPA impact is reconstructed after the weighting for each count section is completed.

Weighting by distance from the colony is calculated using the measured distance between the geometric centre of the development to the geometric centre of the colony. As birds radiate out from a colony density will decrease by a factor proportional to $1/\text{distance}^2$ as area increases proportionally by πr^2. For the purposes of this assessment, a weighting factor based on $1/\text{distance}_i^2$ is used as advised by SNH (2016). For the purposes of this analysis for auk species only which do not fly at any distance over land, all colonies within mean-maximum foraging range with one standard deviation that are on the Scottish west coast, south of Cape Wrath, are not included.

The available sea area for foraging is measured by plotting a circle defined by the species- specific foraging range around the colony in ArcGIS and calculating the area of sea available to each seabird species. The fraction of the disc centred on the colony that is occupied by sea surface is then expressed as a decimal. As the density of birds will increase as the area of available foraging area decreases this is used in the formula as 1-estimated area.

The three weighting factors (weightings by colony size, distance from the colony and sea area) are combined to produce an overall weighting for each colony. Each factor is given equal weight in the combined weighting. The calculation is made as follows:

$$\text{Colony Weight} = \frac{\text{Colony Population}}{\text{Sum of Populations}} \times \frac{\text{Sum of Distance}^2}{\text{Colony Distance}^2} \times 1 - \frac{\text{Colony Sea Proportion}}{\text{Sum of 1} - \text{Sea Proportions}}.$$

The weighting is then used to calculate the proportion of birds attributed to each colony ("proportional weight of colony") by calculating colony weight divided by sum of all colony weights. As noted in 0, if a single SPA is made up of several count sections the combined weight for the SPA is reconstructed after the combined weighting for each count section is completed by summation of the colony weights.

3.1.2 Calculation of the Number of Birds Allocated to Each SPA at the Moray West Site

To estimate the contribution of each SPA to the population of birds at the Moray West Site, the total number of breeding birds at the latter site is multiplied by proportion allocated to the SPA ("proportional weight of colony"). This requires the Moray West Site count to be adjusted to account for the presence of birds aged as sub-adult or immatures. The approaches used for defining the age composition of a species population at the Moray West Site is described in Section 5.

4 Methods: Calculation of Apportioning Values for Non-Breeding Seasons

4.1 Methodology

The calculation of apportioning values for non-breeding seasons (post-breeding, non-breeding and pre-breeding) follows the approach used previously in the application and examination documentation for multiple offshore wind farms (e.g. East Anglia THREE Ltd. 2015, Forewind 2013, SMart Wind 2015a). The contribution of adult birds from an individual SPA, as estimated by Furness (2015), to the relevant BDMPS population for each species/season combination is divided by the total BDMPS population to calculate the proportion of the BDMPS population represented by adult birds from the SPA considered. An example of the computation involved is given in Section 4.2. It should be noted that no updates have been made to the population data presented in Furness (2015) as any updates will not be contemporaneous with those data not updated.

4.2 Worked Example

The following calculations are an example, in this case for guillemot, of the approach used to assess the contribution of the focal colony to the BDMPS population (i.e. what proportion of the adults in the BDMPS region consist of birds from the focal colony). In this example the focal colony is the East Caithness Cliffs SPA. Furness (2015) defines the guillemot non-breeding season (winter BDMPS) as one period. The population of guillemot in the relevant BDMPS region for the Moray West Offshore Wind Farm, i.e. 'UK North Sea and Channel waters', is estimated in the non-breeding season to be 1,617,306 birds (Furness 2015, p374, Table 62). The East Caithness Cliffs SPA adult population in the BDMPS region is 213,000. The proportion of East Caithness Cliffs SPA adult population present in the non-breeding season in the BDMPS region is 0.7 (Furness 2015, p374, Table 62). Therefore:

- The number of East Caithness Cliffs SPA adult birds in the BDMPS =
- (East Caithness Cliffs SPA adult population in the BDMPS region) * (proportion of East Caithness Cliffs SPA adult population present in the non-breeding season in the BDMPS region) = 213,000 * 0.7 = 149,100
- The proportion adults of the non-breeding BDMPS comprising East Caithness Cliffs SPA birds =
- (No. of East Caithness Cliffs SPA adult birds in the BDMPS) / (Total no. of birds in the BDMPS) = 149,100 / 1,617,306 = 0.09 (to two significant figures).

5 Methods: Age composition and sabbaticals

5.1 Age Composition During the Breeding Season

When assigning effects from the Moray West Offshore Wind Farm between age classes[2], for herring gull and kittiwake effects are apportioned to age classes using proportions derived from site survey data gathered at the Moray West Site plus a 4 km buffer. For species where this information is not available e.g. the auk species (puffin, razorbill and guillemot), the numbers of birds in each age class estimated by Furness (2015) using a stable (equilibrium) model population for the relevant species will be applied. These approaches follow recommendations on assigning impacts between age classes as provided by Marine Scotland (2017a, b) to the Inch Cape and Moray East Offshore Wind Farms.

The following species-specific sections provide further discussion on the approaches used in determination of the numbers of birds in each age class. The species considered are those five key species for which there is likely to be connectivity (and hence risk of an impact) between a key SPA breeding colony against which impacts from the Moray West Offshore Wind Farm need consideration, as determined from the Moray West Offshore Wind Farm HRA Screening Report (Moray West 2017a) and Marine Scotland project-specific advice (Marine Scotland 2017c).

5.1.1 Kittiwake

The ageing of birds in both aerial and boat-based surveys can prove problematic for certain species. Immature kittiwake beyond their first year are essentially indistinguishable from adult birds during surveys (Coulson 2011, Malling Olsen and Larsson 2003) but they do not breed until their fourth year. This means that using the age proportions from site-specific data would represent a considerable over-estimate of the proportion of adult birds present at the Moray West Site. In order to address this limitation during the breeding season, an approach was developed during the examination for Hornsea Offshore Wind Farm Project Two (SMart Wind 2015b). This approach utilises age-specific survival rates (Horswill and Robinson 2015) to calculate the proportion of different age classes likely to be present at the Moray West Site.

The approach used for Hornsea Project Two (SMart Wind 2015b) and adopted in the current assessment is considered to be precautionary. The main area of precaution is the affinity exhibited by different immature age classes to natal waters during the breeding season. First year birds show considerably less affinity for natal waters than do older immatures with many birds remaining thousands of kilometres away (Coulson 2011). Applying the approach used at Hornsea Project Two (SMart Wind 2015b) assumes that the proportion of older immatures in natal waters is consistent with the proportion of first year immatures. This under-estimates the proportion of older immature age classes present at the Moray West Site, as these birds show a much greater affinity for natal waters with much higher proportions of these age classes present in natal waters. This and other sources of uncertainty and precaution related to the calculated apportioning values are discussed in the species-specific sections below.

It is certain that an unknown proportion of the cohort of unaged 'adult type' kittiwakes at the Moray West Site will include two and three-year-old birds. Coulson (2011) provides evidence that shows that immature kittiwake visit natal waters with increasing numbers of older immatures visiting breeding colonies. This therefore supports the conclusion that the approach proposed to calculate an apportioning value for the breeding season will under-estimate the proportion of second and third year immatures which will show a much greater affinity for natal waters than first year birds.

Further to this, it is not possible to separate non-breeding adult birds from those that are breeding at SPAs with connectivity to the Moray West Site. A minimum of 4% of adult male birds missed a breeding season at North Shields, Tyneside, whereas females did so about half as frequently with a recorded maximum of

[2] classified as either adult, not adult, immature, juvenile or aged in years.

approximately 13% (Coulson 2011). In the absence of evidence to the contrary, it is reasonable to assume that immature birds that cannot be distinguished from breeding adult birds, based on plumage, are present within Moray West.

Whilst maintaining the proportion represented of each year class of immatures at the Moray West Site, mortality reduces the absolute number of birds present from each successive year class of kittiwake. In calculating the number of two and three-year-old kittiwakes at the Moray West Site, the analysis uses survival rates of each immature year class of kittiwake that follows the Model KI1 in SMart Wind (2015c) (i.e. 0.79 for juveniles, 0.85 for one-year olds and 0.87 for two year olds).

Digital aerial surveys and boat-based surveys have both collected age class data (Moray West, 2017b) within the Moray West Site and the adjacent sea area (Moray East Site) (Figure 5.1) for species where this is possible. The digital aerial surveys were conducted across a series of strip transects spaced 2.5 km apart, covering the Moray West Site plus a 4 km buffer and were undertaken by Hi-Def Aerial Surveying between April 2016 and March 2017. The analysis used data from the four surveys undertaken during the months April to July. Use of this subset of the breeding season (April to August) avoids any error arising from the age code used for newly fledged juveniles from late July. A programme of 28 boat-based surveys covering the Moray East Offshore Wind Farm site plus a 4 km buffer were undertaken between April 2010 and March 2012. This survey's coverage overlapped with the eastern end of the Moray West Offshore Wind Farm. The analysis used data from the 10 surveys undertaken during the months April to July. The following analyses present data from both datasets, with a discussion then provided as to which provides a better estimate of the age structure of the population present at the Moray West Site.

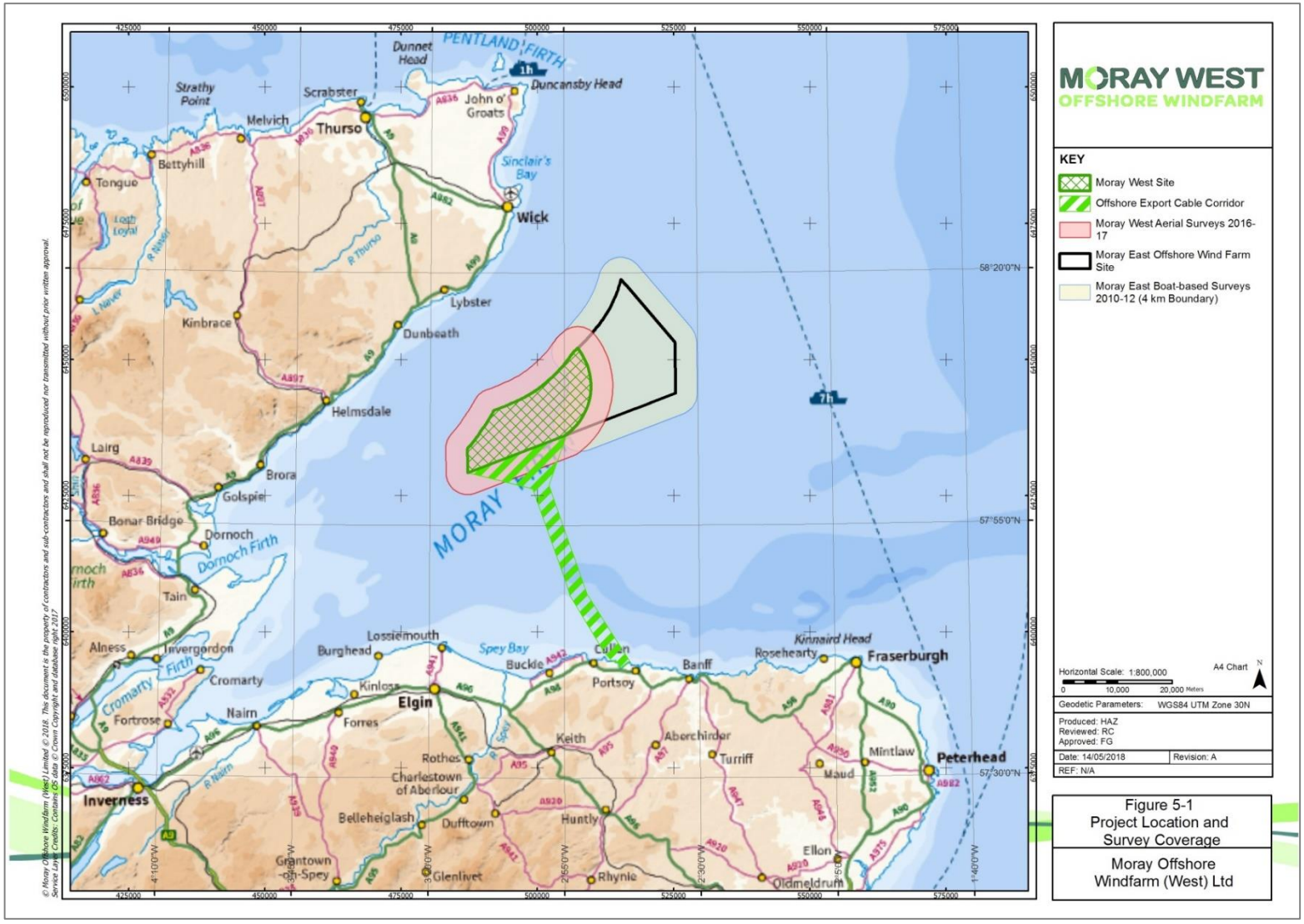

Figure 5.1:Moray West Site location and coverage by digital aerial surveys and boat-based surveys within the Moray West Site and the adjacent sea area (Moray East Site)

Table 5.1 presents the proportion of adult and immature kittiwake recorded during aerial and boat-based surveys of the Moray West Site for the months April to July.

Table 5.1:The Proportion of Adult and Immature Kittiwake Calculated using the Moray West Site Aerial Survey Data and Moray East Offshore Wind Farm Boat-Based Survey Data Collected in the Breeding Season (April to July)

Data	Sample Size	Adult Proportion (%)	Immature Proportion (%)
Aerial survey data	799	99.0	1.0
Boat-based survey data	1395	96.7	3.3

The two datasets are used in Table 5.2(boat-based survey transects covering the Moray East Offshore Wind Farm) and Table 5.3 (digital aerial survey transects covering the Moray West Site) to calculate the likely proportion of adult birds at the Moray West Site taking into account the presence of older immatures which are indistinguishable from adult birds using plumage characteristics.

Table 5.2: Breeding Season Contribution of Adult Birds to the Total Predicted to be Present at the Moray West Site using Immature Proportions as Calculated from Survival Rates and Numbers of One-Year Old Birds Recorded on Boat-Based Survey Transects Covering the Moray East Offshore Wind Farm

Analysis step	Formula (using the parameters identified as part of each analysis step)	Value
(a) Survival rate of juvenile birds		0.79
(b) Survival rate of one year old birds		0.85
(c) Survival rate of two year old birds		0.87
(d) % of kittiwake at the Moray East Offshore Wind Farm Three assigned to one year old birds		3.3%
% of kittiwake at the Moray East Offshore Wind Farm assigned to other immature age classes (e) two years old (f) three years old	$e = \frac{a \times b}{a} \times \frac{d}{100} \times 100$ $f = \frac{(a \times b) \times c}{a} \times \frac{d}{100} \times 100$	2.8% 2.4%
(g) % of kittiwakes at the Moray East Offshore Wind Farm assigned to adults	$g = 100\% - (d + e + f)$	91.5%

Table 5.3: Estimated breeding season contribution of adult birds to the total predicted to be present at the Moray West Site using immature proportions as calculated from survival rates and numbers of one-year old birds recorded on digital aerial survey transects covering the Moray West Site

Analysis step	Formula (using the parameters identified as part of each analysis step)	Value
(a) Survival rate of juvenile birds		0.79
(b) Survival rate of one year old birds		0.85
(c) Survival rate of two year old birds		0.87
(d) % of kittiwake at the Moray West Offshore Wind Farm assigned to one year old birds		1.0%
% of kittiwake at the Moray West Offshore Wind Farm assigned to other immature age classes (e) two years old (f) three years old	$e = \frac{a \times b}{a} \times \frac{d}{100} \times 100$ $f = \frac{(a \times b) \times c}{a} \times \frac{d}{100} \times 100$	0.9% 0.7%
(g) % of kittiwakes at the Moray West Offshore Wind Farm assigned to adults	$g = 100\% - (d + e + f)$	97.4%

Boat-based surveys conducted across the Moray East Site and in part, the Moray West Site, provide information on over 3,575 kittiwake of which 39% were aged. These birds were identified and aged based on direct observation by experienced seabird observers. The Moray West Site digital aerial surveys recorded 1,983 kittiwakes of which 40% were aged. The proportion of birds for which an age could be assigned are therefore comparable between the two datasets. However, the boat-based survey dataset is much larger and covers two as opposed to one season. One of the main limitations of ageing birds from digital aerial survey data is the inability to age birds recorded on the sea surface. For kittiwake, 55% of the birds recorded were on the sea surface and therefore could not be aged. The ageing of birds is also different between the two survey types. It can be argued that during boat-based surveys surveyors are able to observe the bird for a longer period of time, allowing for better consideration of the behaviour (e.g. flight characteristics, interactions with other birds), size and shape of the bird all of which can provide an indication as to the age of a bird. Digital aerial surveys allow for some consideration of these factors with aging, the protocols for which are repeatable between reviewers, conducted from videos which provide a permanent record.

Based on the proportion of first year birds observed from digital aerial surveys and boat-based surveys, and the likely age structure of the kittiwake population it is considered that adults will comprise 91.5-97.4% of the individuals observed at the Moray West Site. However, this range, is considered to be precautionary due to the following:

- Neither value accounts for adults in the population not breeding in a given year – this could account for a further reduction of *c.*5-10% (Coulson 2011, Marine Scotland 2017a, b);
- A smaller proportion of first year birds are likely to be present in natal waters with a much greater proportion of older age classes of immature birds showing affinity with natal waters; and

- Immature birds are not likely to be evenly distributed within the North Sea and will show aggregations near to foraging resources. If the area within which the Moray West Site lies is seen to be notable for kittiwake foraging, immatures may be present in larger proportions.

The evidence reviewed here, therefore suggests the proportion of adult kittiwake at the Moray West Site will be lower than the 91.5-97.4% values obtained through digital aerial and boat-based surveys respectively. In addition, the use of survival rates in the apportioning approach presented in Table 5.2 and Table 5.3 is considered to be appropriately precautionary. Older immature year classes are known to show a greater affinity for natal waters with the proportion of older immature year classes returning to natal waters during the breeding season therefore higher than the proportion of first year birds returning to natal waters. The approach applied in Table 5.2and Table 5.3 assumes that a consistent proportion of each year group will be present at the Moray West Site and therefore likely under-estimates the proportions of older immature year classes present at the Moray West Site. The apportioning value calculated using boat-based survey data from across two seasons is considered to be appropriately precautionary for use in further analyses.

5.1.2 Herring Gull

To calculate the apportioning of birds to age classes for herring gull, site-specific data collected as part of boat-based surveys of Moray East Offshore Wind Farm plus a 4 km buffer have been analysed. 28 boat-based surveys were undertaken between April 2010 and March 2012. This survey's coverage overlapped with the eastern end of the Moray West Site. The analysis used data from the 10 surveys undertaken during the months April to July. Use of a subset of the breeding season (April to August) reduces any error arising from the age code used for newly fledged juveniles. In boat-based surveys, birds were classified as either adult, not adult, immature, juvenile or aged using a number representing the year of life (i.e. 2 = second year). Digital aerial survey data from the Moray West Site has not been used on account of the small sample size with only 9 birds (17%) aged.

In the data presented below only those birds identified as adults, non-adults, immatures and those aged using a number are included. Very few juvenile birds were recorded in surveys during the breeding season sampled (April – July; 10 boat-based surveys) and, on a precautionary basis these were excluded from the calculations presented.

Table 5.4 presents the proportion of adult and immature herring gull recorded during boat-based surveys of the Moray East Offshore Wind Farm for April to July. These proportion are used in further analysis as the estimated breeding season contribution of adult birds to total predicted to be present at the Moray West Site.

Table 5.4: The Proportion of Adult and Immature Herring Gull Calculated using the Moray East Offshore Wind Farm Boat-Based Survey Data Collected in the Breeding Season (April to July)

Data	Sample Size	Adult Proportion (%)	Immature Proportion (%)
Boat-based survey data	69	84.1%	15.9%

5.1.3 Auk Species

For the three auk species (puffin, razorbill and guillemot) where the ageing of birds is not possible from digital aerial and boat-based surveys, a theoretical approach is necessary to estimate the breeding season contribution of adult birds predicted to be present at the Moray West Site. Furness (2015) uses a stable (equilibrium) model population (i.e. a Leslie Matrix model using a stable age distribution and immature survival rates adjusted to give a zero net rate of population change) to derive an estimate of the number of immatures per breeding adult in a typical population of individual seabird species in UK waters, including the three auk species. In the absence of a more robust approach, the current assessment uses the Furness (2015) estimate of the number of immatures per breeding adult in a typical population to estimate the breeding season contribution of adult birds to the total predicted to be present at the Moray West Site (Table 5.5). This is in accordance with Marine Scotland advice to Inch Cape and Moray East Offshore Wind Farm projects (Marine Scotland 2017a, b) for breeding auks.

Table 5.5: The Derived Estimate of the Proportion of Immatures per Breeding Adult in a Typical Population of each of the Three Auk Species

Species	Estimated Immatures per Breeding Adult in a Typical Population	Adult Proportion (%)	Immature Proportion (%)
Puffin	1.04	49.0%	51.0%
Razorbill	0.75	57.1%	42.9%
Guillemot	0.74	57.5%	42.5%

5.2 Age Composition during the Non-Breeding Season

For all species under consideration, the age class composition of a seabird species present at the Moray West Site during non-breeding seasons, including all the breeding interest features of individual SPAs in the UK, were derived using population data from Furness (2015).

Furness (2015) presented breeding adult and immature populations associated with colonies with predicted connectivity with the BDMPS population relevant to the Moray West Site during the non-breeding seasons (i.e. UK North Sea waters and, for some species, with Channel waters). Also presented is the proportion of each breeding colony designated as a SPA in the UK predicted to be present in the BDMPS during the non-breeding seasons together with the proportion of birds that exhibit connectivity with the BDMPS from foreign and non-SPA UK colonies (Furness 2015). For each colony with connectivity to the Moray West Site, the proportion of an age group (i.e. breeding adults or immatures) at the Moray West Site present from a colony will equate to the species age group population estimate for the colony divided by the species BDMPS population during the non-breeding seasons, for all age classes, as derived by Furness (2015). This approach is consistent with the approach applied at Hornsea Project Two and East Anglia Three by both the relevant Applicant and Natural England (East Anglia THREE Ltd. 2015, SMart Wind 2015a). Moreover it follows recommendations on assigning effects between age classes as provided by Marine Scotland (2017a, b) to Inch Cape and Moray East Offshore Wind Farms.

6 Methods: Sabbaticals

Every breeding season a proportion of adults skip breeding and take a sabbatical. To include any impacts occurring on any sabbatical birds would seem likely to overestimate the effects to these species/populations (Marine Scotland 2017a, b), as breeding colony population size estimates do not include these sabbatical birds. Therefore in accordance with Marine Scotland guidance (Marine Scotland 2017a, b), the impacts assigned to sabbaticals are removed from the assessment including any subsequent population modelling (i.e. PVA) using the values presented in Table 6.1 as advised by SNH following an initial review of the literature.

Table 6.1: The Proportion of Adults Taking Sabbaticals from Breeding in a Given Year

Species	% sabbaticals
Kittiwake	10%
Herring gull	35%
Puffin	7%
Razorbill	7%
Guillemot	7%

While there is uncertainty around appropriate rates to use, SNH were content to advise in 2017, Inch Cape and Moray East Offshore Wind Farms to adopt the above tabulated '% sabbaticals' (Marine Scotland 2017a, b). These are considered likely to be underestimates and therefore remain precautionary.

7 Results: Apportioning of Breeding Seabirds at the Moray West Site Across Multiple SPAs Within Foraging Range

Table 7.1 to Table 7.5 present the apportioning values to be used to apportion impacts from the Moray West Offshore Wind Farm to breeding populations of relevant species at SPAs for which connectivity has been identified. The species and SPAs presented are those identified in the Moray West Offshore Wind Farm HRA Screening Report (Moray West 2017a) and from Marine Scotland project-specific advice (Marine Scotland 2017c).

Table 7.1: The Proportion of Breeding Kittiwake at the Moray West Offshore Wind Farm Apportioned to SPAs and Sites outside of SPAs within Foraging Range

SPA name	Count of occupied nests on SPA	Distance from SPA to the Moray West Offshore Wind Farm (km)	1-Proportion of foraging range at sea	Resulting weight for SPA	Proportional weight of SPA[3]
North Caithness Cliffs	10,147	67.5	0.31	0.07	0.03
East Caithness Cliffs	40,450	30.6	0.39	1.68	0.86
Troup, Pennan and Lion's Heads	18,991	63.6	0.33	0.16	0.08
All other colonies	3,428	64.0	0.45	0.05	0.02

Table 7.2: The Proportion of Breeding Herring Gull at the Moray West Offshore Wind Farm Apportioned to SPAs and Sites Outside of SPAs within Foraging Range

SPA name	Count of occupied nests/territories on SPA	Distance of SPA to the Moray West Offshore Wind Farm (km)	1-Proportion of foraging range at sea	Resulting weight for SPA	Proportional weight of SPA[3]
East Caithness Cliffs	3,411	30.4	0.41	1.31	0.60
Troup, Pennan and Lion's Heads	2,001	63.6	0.33	0.14	0.06
Buchan Ness to Collieston Coast	3,317	102.8	0.28	0.08	0.03
All other colonies	5,736	74.0	0.42	0.66	0.30

[3] The summation of the values in the column of the proportional weight of SPA does not add to 1.0 due to rounding of the individual values.

Table 7.3: The Proportion of Breeding Puffin at the Moray West Offshore Wind Farm Apportioned to SPAs and Sites Outside of SPAs within Foraging Range					
SPA name	**Count of occupied burrows on SPA**	**Distance from SPA to the Moray West Offshore Wind Farm (km)**	**1-Proportion of foraging range at sea**	**Resulting weight for SPA**	**Proportional weight of SPA**
North Caithness Cliffs	7,075	66.8	0.26	0.21	0.32
All other colonies	66,621	98.8	0.27	0.44	0.68

Table 7.4: The Proportion of Breeding Razorbill at the Moray West Offshore Wind Farm Apportioned to SPAs and Sites Outside of SPAs Within Foraging Range					
SPA name	**Count of adult birds on SPA**	**Distance from SPA to the Moray West Offshore Wind Farm (km)**	**1-Proportion of foraging range at sea**	**Resulting weight for SPA**	**Proportional weight of SPA**
North Caithness Cliffs	2,472	66.6	0.30	0.05	0.02
East Caithness Cliffs	17,869	30.3	0.38	2.14	0.91
Troup, Pennan and Lion's Heads	4,958	62.9	0.34	0.36	0.06
All other colonies	1,942	70.5	0.35	0.04	0.01

Table 7.5: The Proportion of Breeding Guillemots at the Moray West Offshore Wind Farm Apportioned to SPAs and Sites Outside of SPAs within Foraging Range					
SPA name	**Count of adult birds on SPA**	**Distance from SPA to the Moray West Offshore Wind Farm (km)**	**1-Proportion of foraging range at sea**	**Resulting weight for SPA**	**Proportional weight of SPA**
North Caithness Cliffs	70,154	66.6	0.36	0.29	0.05
East Caithness Cliffs	159,005	30.4	0.40	4.57	0.84
Troup, Pennan and Lion's Heads	47,953	62.9	0.36	0.31	0.06
Buchan Ness to Collieston Coast	29,362	103.0	0.26	0.05	0.01
All other colonies	175,578	105.8	0.19	0.20	0.04

8 Results: Calculation of Apportioning Values for Non-Breeding Seasons

Table 8.1 to Table 8.5 present the calculated proportion of the relevant BDMPS population represented by adult birds of the SPAs for which connectivity has been identified in the breeding season with the Moray West Site. The species and SPAs presented are those identified in the Moray West Offshore Wind Farm HRA Screening Report (Moray West 2017a) and from Marine Scotland project-specific advice (Marine Scotland 2017c).

Table 8.1: The Contribution of Breeding Kittiwakes from SPAs to the UK North Sea Waters BDMPS Population

SPA name	Post-breeding (August - December)	Pre-breeding (January - April)
North Caithness Cliffs	0.01	0.02
East Caithness Cliffs	0.06	0.08
Troup, Pennan and Lions Heads	0.02	0.03

Table 8.2: The Contribution of Breeding Herring Gull from SPAs to the UK North Sea and Channel Waters BDMPS Population

SPA name	Non-breeding season (September - February)
East Caithness Cliffs	0.01
Troup, Pennan and Lions Heads	0.01
Buchan Ness to Collieston Coast	0.01

Table 8.3: The Contribution of Breeding Puffin from SPAs to the UK North Sea and Channel Waters BDMPS Population

SPA name	Non-breeding season
North Caithness Cliffs	0.00

Table 8.4: The Contribution of Breeding Razorbill from SPAs to the UK North Sea and Channel Waters BDMPS Population

SPA name	Post and pre-breeding (August – October, January - March)	Non-breeding (November - December)
North Caithness Cliffs	0.01	0.00
East Caithness Cliffs	0.04	0.03
Troup, Pennan and Lions Heads	0.01	0.00

Table 8.5: The Contribution of Breeding Guillemot from SPAs to the UK North Sea and Channel Waters BDMPS Population	
SPA name	**Non-breeding season (August - February)**
North Caithness Cliffs	0.04
East Caithness Cliffs	0.09
Troup, Pennan and Lions Heads	0.01
Buchan Ness to Collieston Coast	0.01

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MORAY WEST
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Population Viability Analyses

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Appendix 4.5

DMP STATS

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MORAY WEST PVA REPORT

Prepared for M. Hazleton & I. Ellis, Niras

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15 May 2018

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DOCUMENT INFORMATION	
VERSION	1.0
ISSUED DATE	15 May 2018
AUTHOR	B. Caneco & C. Donovan
STATUS	Draft

REVISION HISTORY		
VERSION	ISSUED DATE	REASON FOR ISSUE
1.0	15 May 2018	Issued for Information & review

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1 OVERVIEW

This document presents the underpinnings of the Population Viability Analyses (PVAs) conducted for Niras and the Moray West wind farm EIA. The analysis was performed for breeding colonies of seven species of seabirds in three different Special Protected Areas (SPAs). Stochastic, density independent, age-structured matrix models were used to simulate population trends over time for a range of impacts scenarios. Full details of the analysis, including model specifications and demographic rates used, are provided below.

2 METHODS

The potential impacts of the Moray West wind-farm development on the population growth and size of seven seabird species inhabiting three local SPAs/pSPAs were predicted via population viability analysis (PVA). Table 1 describes the populations and the SPAs analysed.

2.1 Matrix Models and parameterisation

Table 1: Populations and SPAs considered for analysis, and corresponding initial population sizes used in the modelling

Species	SPA	Initial population size (breeding individuals)	Year	Source
Northern Gannet	Troup Head SSSI	7694		pers. comm. I. Ellis (07/03/2018)
Puffin	North Caithness Cliffs	3507	2016	Marine Scotland Scoping Opinion, Appendix A
Razorbill	East Caithness Cliffs	30042	2015	Marine Scotland Scoping Opinion, Appendix A
	North Caithness Cliffs	3507	2015	Marine Scotland Scoping Opinion, Appendix A
Common Guillemot	East Caithness Cliffs	149228	2015	Marine Scotland Scoping Opinion, Appendix A
	North Caithness Cliffs	38863	2016	Marine Scotland Scoping Opinion, Appendix A
Black-legged Kittiwake	East Caithness Cliffs	48920		Marine Scotland Scoping Opinion, Appendix A
	North Caithness Cliffs	11146		Marine Scotland Scoping Opinion, Appendix A
Herring gull	East Caithness Cliffs	6534	2015	Marine Scotland Scoping Opinion, Appendix A
Great Black-Backed Gull	East Caithness Cliffs	532	2015	Marine Scotland Scoping Opinion, Appendix A

For each species, an age-structured matrix model (Caswell, 2001) was built to simulate the population's progress through time in terms of abundance and age distribution, based on species-specific demographic rates and count estimates. The model assumes individuals to be grouped into discrete year age-classes, and all members of a particular age-class are considered equal with respect to their demographic vital rates (i.e. survival, growth and reproduction). The model dynamics involves predicting the population numbers at age in the next year given its previous year's numbers and vital rates.

The generic population model can be written in compact form as

$$\mathbf{n}_{y+1} = \mathbf{L}\mathbf{n}_y$$

where $\mathbf{n}_y$ is the population vector with elements $n_{a,y}$ denoting the number of individuals at each age-class $a = 1, \dots, A$ at year y, $\mathbf{n}_{y+1}$ is the numbers at age-class in the following year, and $\mathbf{L}$ represents the $A \times A$ projection matrix (also known as the Leslie matrix). The projection matrix $\mathbf{L}$ defines the expected contribution of individuals in each age-class in a given year to each age-class in the subsequent year.

Models used in this analysis were built under the following assumptions, for all considered species:

- models represent an annual post-breeding census over a period of $y = 1, \dots, Y$ year steps. Therefore, the model annual cycle comprises a census immediately after fledging on the first day of the biological year, with the first age-class ($a = 1$) containing newly hatched birds, followed by a 12 months period of survival. Then, on the first day of the subsequent year, surviving animals increment in age, adult age-classes reproduce and resultant newborns fledge, and the next census is carried out.
- reproduction is considered to be confined to adult birds, with age of first breeding being species-specific.
- population size is density independent, and therefore projections will either increase to infinity or decrease to extinction.
- population is considered to be closed system, i.e. age distributions are not affected by migration exchanges between neighbouring colonies
- the final age-class A is a aggregated age group, representing A years-old birds and older. This implies the absence of senescence, i.e. the survival and reproductive performances of the oldest animals remain constant over time. The value of A, and hence the size of the projection matrix, of each species is determined by either the age of first breeding or the oldest adult age-class for which survival data is available (the largest of the two values).

Based on the above assumptions, the expanded version of the generic population model used in this analysis can be expressed as

$$\begin{bmatrix} n_{1,t+1} \\ n_{2,t+1} \\ n_{3,t+1} \\ \vdots \\ n_{A,t+1} \end{bmatrix} = \begin{bmatrix} 0 & \cdots & 0 & P_{A-1}(0.5)S_{A-1\to A} & P_A(0.5)S_A \\ S_{1\to 2} & 0 & 0 & \cdots & 0 \\ 0 & S_{2\to 3} & 0 & \cdots & 0 \\ \vdots & \vdots & \ddots & \ddots & \vdots \\ 0 & 0 & 0 & S_{A-1\to A} & S_A \end{bmatrix} \times \begin{bmatrix} n_{1,t} \\ n_{2,t} \\ n_{3,t} \\ \vdots \\ n_{A,t} \end{bmatrix}$$

where P_A denotes the annual productivity rate of age-class A, expressed as the annual average number of fledged young per breeding pair; and $S_{a\to a+1}$ represents the annual survival transition rate of animals of age-class a, i.e. the average proportion of birds in age-class a that will survive the whole year and trasition to age-class $a + 1$. Elements in the top row of the projection matrix $\mathbf{L}$ (i.e. half of the produtivity rate multiplied by the survival rate) reflect the annual fecundity rate per capita of each adult age-class.

Environmental stochasticity, which accounts for the variation arising from environmental changes affecting individuals in the same group (e.g. between-year differences in weather conditions), was incorporated in the models at the level of productivity and survival rates. For each simulated year, a value for each demographic rate was randomly generated from a probability distribution defined by the mean and standard deviation estimates of that rate for the population under consideration.

Random survival rates, which are theoretically bounded at 0 and 1, were drawn from beta distributions. Stretched beta distributions were used to generate productivity rates as it allows an upper limit greater than one, which was set based on the maximum number of eggs laid per pair per year for each species. These two distributions are considered to provide biologically reasonable random values of each vital rate (Morris and Doak, 2002).

Demographic stochasticity, which accounts for individual-level variation affecting transition probabilities between age-classes, was not included in the models. For large populations, like the ones considered in this analysis (Table 1), the effects of environmental stochasticity are deemed more important than those associated with demographic stochasticity (Morris and Doak, 2002).

Table 2 provides the demographic parameters used to specify the models for each species. With the exception of maximum number of eggs per pair (taken from Snow and Perrins, 1998), all remaining parameter were obtained from Horswill and Robinson (2015).

Table 2: Species features and demographic parameters and vital rates used in the population models (Snow & Perrins, 1998; Horswill & Robinson, 2015).

	Reproduction				Survivals						Productivities	
Species	Age first breeding	Final age (A)	Eggs/pair		$S_{1->2}$	$S_{2->3}$	$S_{3->4}$	$S_{4->5}$	$S_{5->6}$	S_A	P_{A-1}	P_A
Gannet	5.01	5	2	**Mean**	0.424	0.829	0.891	0.895		0.919	0	0.698
				SD	0.007	0.004	0.003	0.003		0.042	0	0.071
Puffin	5	6	3	**Mean**	0.892	0.892	0.892	0.76	0.805	0.906	0.617	0.617
				SD	0.009	0.009	0.009	0.019	0.017	0.083	0.151	0.151
Razorbill	5.01	5	1	**Mean**	0.794	0.794	0.895	0.895		0.895	0	0.459
				SD	0.134	0.134	0.067	0.067		0.067	0	0.236
Guillemot	6	6	1.001	**Mean**	0.56	0.792	0.917	0.939	0.939	0.939	0	0.629
				SD	0.013	0.034	0.022	0.015	0.015	0.015	0	0.174
Black-legged Kittiwake	4	4	2	**Mean**	0.79	0.854	0.854			0.854	0	0.819
				SD	0.092	0.051	0.051			0.051	0	0.332
Herring Gull	5	5	3	**Mean**	0.798	0.798	0.834	0.834		0.834	0	0.92
				SD	0.092	0.092	0.034	0.034		0.034	0	0.477
Great Black-Backed Gull	5.01	5.01	2	**Mean**	0.82	0.885	0.885	0.885		0.885	0	1.139
				SD	0.022	0.022	0.022	0.022		0.022	0	0.533

Annual productivity rates were selected from regional-specific estimates available in Horswill and Robinson (2015). Thus, for the Moray West site, U.K. north-eastern productivity estimates were used whenever possible (Table 3). Single survival estimates attributed to multiple age-classes (e.g. Puffin) were split evenly into annual survival rates, with associated standard deviations computed via simulation (Table 3).

Table 3: Comments on values selected for demographic rates

Species	Demographic Rate	Comments
Gannet	Productivity	Eastern UK figures. Suggested experience-specific productivity not applied
Puffin	Productivity	Average UK rates
	Survivals $S_{1->2}$, $S_{2->3}$ & $S_{3->4}$	Literature provides a single mean (0.709) and SD (0.022) for the first 3 age-classes. Corresponding annual mean rate computed as exp(log(0.709)/3) = 0.892. Approximate annual SD (0.009) derived from 1000 draws from a beta distribution with mean=0.709 and SD=0.022.
Razorbill	Productivity	Northern UK figures
	Survivals $S_{1->2}$ & $S_{2->3}$	Literature provides a single mean (0.630) and SD (0.209) for the first 2 age-classes. Corresponding annual mean rate computed as exp(log(0.63)/2) = 0.794. Approximate annual SD (0.134) derived from 1000 draws from a beta distribution with mean=0.63 and SD=0.209.
Guillemot	Productivity	Northern UK figures
Black-legged Kittiwake	Productivity	Eastern UK figures
Herring Gull	Productivity	Age-specific productivity rates available, but data quality noted as being poor. No figures available for colonies in the Moray Firth. Average UK rates used instead.
Great Black-Backed Gull	Productivity	Average UK rates
	All survivals	Survival rates largely unknown for this species. Following Horswill and Robinson's (2015) advice, survival rates from the Lesser Black-backed Gull used instead

For each population model, assuming that the population was at equilibrium before the windfarm development, the initial population vector (i.e. $\mathbf{n_1}$) was obtained by multiplying the initial population size (Table 1) by the population's stable age distribution (i.e. the proportion of individuals per age-class). The stable age distribution was provided by the right eigenvector associated with the dominant eigenvalue of the population projection matrix based on mean demographic rates (Table 2). The (average) stable age distribution for each species is provided in Table 4.

Therefore, starting with the initial population vector for the first simulated year, new population vectors were calculated by multiplying the previous year's population vector by a new projection matrix generated from sampling each demographic rate (i.e. different projection matrices prevailing in each simulated year).

Models were run for 50 years, representing the likely lifespan of the wind farm developments. Each 50-year simulation was run 1000 times to obtain indicative population trends and estimates of uncertainty surrounding those trends. Models were run for each SPA separately based on population size estimates.

Table 4: Stable age structure for each species under analysis

Age-class	Gannet	Puffin	Razorbill	Guillemot	Kittiwake	Herring Gull	Great Black-backed Gull
1	0.192	0.143	0.127	0.162	0.187	0.18	0.199
2	0.081	0.124	0.101	0.088	0.143	0.143	0.15
3	0.067	0.108	0.08	0.068	0.118	0.114	0.122
4	0.059	0.094	0.072	0.06	0.553	0.095	0.099
5	0.602	0.069	0.619	0.055		0.469	0.43
6		0.463		0.566			

Wind farm impacts from collision and displacement effects were incorporated in the models in terms of additional mortalities. Displacement effects were assumed to have no impact on productivity rates. Additional mortalities were assumed to be applied to all age classes in proportion to their presence (i.e. the probability of a bird being killed by the wind farm is independent its age). A range of absolute additional adult mortalities, from 0 to a species-specific maximum value by incremental steps of 50, were considered for reporting.

The impact scenarios are expressed as an absolute number of adult deaths. However, this is not expected to remain constant as population sizes change. As such, the absolute number of additional adult deaths only strictly applies in the first year of simulation. It is converted to per-capita deaths for projection forwards i.e. the number of additional adult deaths in a year will increase proportionately with an increase in the simulated population size.

2.2 Implementation

All modelling was done in the R statistical programming environment v3.3.x (R Core Team, 2017). All code was bespoke.

2.3 Key outputs

Outputs here focus on reference points indicated in the relevant scoping document[1]. The principal metrics indicated in the scoping document follow recommendations by Jitlal *et al.* (2017)[2] and are the:

1. median of the ratio of impacted to unimpacted annual growth rate.
2. median of the ratio of impacted to unimpacted population size.
3. centile for unimpacted population that matches the 50th centile for impacted population.

Where annual population growth rate was required, this was calculated as the average over years 5 to 50 of the simulations, as per scoping recommendations – the first 5 years being discarded to mitigate against effects of starting conditions.

[1] Marine Scotland - Licensing Operations Team (16 June 2017) Scoping Opinion Addendum: Ornithology. SCOPING OPINION FOR THE PROPOSED SECTION 36 CONSENT AND ASSOCIATED MARINE LICENCE APPLICATION FOR THE MORAY EAST OFFSHORE WINDFARM ALTERNATIVE DESIGN PARAMETERS – ORNITHOLOGY ASPECTS ONLY

[2] Jitlal, M., Burthe, S., Freeman, S. and Daunt F. 2017 Testing and validating metrics of change produced by Population Viability Analysis (PVA) – Marine Scotland Science commissioned report (currently unpublished)

3 REFERENCES

Caswell, H. 2001. Matrix Population models, Second Edition. Sinauer Associates, Inc. Sunderland, MA.

Horswill, C. & Robinson R. A. 2015. Review of seabird demographic rates and density dependence. JNCC Report No. 552. Joint Nature Conservation Committee, Peterborough.

Marine Scotland - Licensing Operations Team (16 June 2017) Scoping Opinion Addendum: Ornithology. Scoping opinion for the proposed section 36 consent and associated marine licence application for the moray east offshore windfarm alternative design parameters – ornithology aspects only.

Morris, W.F. and Doak, D.F. 2002. Quantitative conservation biology: theory and practice of population viability analysis. Sinauer, MA.

R Core Team (2017). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Snow, D.W. & Perrins, C.M. 1998. The birds of the western Palearctic, Concise editon. Oxford University Press.

4 APPENDIX

The following are selected outputs for the simulations run for:

- Gannets: Troup Head
- Puffin: North Caithness Cliffs
- Razorbill: North/East Caithness Cliffs
- Guillemot: North/East Caithness Cliffs
- Kittiwake: North/East Caithness Cliffs
- Herring gull: East Caithness Cliffs
- Great Black-backed Gull: East Caithness Cliffs

Outputs from VPAs can be voluminous and may be summarised in many ways. Outputs here focus on reference points indicated in the relevant scoping document[3], as well as over-arching views of the simulations. The principal metrics indicated in the scoping document follow recommendations by Jitlal *et al.* (2017)[4] and are the:

4. median of the ratio of impacted to unimpacted annual growth rate
5. median of the ratio of impacted to unimpacted population size
6. centile for unimpacted population that matches the 50th centile for impacted population

Here for each species/population we present:

1. Plots of the distributions of simulated final population sizes after 50 years. Unimpacted distributions are presented in each, along with a range of impact scenarios, in terms of varying additional adult mortalities.
2. Plots of the population size projections through time, 0 - 50 years post-construction. A range of impact scenarios are presented in terms of varying additional adult mortalities, ranging from 0 (unimpacted) to a species/population-specific upper limit.
3. Plots comparing the 50th percentile points of the simulated impacted and unimpacted populations sizes through time (two representations are given).
4. Plots comparing the growth rates of simulated impacted and unimpacted populations, for a range of impact sizes.
5. A table of growth rates under varying impact scenarios, with several reference points expressed: the 2.5%, 50% & 97.5% points of the distribution of simulated rates.

[3] Marine Scotland - Licensing Operations Team (16 June 2017) Scoping Opinion Addendum: Ornithology. SCOPING OPINION FOR THE PROPOSED SECTION 36 CONSENT AND ASSOCIATED MARINE LICENCE APPLICATION FOR THE MORAY EAST OFFSHORE WINDFARM ALTERNATIVE DESIGN PARAMETERS – ORNITHOLOGY ASPECTS ONLY

[4] Jitlal, M., Burthe, S., Freeman, S. and Daunt F. 2017 Testing and validating metrics of change produced by Population Viability Analysis (PVA) – Marine Scotland Science commissioned report (currently unpublished)

4.1 Gannets – Troup Head

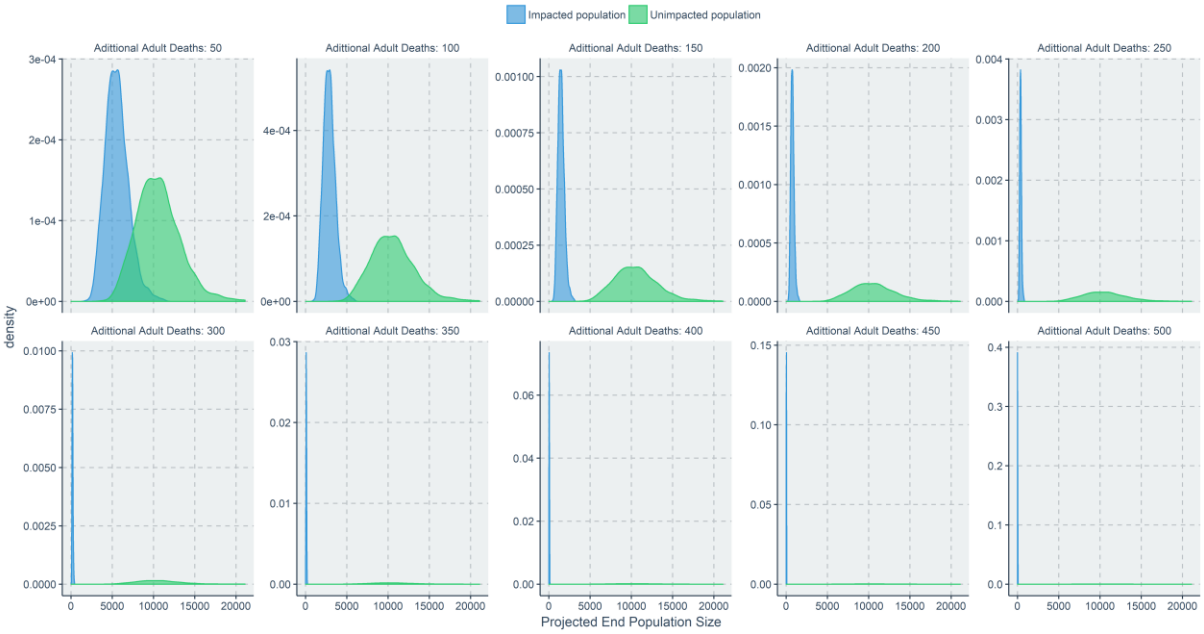

Figure 1: Distributions of end population sizes under simulation. Each plot represents a different impact scenario in terms of additional adult mortalities. The distribution of end population sizes for the unimpacted simulations are given in each.

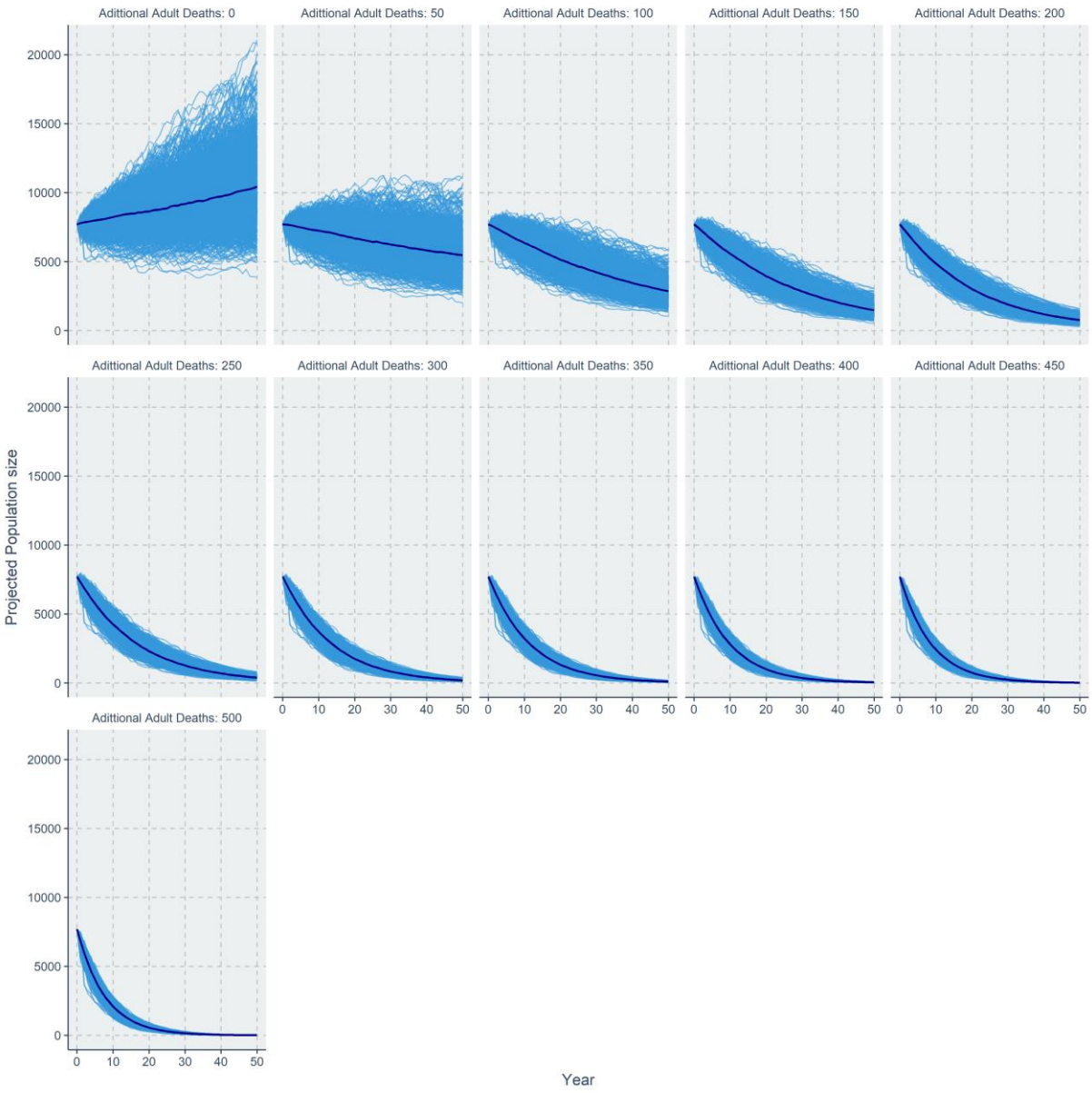

Figure 2: projections of population sizes over a 50-year time-frame. Each plot represents a different impact scenario in terms of additional adult mortalities (starting at 0 i.e. unimpacted). Individual blue lines are different realisations of the population trajectory, when population parameters are sampled from their distributions. The dark blue line is the median at each time point.

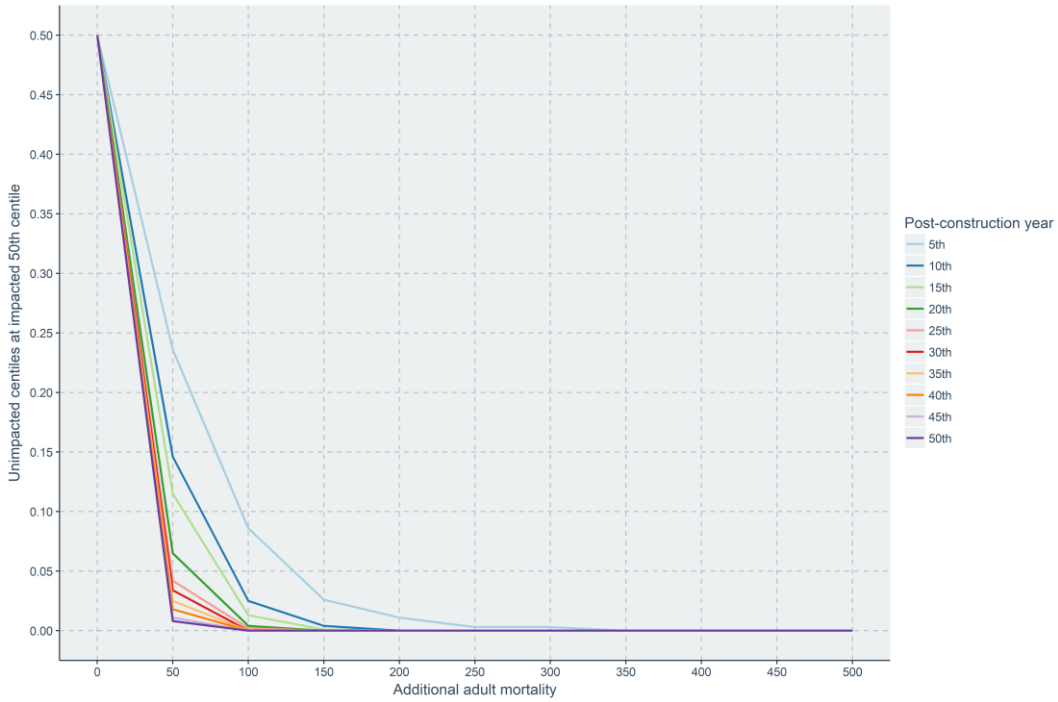

Figure 3: the median of the impacted population as a centile of the unimpacted population, under a range of impact scenarios (additional adult mortalities – x-axis). For example, 0.3 means the median (50th percentile) of the impacted projections sits at the 30th percentile of the unimpacted projections. Individual lines represent years post-construction (0-50 years).

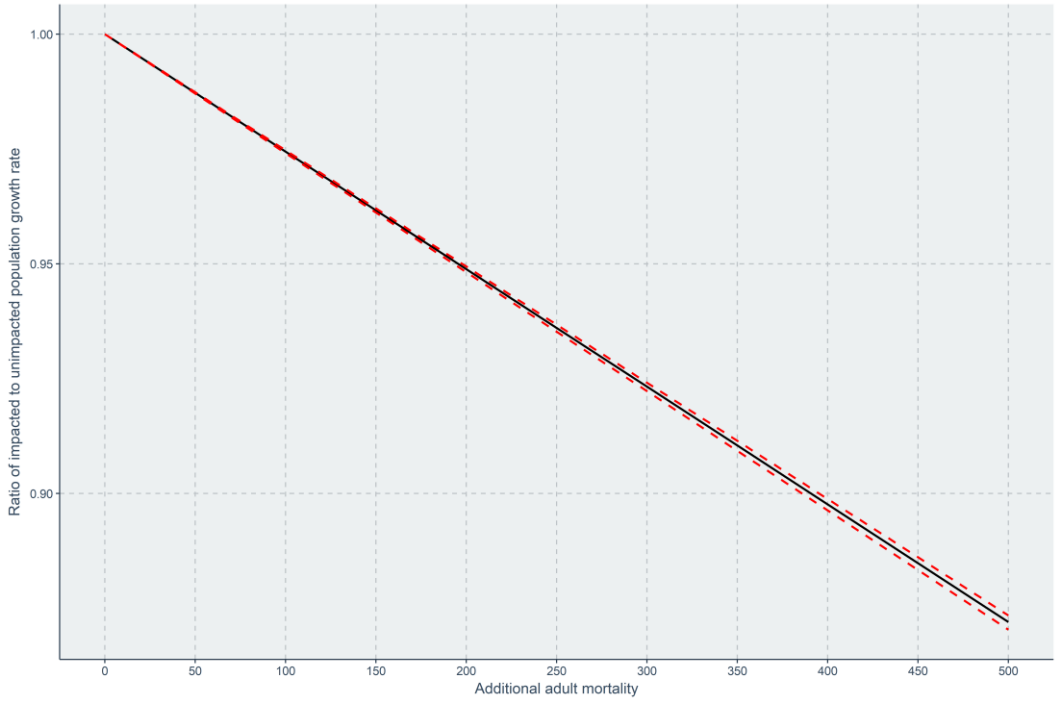

Figure 4: ratio of impacted and unimpacted growth rates under a range of impact scenarios (additional adult mortalities – x-axis) i.e. 0.9 means a 10% decrease in the growth rate under the impact scenario. Figures are based on paired simulations for the impacted and unimpacted populations i.e. based on the same sampled population parameters. The black line represents the 50th percentile (median), red lines give the central 95% of simulated values (2.5% and 97.5% reference points).

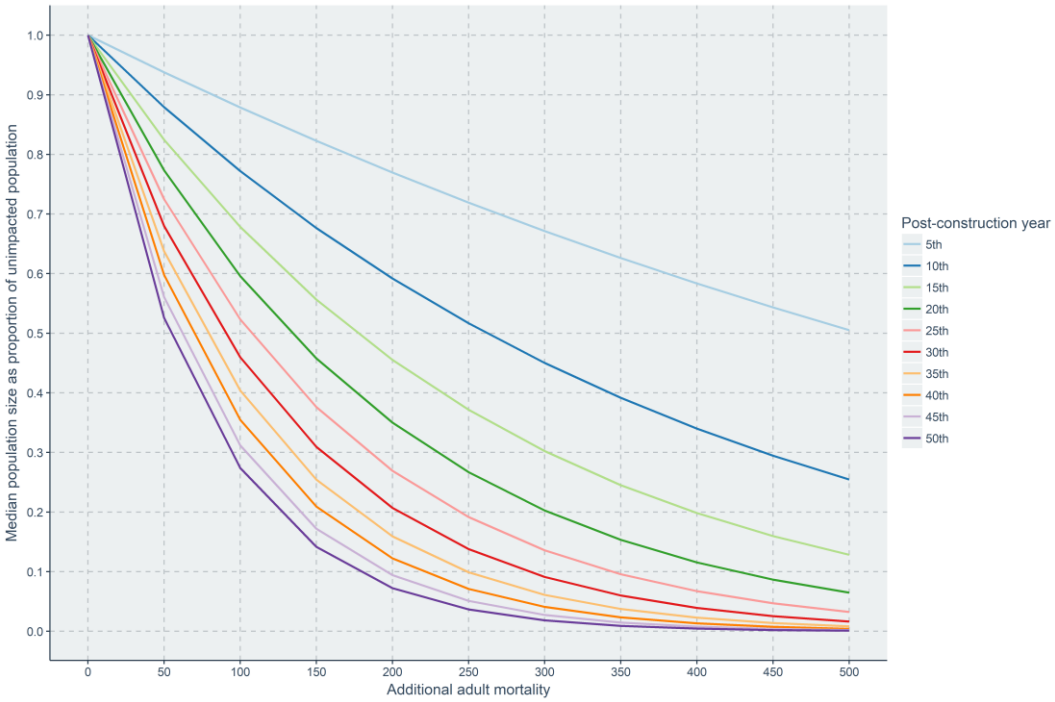

Figure 5: the ratio of the median impacted and median unimpacted population sizes from the simulations i.e. 0.5 means the median impacted population size is one-half the median unimpacted population size. Impact scenarios, in terms of additional adult mortalities, are given on the x-axis. Individual lines represent post-construction time points (projected 0 – 50 years).

Table 5: Growth rates of simulated populations under different impact scenarios. Reference points are 2.5%, 50% (median) and 97.5% of the distribution of simulated growth rates.

Additional adult mortalities	Median growth rates	2.5 percentile of simulated growth rates	97.5 percentile of simulated growth rates
0	1.006	0.995	1.016
50	0.993	0.982	1.003
100	0.980	0.969	0.991
150	0.967	0.956	0.978
200	0.955	0.943	0.965
250	0.942	0.930	0.952
300	0.929	0.918	0.939
350	0.916	0.905	0.926
400	0.903	0.892	0.913
450	0.890	0.879	0.900
500	0.877	0.866	0.888

4.2 Puffin – North Caithness Cliffs

Figure 6: Distributions of end population sizes under simulation. Each plot represents a different impact scenario in terms of additional adult mortalities. The distribution of end population sizes for the unimpacted simulations are given in each.

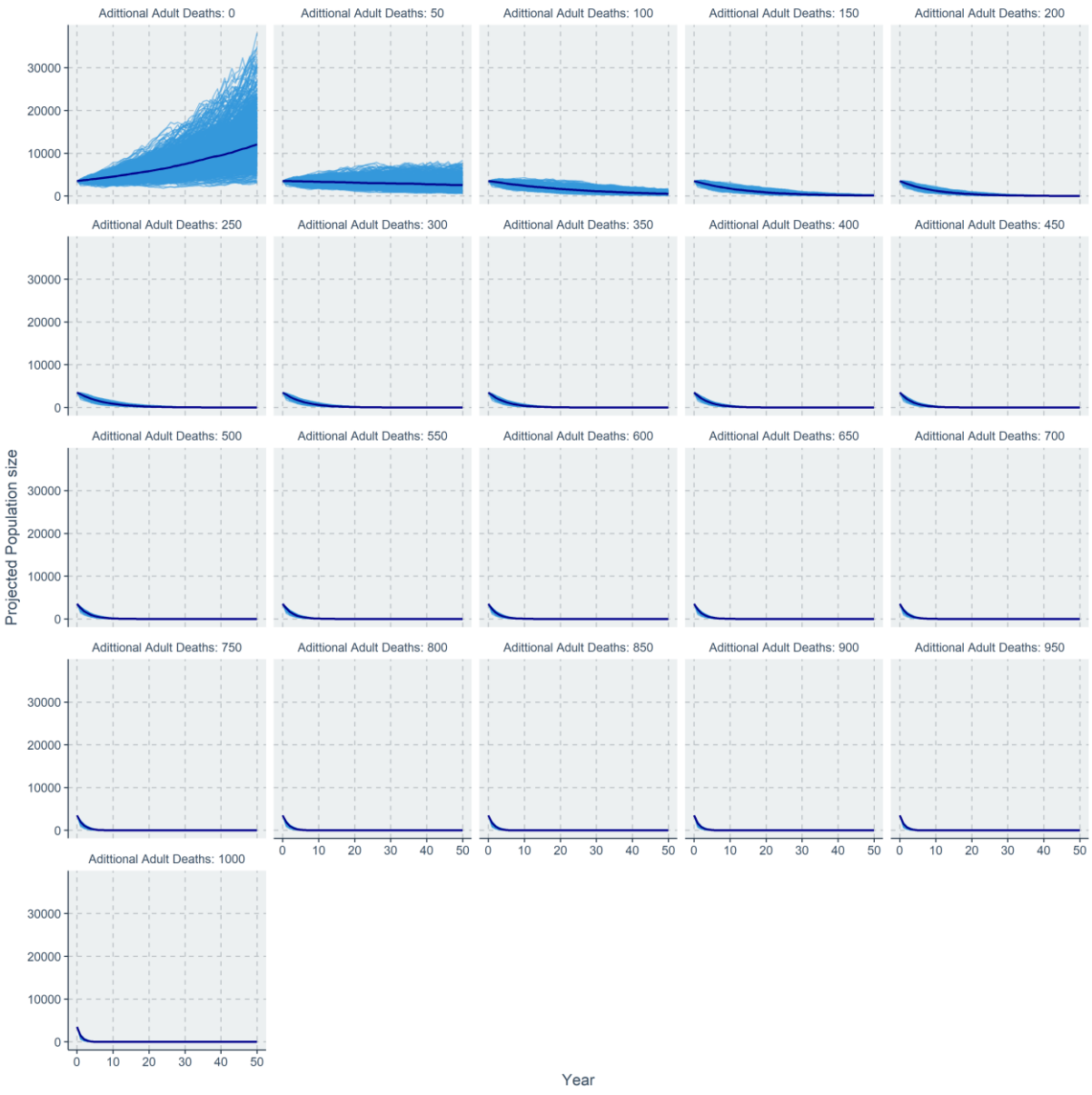

Figure 7: projections of population sizes over a 50-year time-frame. Each plot represents a different impact scenario in terms of additional adult mortalities (starting at 0 i.e. unimpacted). Individual blue lines are different realisations of the population trajectory, when population parameters are sampled from their distributions. The dark blue line is the median at each time point.

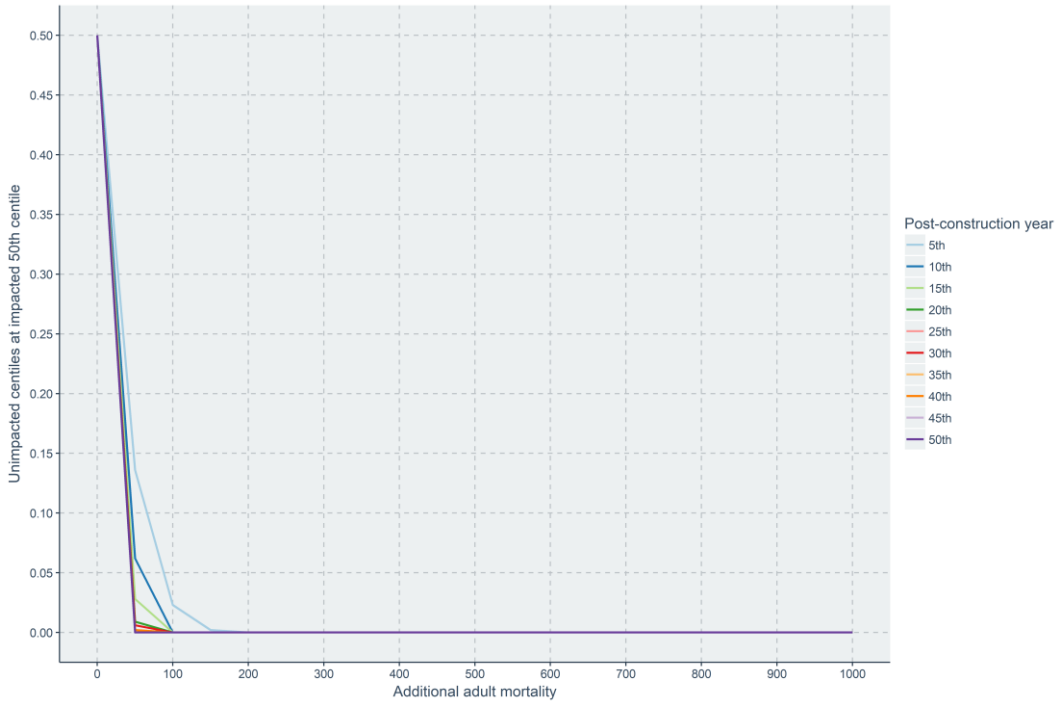

Figure 8: the median of the impacted population as a centile of the unimpacted population, under a range of impact scenarios (additional adult mortalities – x-axis). For example, 0.3 means the median (50th percentile) of the impacted projections sits at the 30th percentile of the unimpacted projections. Individual lines represent years post-construction (0-50 years).

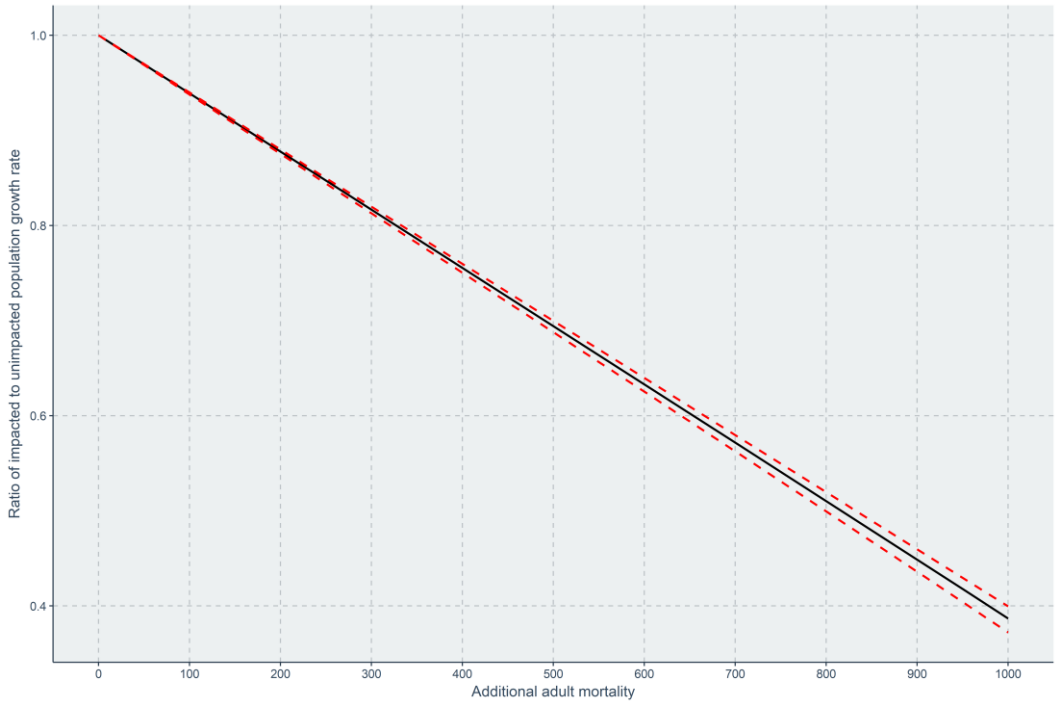

Figure 9: ratio of impacted and unimpacted growth rates under a range of impact scenarios (additional adult mortalities – x-axis) i.e. 0.9 means a 10% decrease in the growth rate under the impact scenario. Figures are based on paired simulations for the impacted and unimpacted populations i.e. based on the same sampled population parameters. The black line represents the 50th percentile (median), red lines give the central 95% of simulated values (2.5% and 97.5% reference points).

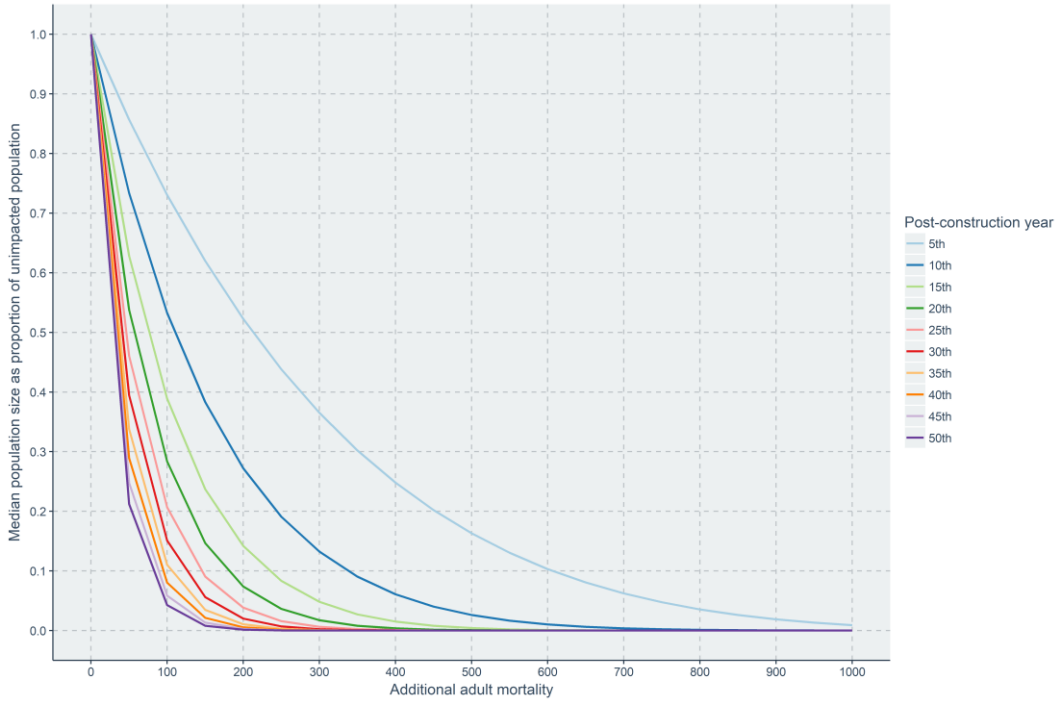

Figure 10: the ratio of the median impacted and median unimpacted population sizes from the simulations i.e. 0.5 means the median impacted population size is one-half the median unimpacted population size. Impact scenarios, in terms of additional adult mortalities, are given on the x-axis. Individual lines represent post-construction time points (projected 0 – 50 years).

Table 6: Growth rates of simulated populations under different impact scenarios. Reference points are 2.5%, 50% (median) and 97.5% of the distribution of simulated growth rates.

Additional adult mortalities	Median growth rates	2.5 percentile of simulated growth rates	97.5 percentile of simulated growth rates
0	1.025	1.006	1.042
50	0.994	0.975	1.011
100	0.962	0.943	0.979
150	0.931	0.912	0.948
200	0.899	0.881	0.917
250	0.868	0.849	0.885
300	0.837	0.818	0.854
350	0.806	0.787	0.823
400	0.774	0.755	0.791
450	0.743	0.724	0.760
500	0.711	0.692	0.729
550	0.680	0.661	0.698
600	0.649	0.629	0.666
650	0.617	0.598	0.635
700	0.586	0.566	0.604
750	0.554	0.535	0.572
800	0.523	0.503	0.541
850	0.491	0.471	0.510
900	0.460	0.439	0.479
950	0.428	0.407	0.447
1000	0.396	0.375	0.416

4.3 Razorbill – North Caithness Cliffs

Figure 11: Distributions of end population sizes under simulation. Each plot represents a different impact scenario in terms of additional adult mortalities. The distribution of end population sizes for the unimpacted simulations are given in each.

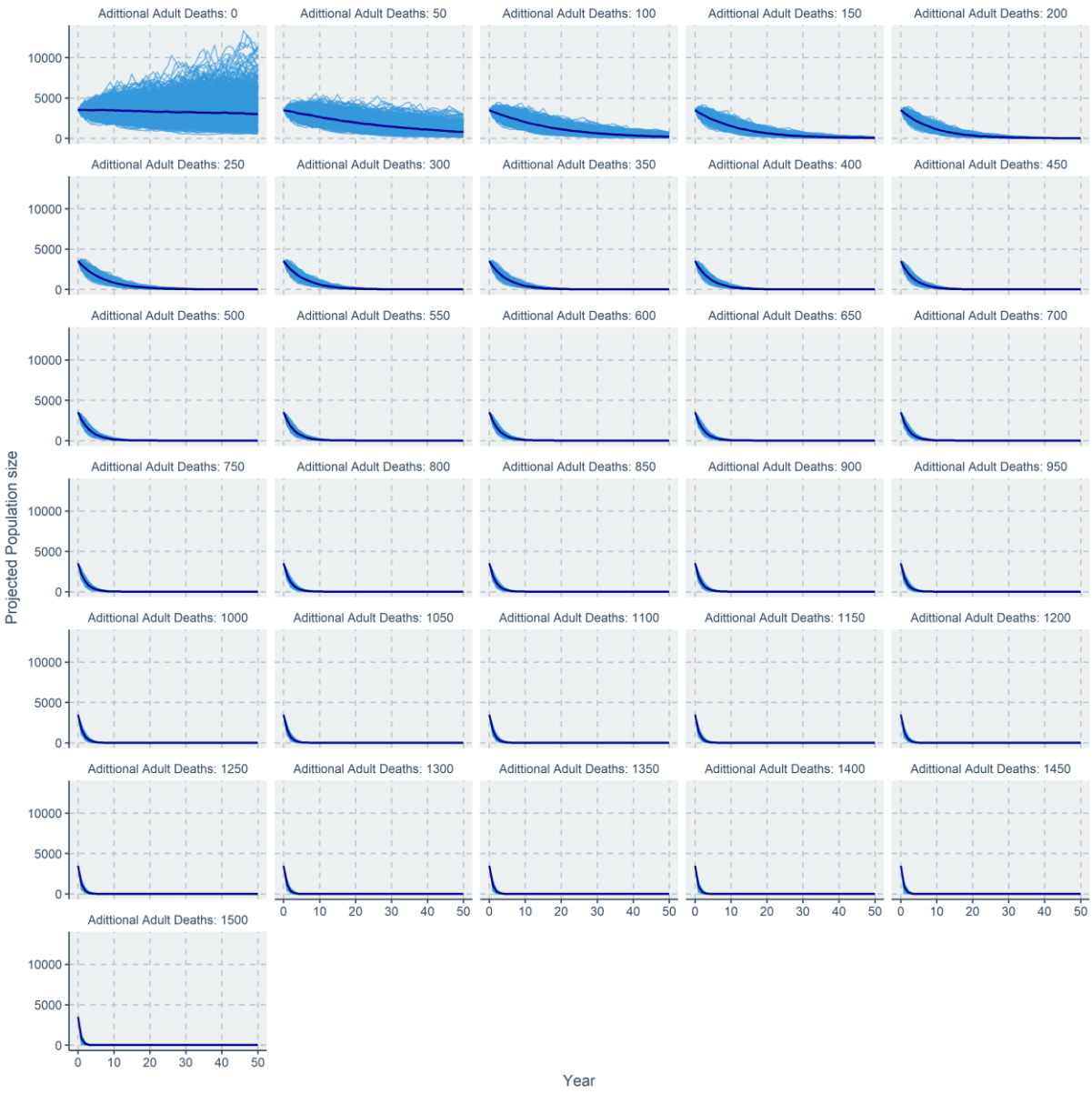

Figure 12: projections of population sizes over a 50-year time-frame. Each plot represents a different impact scenario in terms of additional adult mortalities (starting at 0 i.e. unimpacted). Individual blue lines are different realisations of the population trajectory, when population parameters are sampled from their distributions. The dark blue line is the median at each time point.

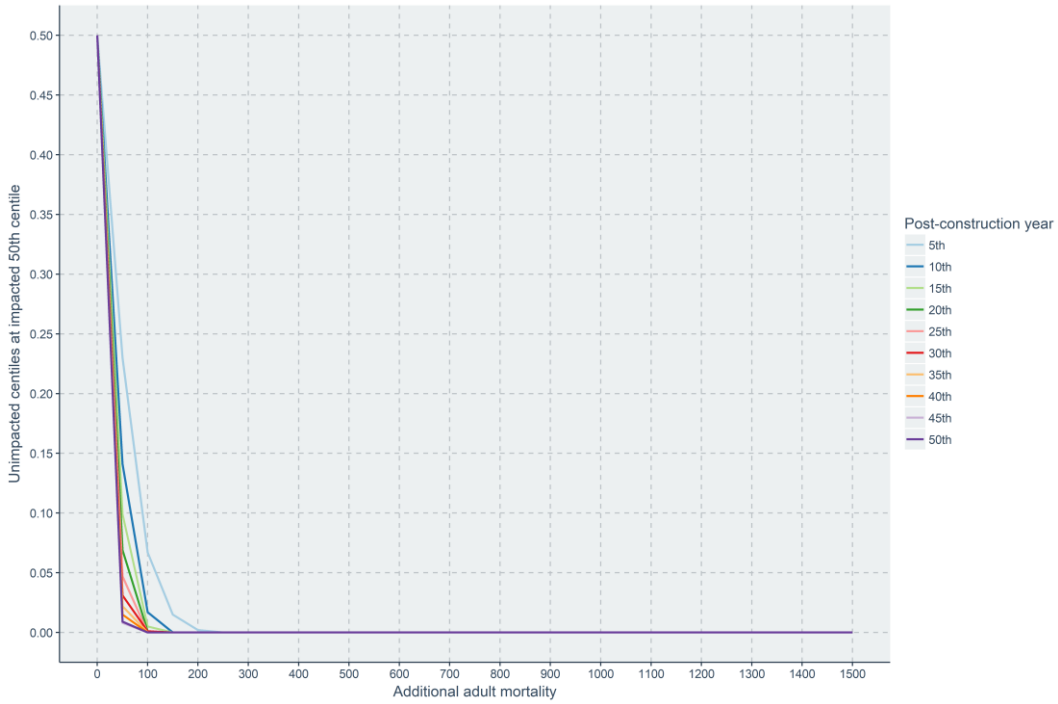

Figure 13: the median of the impacted population as a centile of the unimpacted population, under a range of impact scenarios (additional adult mortalities – x-axis). For example, 0.3 means the median (50th percentile) of the impacted projections sits at the 30th percentile of the unimpacted projections. Individual lines represent years post-construction (0-50 years).

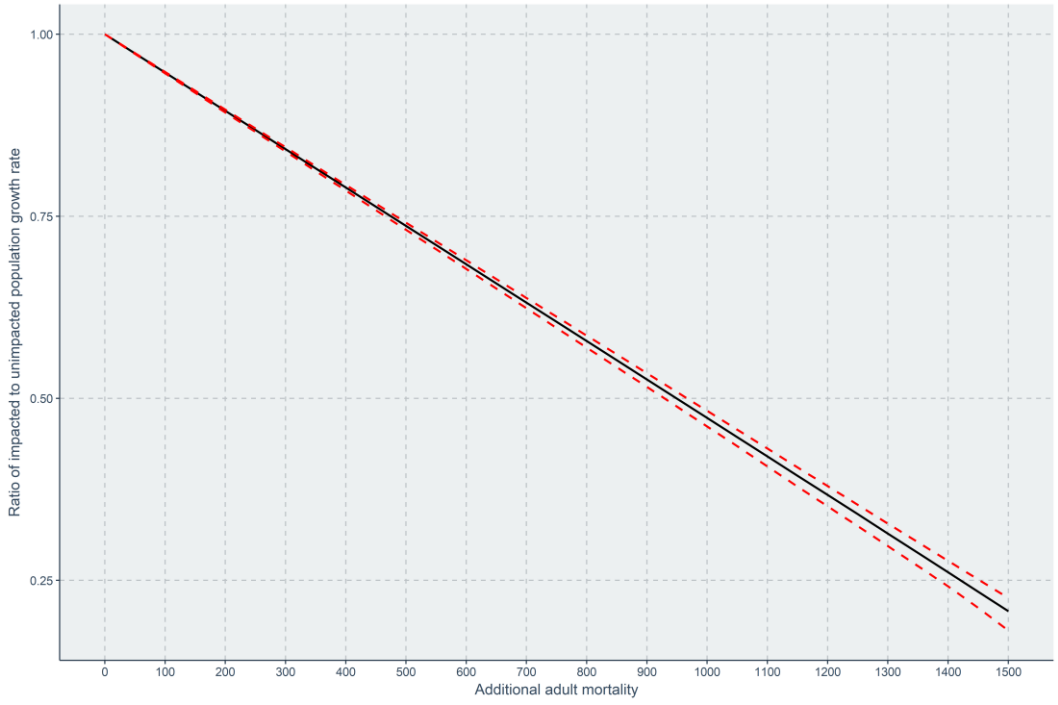

Figure 14: ratio of impacted and unimpacted growth rates under a range of impact scenarios (additional adult mortalities – x-axis) i.e. 0.9 means a 10% decrease in the growth rate under the impact scenario. Figures are based on paired simulations for the impacted and unimpacted populations i.e. based on the same sampled population parameters. The black line represents the 50th percentile (median), red lines give the central 95% of simulated values (2.5% and 97.5% reference points).

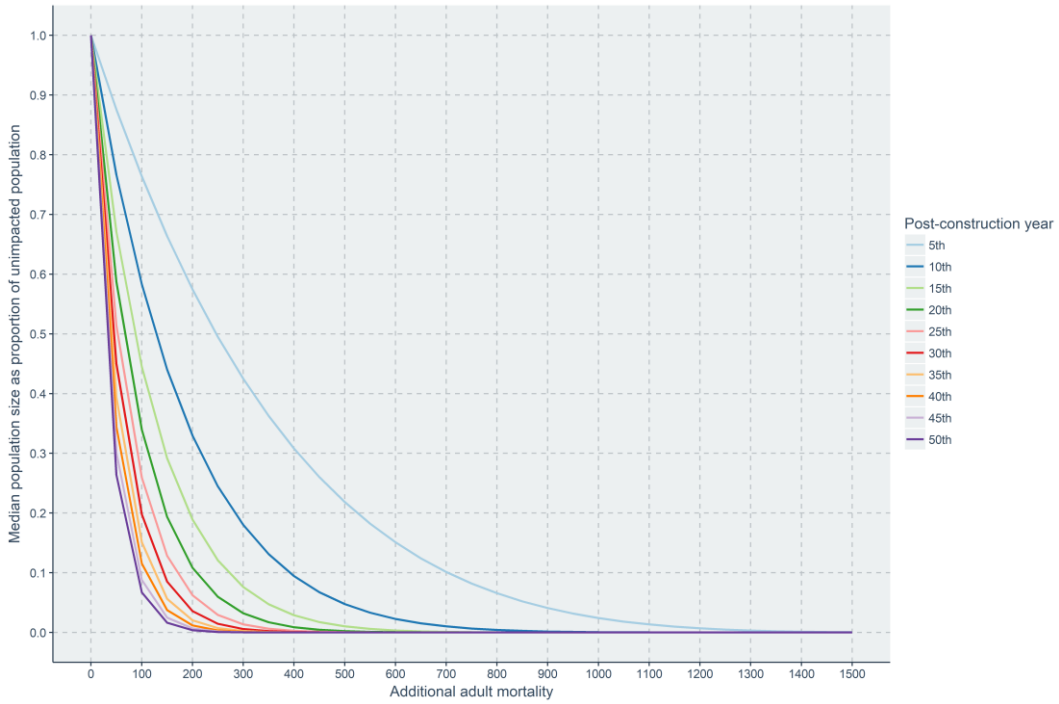

Figure 15: the ratio of the median impacted and median unimpacted population sizes from the simulations i.e. 0.5 means the median impacted population size is one-half the median unimpacted population size. Impact scenarios, in terms of additional adult mortalities, are given on the x-axis. Individual lines represent post-construction time points (projected 0 – 50 years).

Table 7: Growth rates of simulated populations under different impact scenarios. Reference points are 2.5%, 50% (median) and 97.5% of the distribution of simulated growth rates.

Additional adult mortalities	Median growth rates	2.5 percentile of simulated growth rates	97.5 percentile of simulated growth rates
0	0.997	0.977	1.016
50	0.971	0.951	0.990
100	0.945	0.925	0.963
150	0.919	0.899	0.937
200	0.892	0.872	0.911
250	0.866	0.846	0.884
300	0.840	0.820	0.858
350	0.814	0.794	0.831
400	0.787	0.768	0.805
450	0.761	0.742	0.778
500	0.735	0.716	0.752
550	0.709	0.689	0.726
600	0.682	0.663	0.700
650	0.656	0.637	0.673
700	0.630	0.610	0.647
750	0.603	0.584	0.621
800	0.577	0.558	0.594
850	0.551	0.531	0.568
900	0.524	0.505	0.542
950	0.498	0.478	0.515
1000	0.472	0.452	0.489
1050	0.446	0.425	0.463
1100	0.419	0.398	0.437
1150	0.393	0.372	0.410
1200	0.366	0.345	0.384
1250	0.340	0.318	0.358
1300	0.314	0.291	0.332
1350	0.287	0.264	0.306
1400	0.260	0.238	0.280
1450	0.234	0.209	0.254
1500	0.207	0.178	0.229

4.4 Razorbill – East Caithness Cliffs

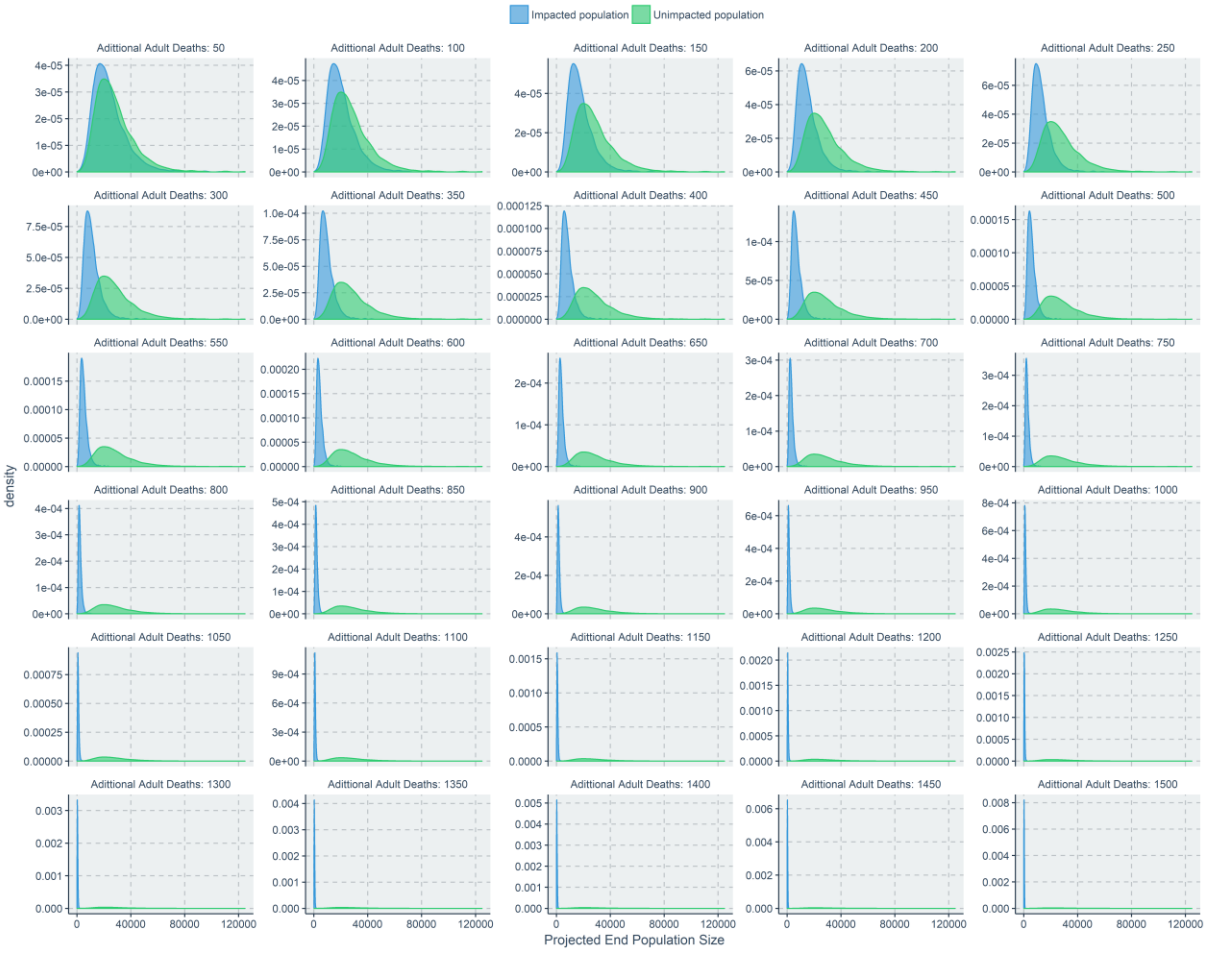

Figure 16: Distributions of end population sizes under simulation. Each plot represents a different impact scenario in terms of additional adult mortalities. The distribution of end population sizes for the unimpacted simulations are given in each.

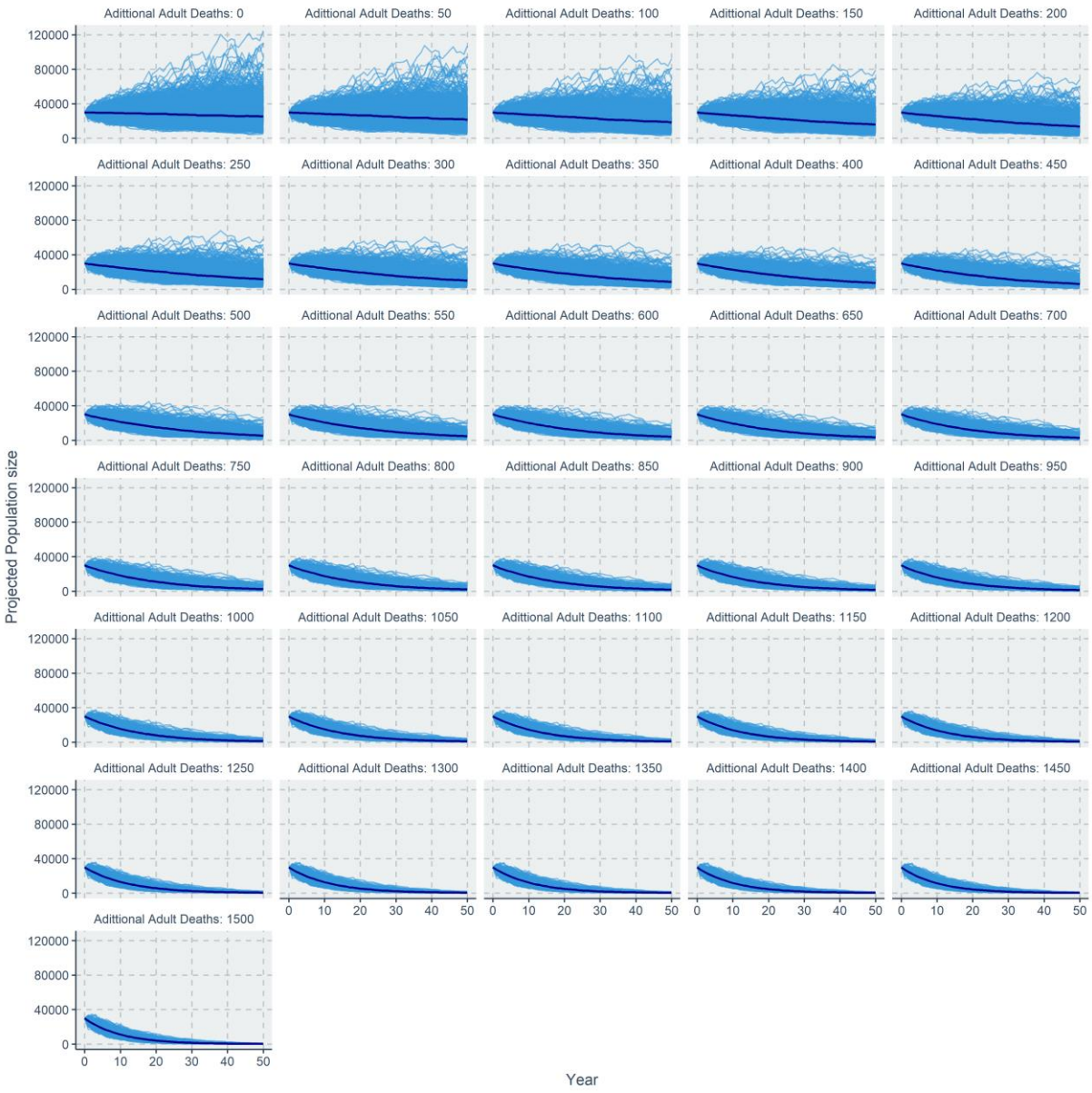

Figure 17: projections of population sizes over a 50-year time-frame. Each plot represents a different impact scenario in terms of additional adult mortalities (starting at 0 i.e. unimpacted). Individual blue lines are different realisations of the population trajectory, when population parameters are sampled from their distributions. The dark blue line is the median at each time point.

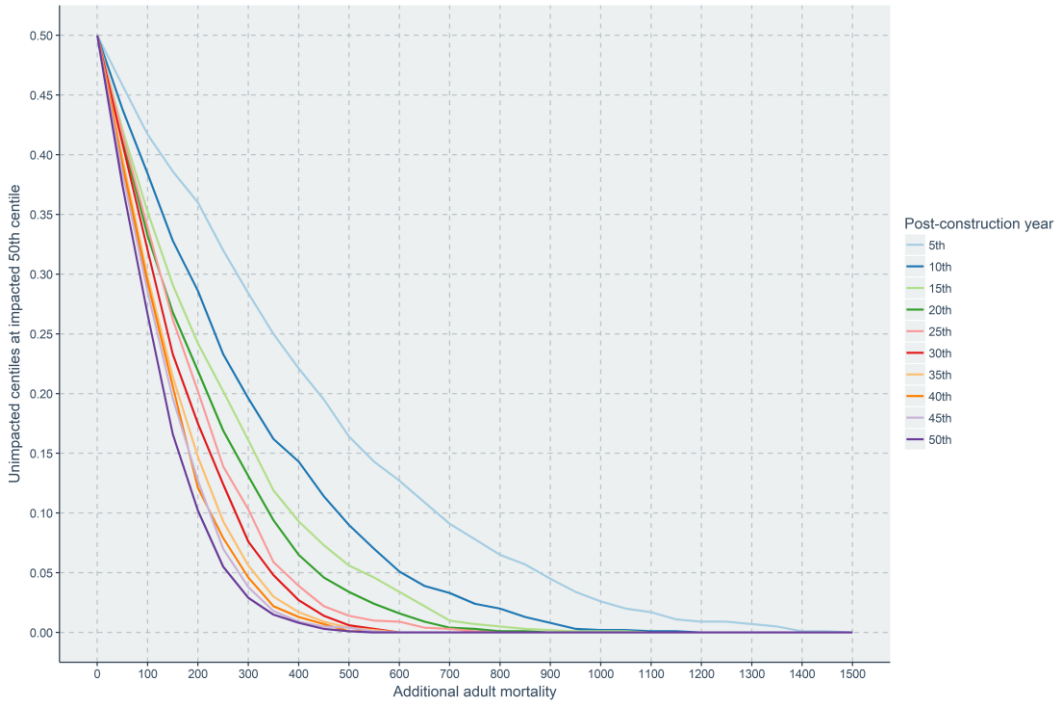

Figure 18: the median of the impacted population as a centile of the unimpacted population, under a range of impact scenarios (additional adult mortalities – x-axis). For example, 0.3 means the median (50th percentile) of the impacted projections sits at the 30th percentile of the unimpacted projections. Individual lines represent years post-construction (0-50 years).

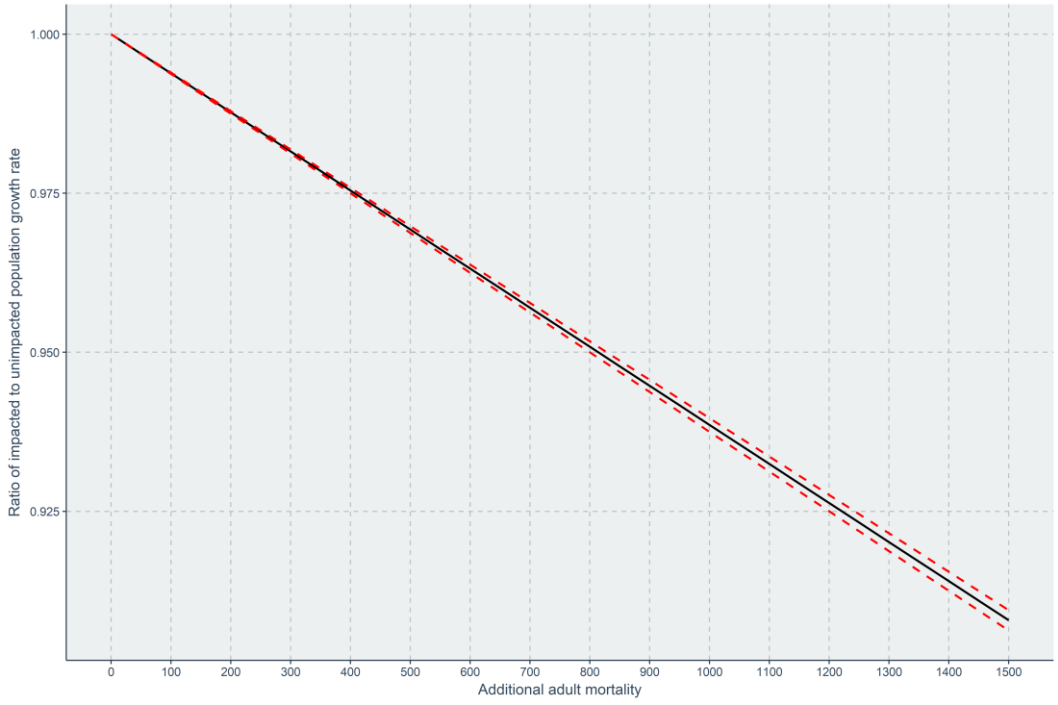

Figure 19: ratio of impacted and unimpacted growth rates under a range of impact scenarios (additional adult mortalities – x-axis) i.e. 0.9 means a 10% decrease in the growth rate under the impact scenario. Figures are based on paired simulations for the impacted and unimpacted populations i.e. based on the same sampled population parameters. The black line represents the 50th percentile (median), red lines give the central 95% of simulated values (2.5% and 97.5% reference points).

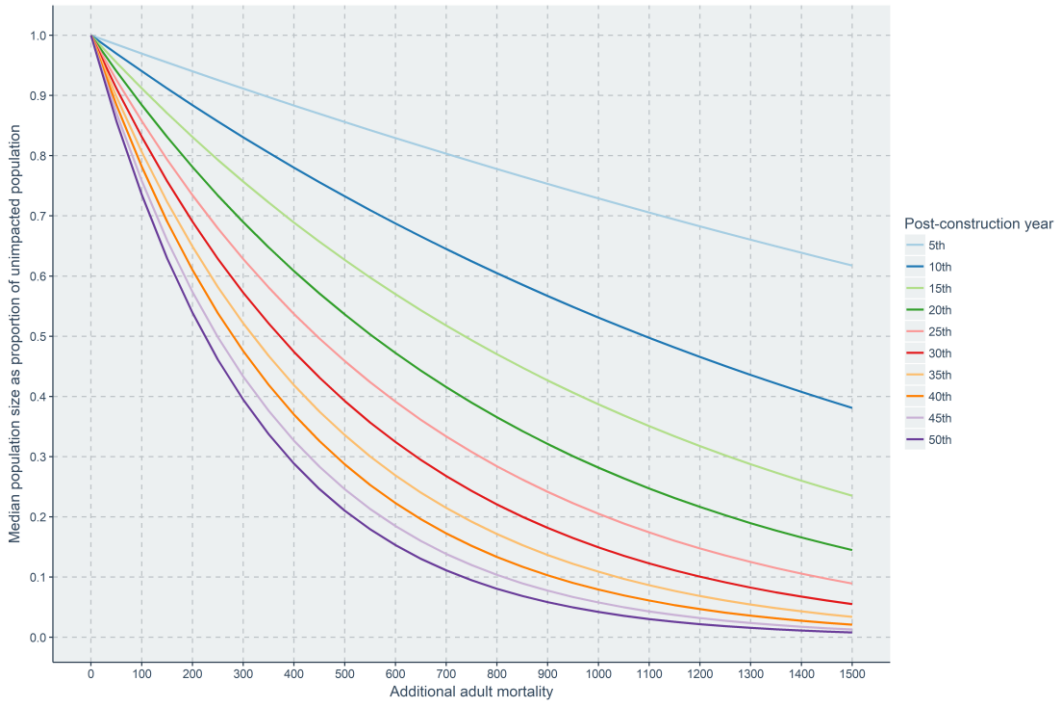

Figure 20: the ratio of the median impacted and median unimpacted population sizes from the simulations i.e. 0.5 means the median impacted population size is one-half the median unimpacted population size. Impact scenarios, in terms of additional adult mortalities, are given on the x-axis. Individual lines represent post-construction time points (projected 0 – 50 years).

Table 8: Growth rates of simulated populations under different impact scenarios. Reference points are 2.5%, 50% (median) and 97.5% of the distribution of simulated growth rates.

Additional adult mortalities	Median growth rates	2.5 percentile of simulated growth rates	97.5 percentile of simulated growth rates
0	0.997	0.975	1.016
50	0.994	0.972	1.013
100	0.990	0.969	1.010
150	0.987	0.966	1.007
200	0.984	0.963	1.004
250	0.981	0.960	1.001
300	0.978	0.957	0.997
350	0.975	0.954	0.994
400	0.972	0.951	0.991
450	0.969	0.948	0.988
500	0.966	0.945	0.985
550	0.963	0.942	0.982
600	0.960	0.939	0.979
650	0.957	0.936	0.976
700	0.954	0.933	0.973
750	0.951	0.930	0.970
800	0.948	0.927	0.967
850	0.945	0.924	0.964
900	0.941	0.921	0.960
950	0.938	0.918	0.957
1000	0.935	0.915	0.954
1050	0.932	0.912	0.951
1100	0.929	0.909	0.948
1150	0.926	0.906	0.945
1200	0.923	0.903	0.942
1250	0.920	0.900	0.939
1300	0.917	0.897	0.936
1350	0.914	0.894	0.933
1400	0.911	0.891	0.930
1450	0.908	0.888	0.927
1500	0.905	0.885	0.923

4.5 Guillemot – North Caithness Cliffs

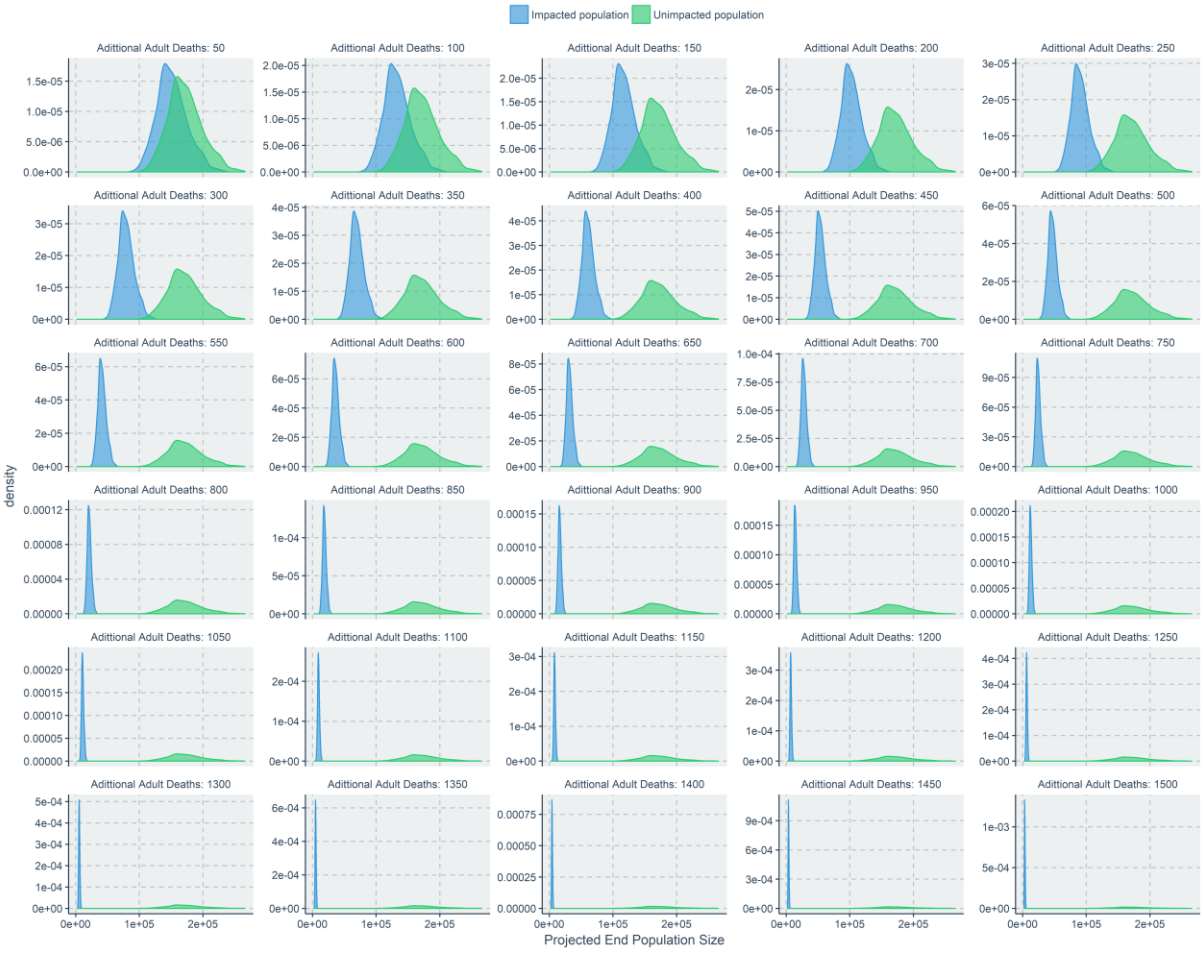

Figure 21: Distributions of end population sizes under simulation. Each plot represents a different impact scenario in terms of additional adult mortalities. The distribution of end population sizes for the unimpacted simulations are given in each.

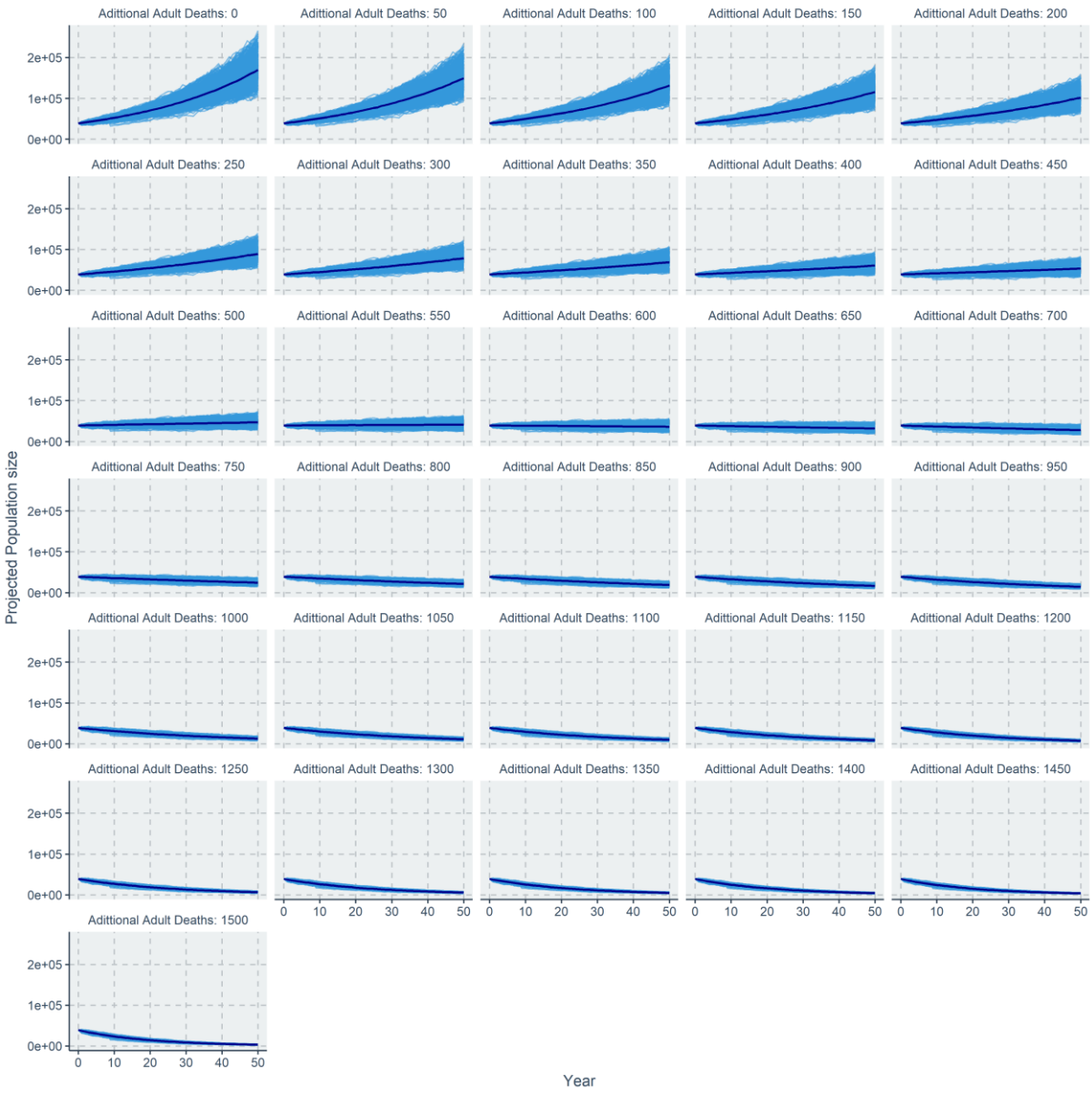

Figure 22: projections of population sizes over a 50-year time-frame. Each plot represents a different impact scenario in terms of additional adult mortalities (starting at 0 i.e. unimpacted). Individual blue lines are different realisations of the population trajectory, when population parameters are sampled from their distributions. The dark blue line is the median at each time point.

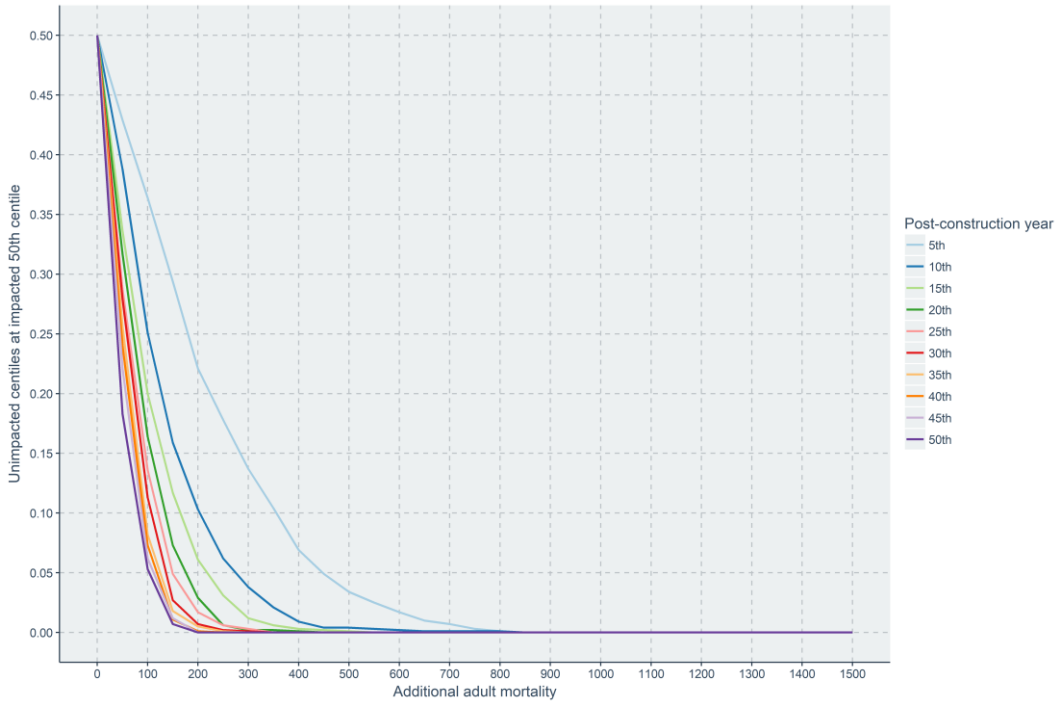

Figure 23: the median of the impacted population as a centile of the unimpacted population, under a range of impact scenarios (additional adult mortalities – x-axis). For example, 0.3 means the median (50th percentile) of the impacted projections sits at the 30th percentile of the unimpacted projections. Individual lines represent years post-construction (0-50 years).

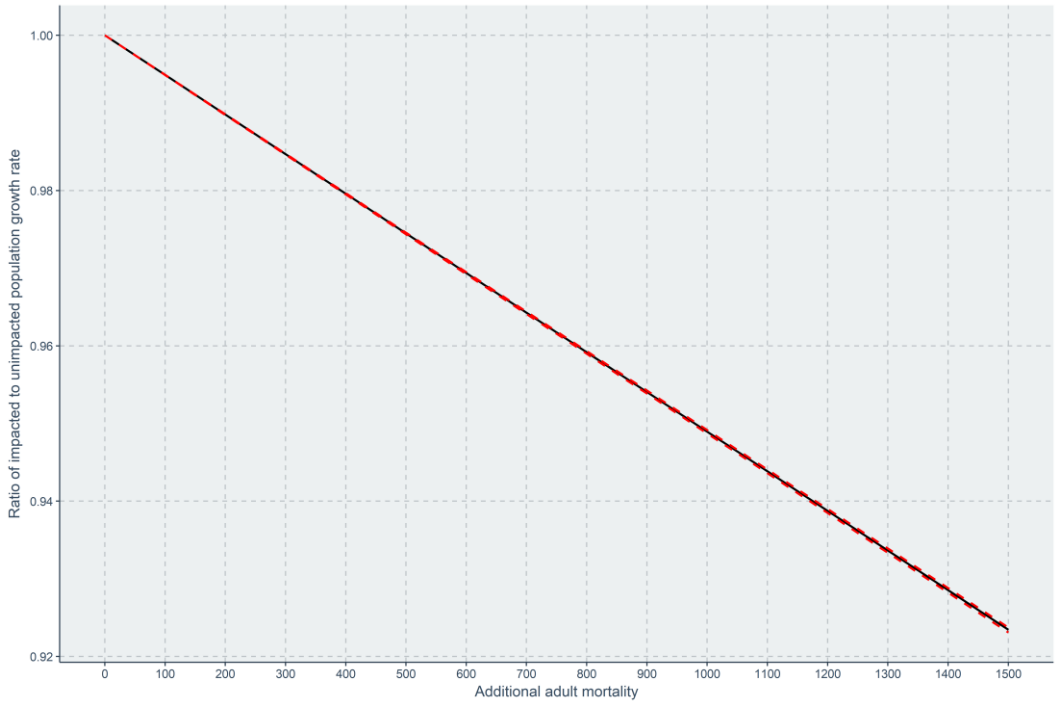

Figure 24: ratio of impacted and unimpacted growth rates under a range of impact scenarios (additional adult mortalities – x-axis) i.e. 0.9 means a 10% decrease in the growth rate under the impact scenario. Figures are based on paired simulations for the impacted and unimpacted populations i.e. based on the same sampled population parameters. The black line represents the 50th percentile (median), red lines give the central 95% of simulated values (2.5% and 97.5% reference points).

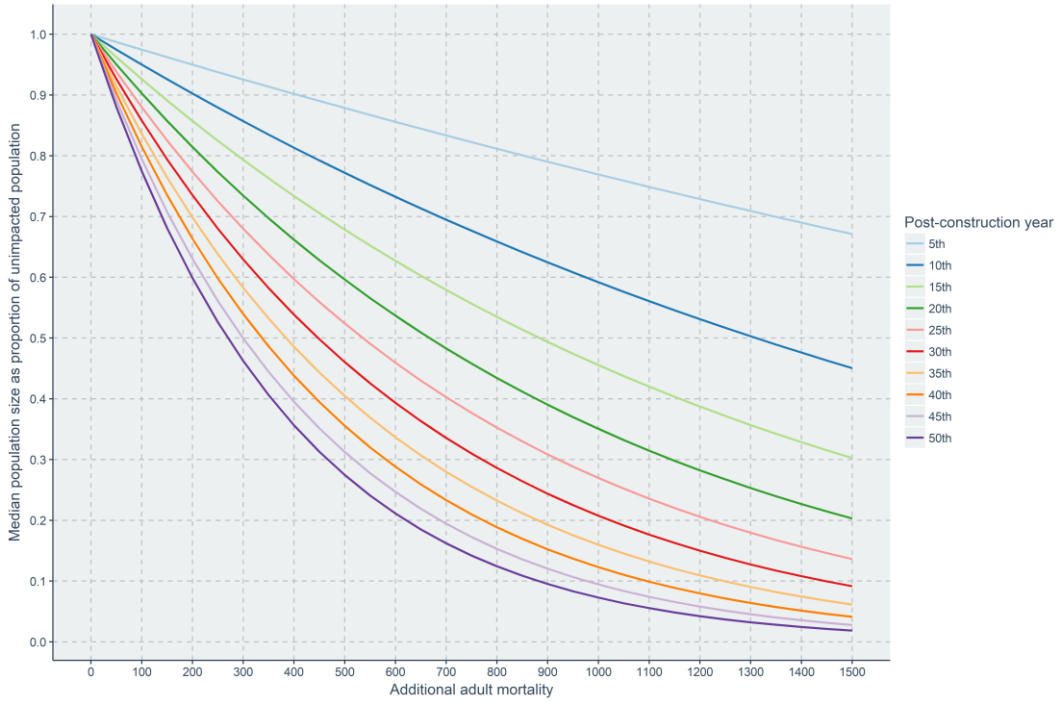

Figure 25: the ratio of the median impacted and median unimpacted population sizes from the simulations i.e. 0.5 means the median impacted population size is one-half the median unimpacted population size. Impact scenarios, in terms of additional adult mortalities, are given on the x-axis. Individual lines represent post-construction time points (projected 0 – 50 years).

Table 9: Growth rates of simulated populations under different impact scenarios. Reference points are 2.5%, 50% (median) and 97.5% of the distribution of simulated growth rates.

Additional adult mortalities	Median growth rates	2.5 percentile of simulated growth rates	97.5 percentile of simulated growth rates
0	1.030	1.023	1.036
50	1.027	1.021	1.034
100	1.025	1.018	1.031
150	1.022	1.016	1.028
200	1.020	1.013	1.026
250	1.017	1.010	1.023
300	1.014	1.008	1.021
350	1.012	1.005	1.018
400	1.009	1.002	1.015
450	1.006	1.000	1.013
500	1.004	0.997	1.010
550	1.001	0.995	1.007
600	0.999	0.992	1.005
650	0.996	0.989	1.002
700	0.993	0.987	0.999
750	0.991	0.984	0.997
800	0.988	0.981	0.994
850	0.985	0.979	0.991
900	0.983	0.976	0.989
950	0.980	0.974	0.986
1000	0.978	0.971	0.984
1050	0.975	0.968	0.981
1100	0.972	0.966	0.978
1150	0.970	0.963	0.976
1200	0.967	0.961	0.973
1250	0.964	0.958	0.970
1300	0.962	0.955	0.968
1350	0.959	0.953	0.965
1400	0.956	0.950	0.962
1450	0.954	0.947	0.960
1500	0.951	0.945	0.957

4.6 Guillemot – East Caithness Cliffs

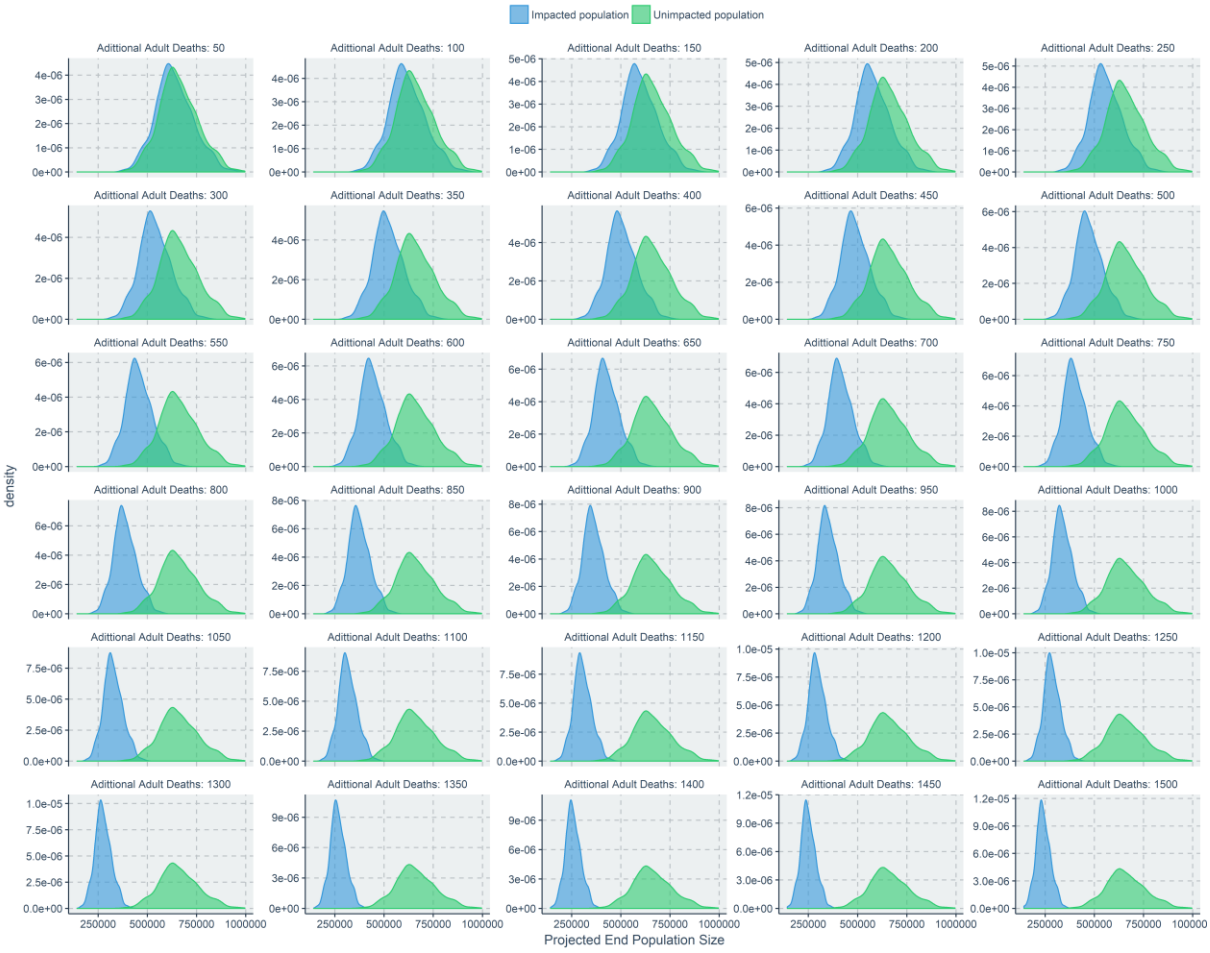

Figure 26: Distributions of end population sizes under simulation. Each plot represents a different impact scenario in terms of additional adult mortalities. The distribution of end population sizes for the unimpacted simulations are given in each.

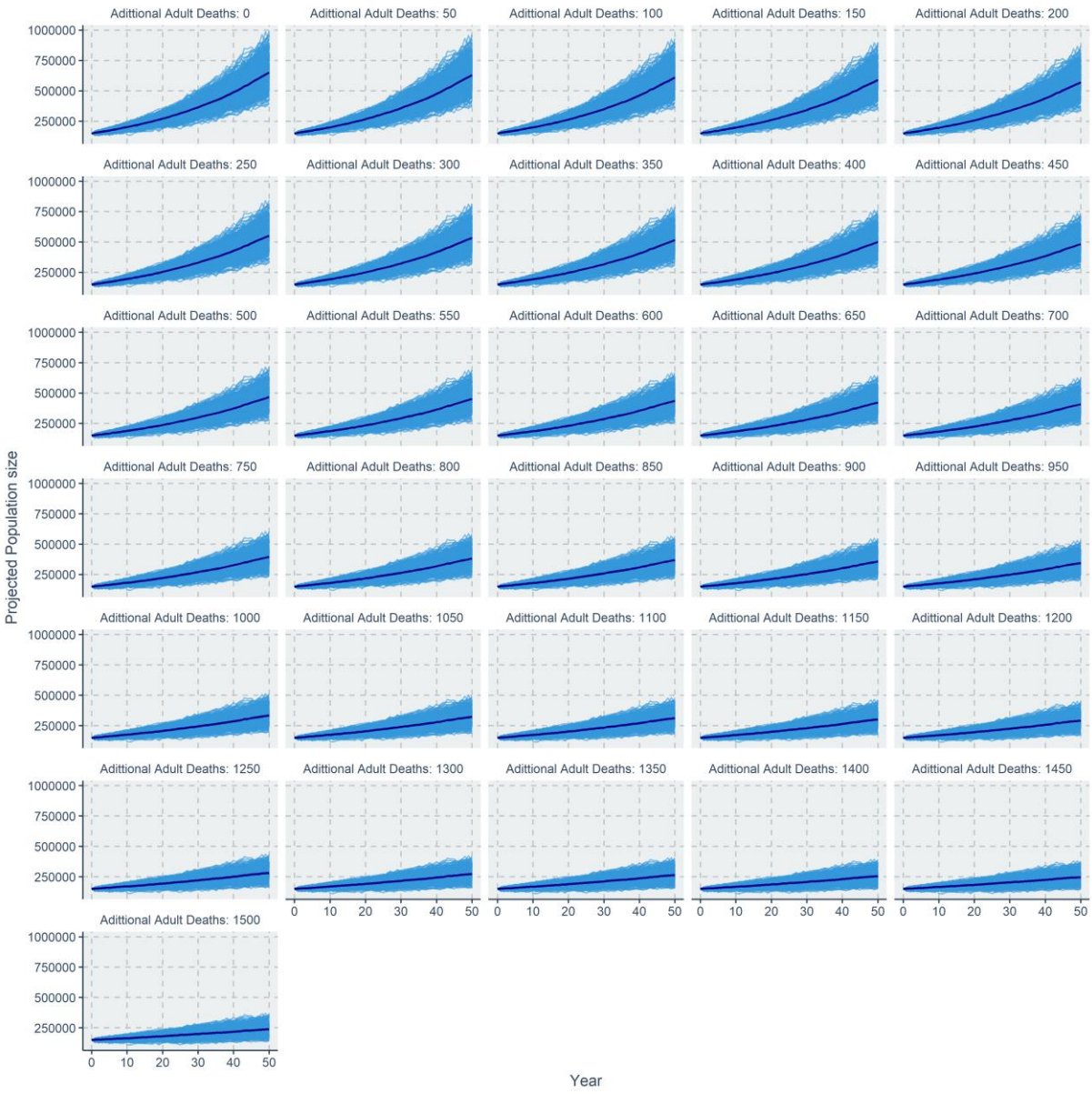

Figure 27: projections of population sizes over a 50-year time-frame. Each plot represents a different impact scenario in terms of additional adult mortalities (starting at 0 i.e. unimpacted). Individual blue lines are different realisations of the population trajectory, when population parameters are sampled from their distributions. The dark blue line is the median at each time point.

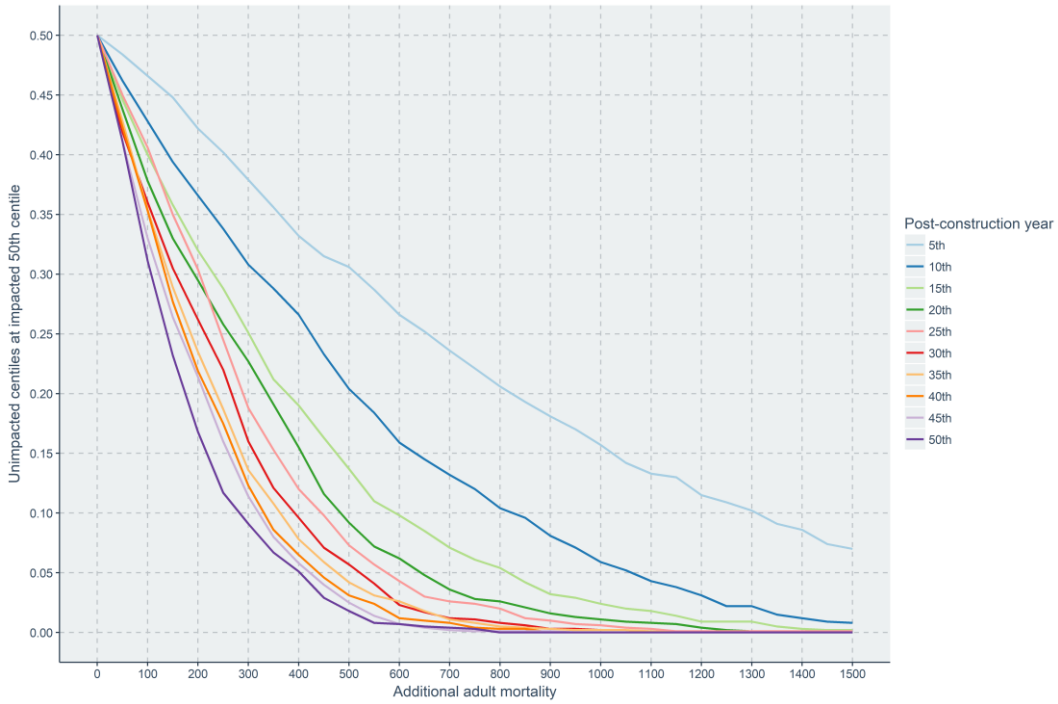

Figure 28: the median of the impacted population as a centile of the unimpacted population, under a range of impact scenarios (additional adult mortalities – x-axis). For example, 0.3 means the median (50th percentile) of the impacted projections sits at the 30th percentile of the unimpacted projections. Individual lines represent years post-construction (0-50 years).

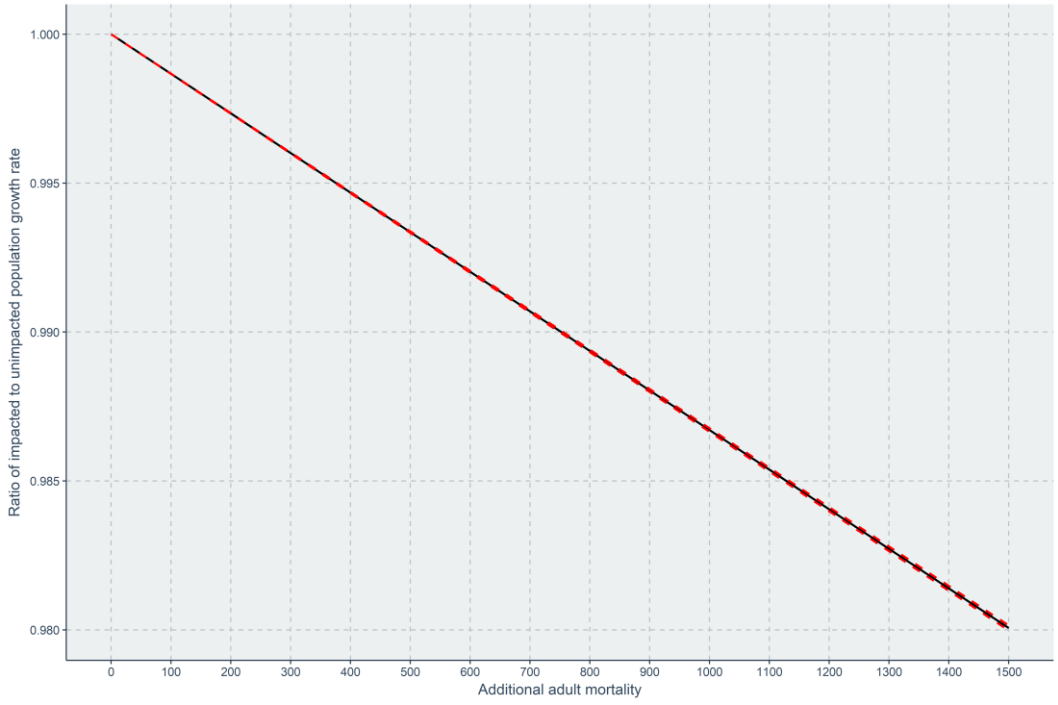

Figure 29: ratio of impacted and unimpacted growth rates under a range of impact scenarios (additional adult mortalities – x-axis) i.e. 0.9 means a 10% decrease in the growth rate under the impact scenario. Figures are based on paired simulations for the impacted and unimpacted populations i.e. based on the same sampled population parameters. The black line represents the 50th percentile (median), red lines give the central 95% of simulated values (2.5% and 97.5% reference points).

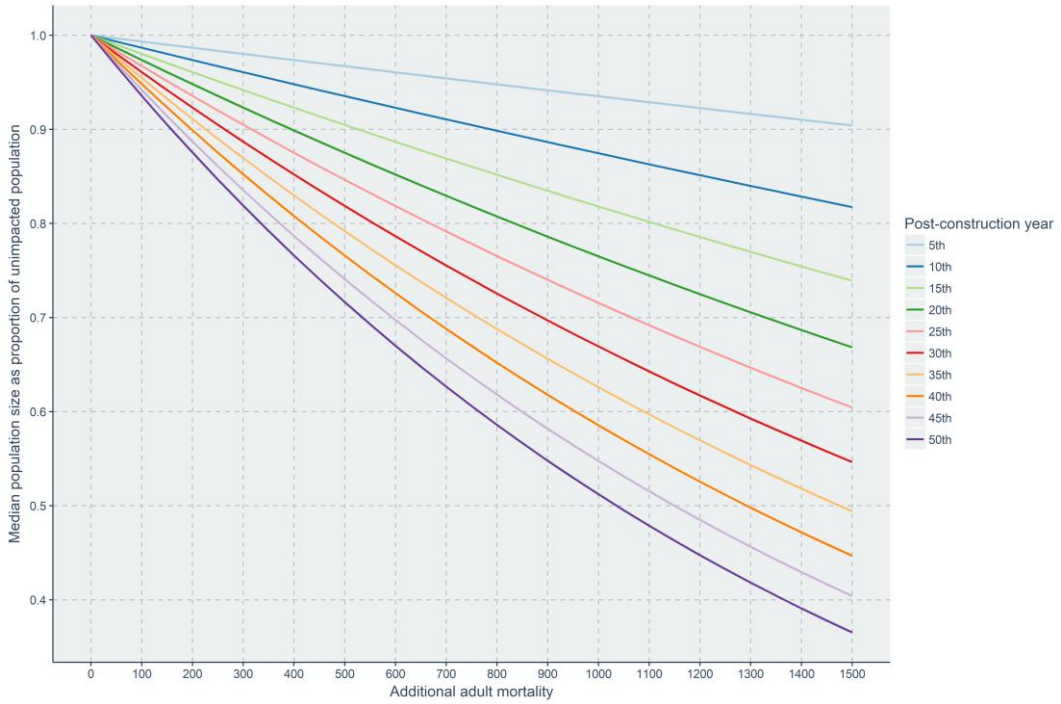

Figure 30: the ratio of the median impacted and median unimpacted population sizes from the simulations i.e. 0.5 means the median impacted population size is one-half the median unimpacted population size. Impact scenarios, in terms of additional adult mortalities, are given on the x-axis. Individual lines represent post-construction time points (projected 0 – 50 years).

Table 10: Growth rates of simulated populations under different impact scenarios. Reference points are 2.5%, 50% (median) and 97.5% of the distribution of simulated growth rates.

Additional adult mortalities	Median growth rates	2.5 percentile of simulated growth rates	97.5 percentile of simulated growth rates
0	1.030	1.023	1.037
50	1.029	1.022	1.036
100	1.029	1.022	1.035
150	1.028	1.021	1.034
200	1.027	1.020	1.034
250	1.027	1.020	1.033
300	1.026	1.019	1.032
350	1.025	1.018	1.032
400	1.025	1.018	1.031
450	1.024	1.017	1.030
500	1.023	1.016	1.030
550	1.022	1.016	1.029
600	1.022	1.015	1.028
650	1.021	1.014	1.028
700	1.020	1.014	1.027
750	1.020	1.013	1.026
800	1.019	1.012	1.026
850	1.018	1.011	1.025
900	1.018	1.011	1.024
950	1.017	1.010	1.023
1000	1.016	1.009	1.023
1050	1.016	1.009	1.022
1100	1.015	1.008	1.021
1150	1.014	1.007	1.021
1200	1.014	1.007	1.020
1250	1.013	1.006	1.019
1300	1.012	1.005	1.019
1350	1.012	1.005	1.018
1400	1.011	1.004	1.017
1450	1.010	1.003	1.017
1500	1.009	1.003	1.016

4.7 Kittiwake – North Caithness Cliffs

Figure 31: Distributions of end population sizes under simulation. Each plot represents a different impact scenario in terms of additional adult mortalities. The distribution of end population sizes for the unimpacted simulations are given in each.

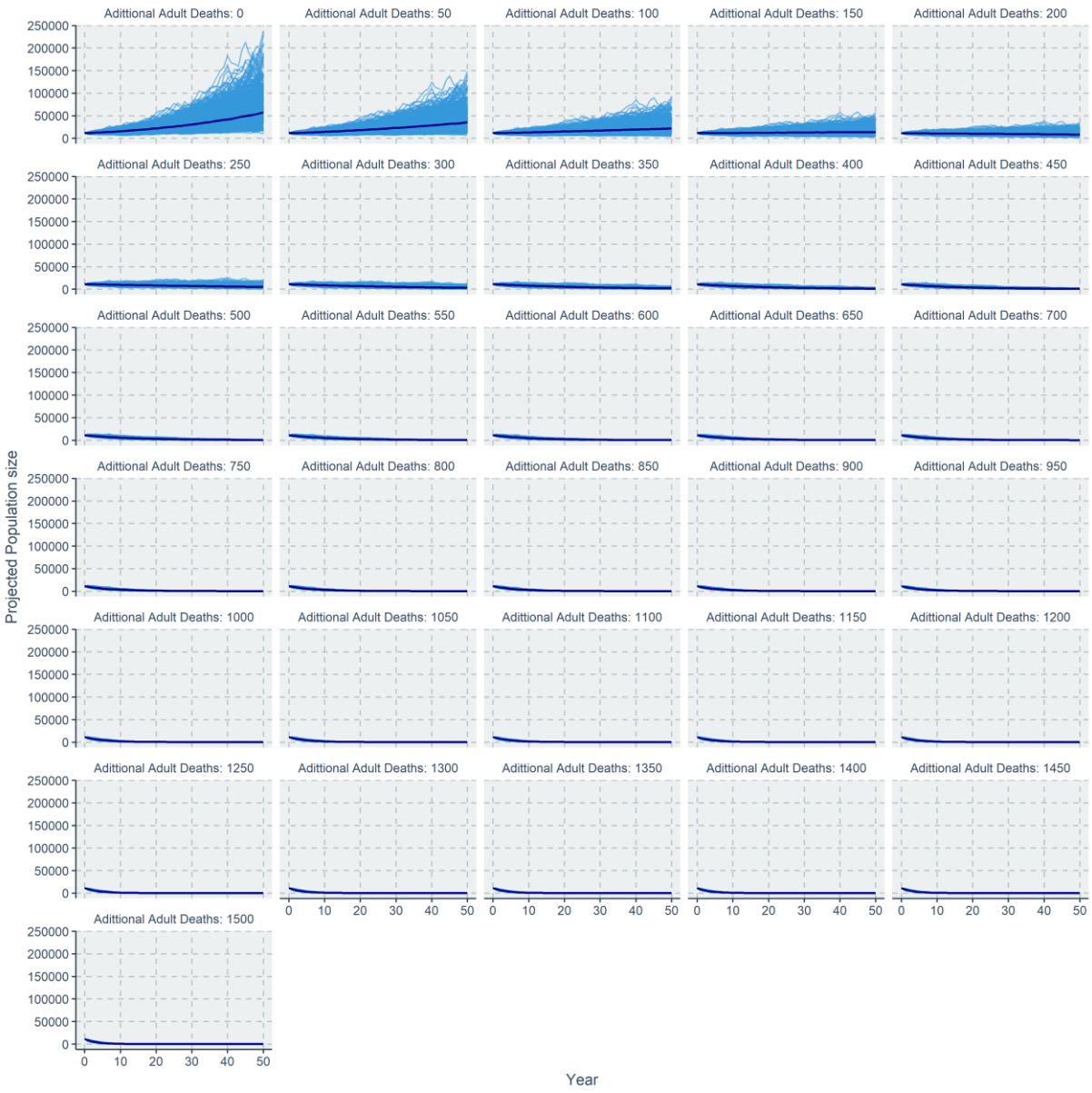

Figure 32: projections of population sizes over a 50-year time-frame. Each plot represents a different impact scenario in terms of additional adult mortalities (starting at 0 i.e. unimpacted). Individual blue lines are different realisations of the population trajectory, when population parameters are sampled from their distributions. The dark blue line is the median at each time point.

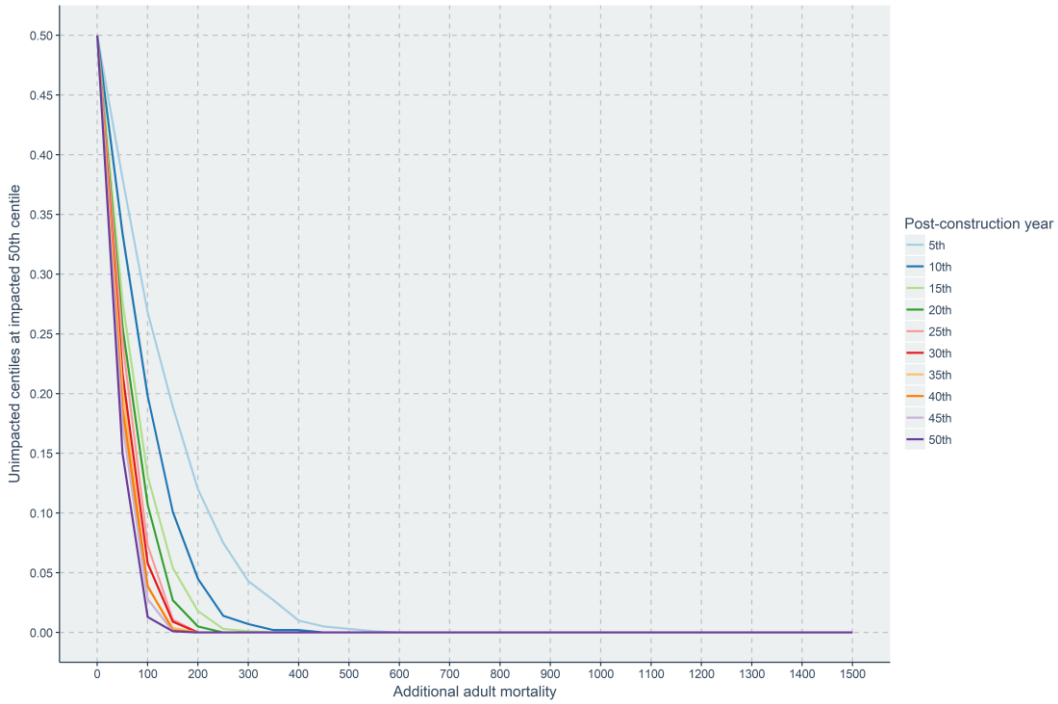

Figure 33: the median of the impacted population as a centile of the unimpacted population, under a range of impact scenarios (additional adult mortalities – x-axis). For example, 0.3 means the median (50th percentile) of the impacted projections sits at the 30th percentile of the unimpacted projections. Individual lines represent years post-construction (0-50 years).

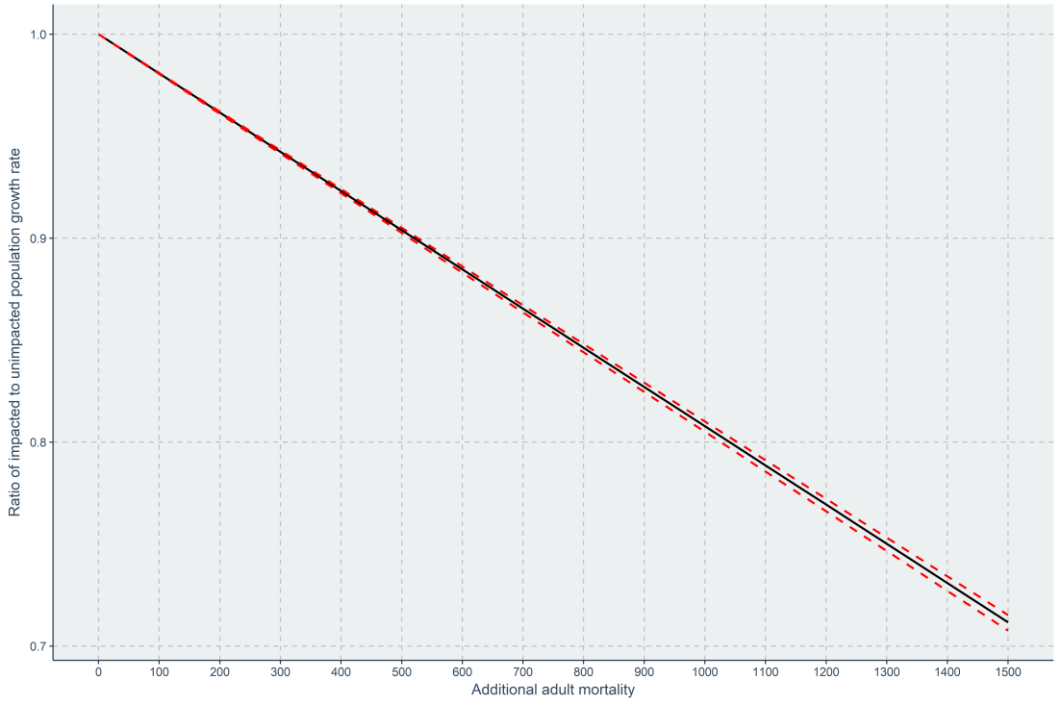

Figure 34: ratio of impacted and unimpacted growth rates under a range of impact scenarios (additional adult mortalities – x-axis) i.e. 0.9 means a 10% decrease in the growth rate under the impact scenario. Figures are based on paired simulations for the impacted and unimpacted populations i.e. based on the same sampled population parameters. The black line represents the 50th percentile (median), red lines give the central 95% of simulated values (2.5% and 97.5% reference points).

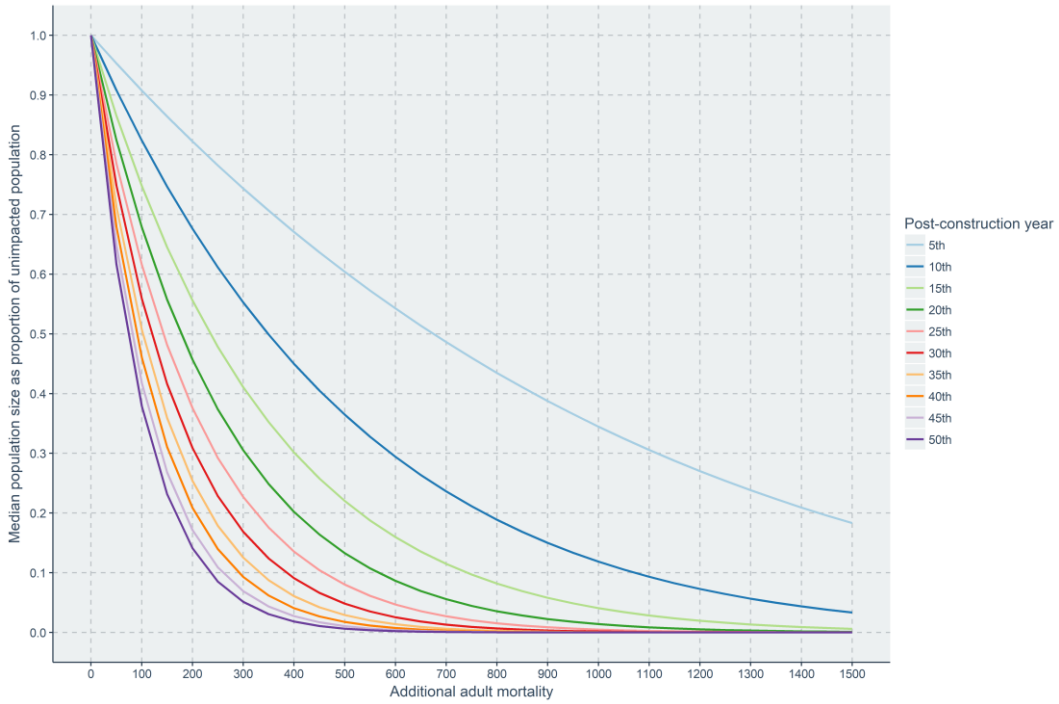

Figure 35: the ratio of the median impacted and median unimpacted population sizes from the simulations i.e. 0.5 means the median impacted population size is one-half the median unimpacted population size. Impact scenarios, in terms of additional adult mortalities, are given on the x-axis. Individual lines represent post-construction time points (projected 0 – 50 years).

Table 11: Growth rates of simulated populations under different impact scenarios. Reference points are 2.5%, 50% (median) and 97.5% of the distribution of simulated growth rates.

Additional adult mortalities	Median growth rates	2.5 percentile of simulated growth rates	97.5 percentile of simulated growth rates
0	1.033	1.015	1.054
50	1.023	1.005	1.044
100	1.014	0.995	1.034
150	1.004	0.986	1.024
200	0.994	0.976	1.014
250	0.984	0.966	1.004
300	0.974	0.956	0.994
350	0.964	0.946	0.984
400	0.954	0.936	0.973
450	0.944	0.926	0.963
500	0.934	0.917	0.953
550	0.924	0.907	0.943
600	0.914	0.897	0.933
650	0.904	0.887	0.923
700	0.895	0.877	0.913
750	0.885	0.867	0.903
800	0.875	0.858	0.893
850	0.865	0.848	0.883
900	0.855	0.838	0.873
950	0.845	0.828	0.863
1000	0.835	0.818	0.853
1050	0.825	0.809	0.843
1100	0.815	0.799	0.833
1150	0.805	0.789	0.823
1200	0.795	0.779	0.813
1250	0.785	0.769	0.803
1300	0.775	0.759	0.793
1350	0.765	0.749	0.783
1400	0.755	0.740	0.773
1450	0.745	0.730	0.763
1500	0.736	0.720	0.753

4.8 Kittiwake – East Caithness Cliffs

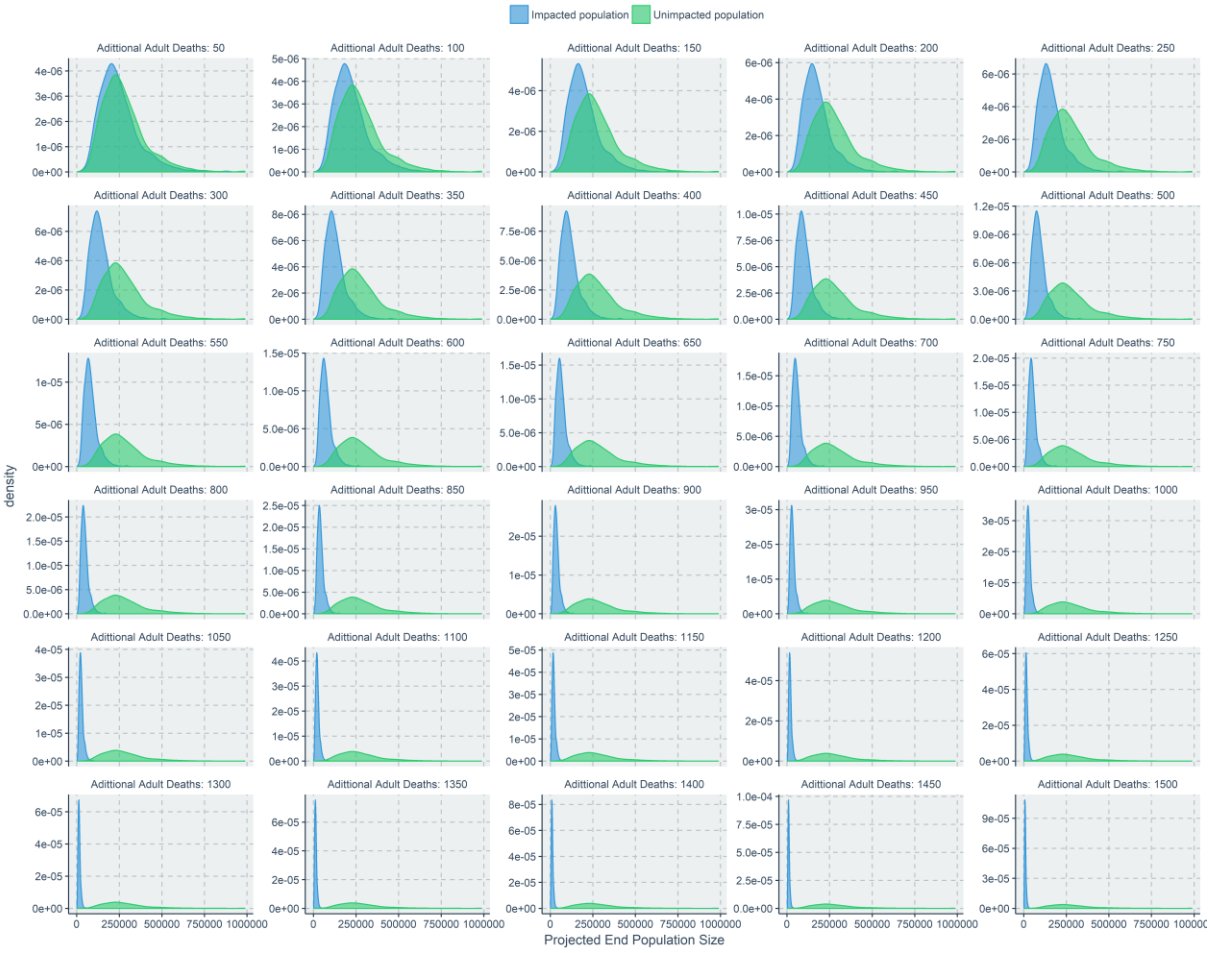

Figure 36: Distributions of end population sizes under simulation. Each plot represents a different impact scenario in terms of additional adult mortalities. The distribution of end population sizes for the unimpacted simulations are given in each.

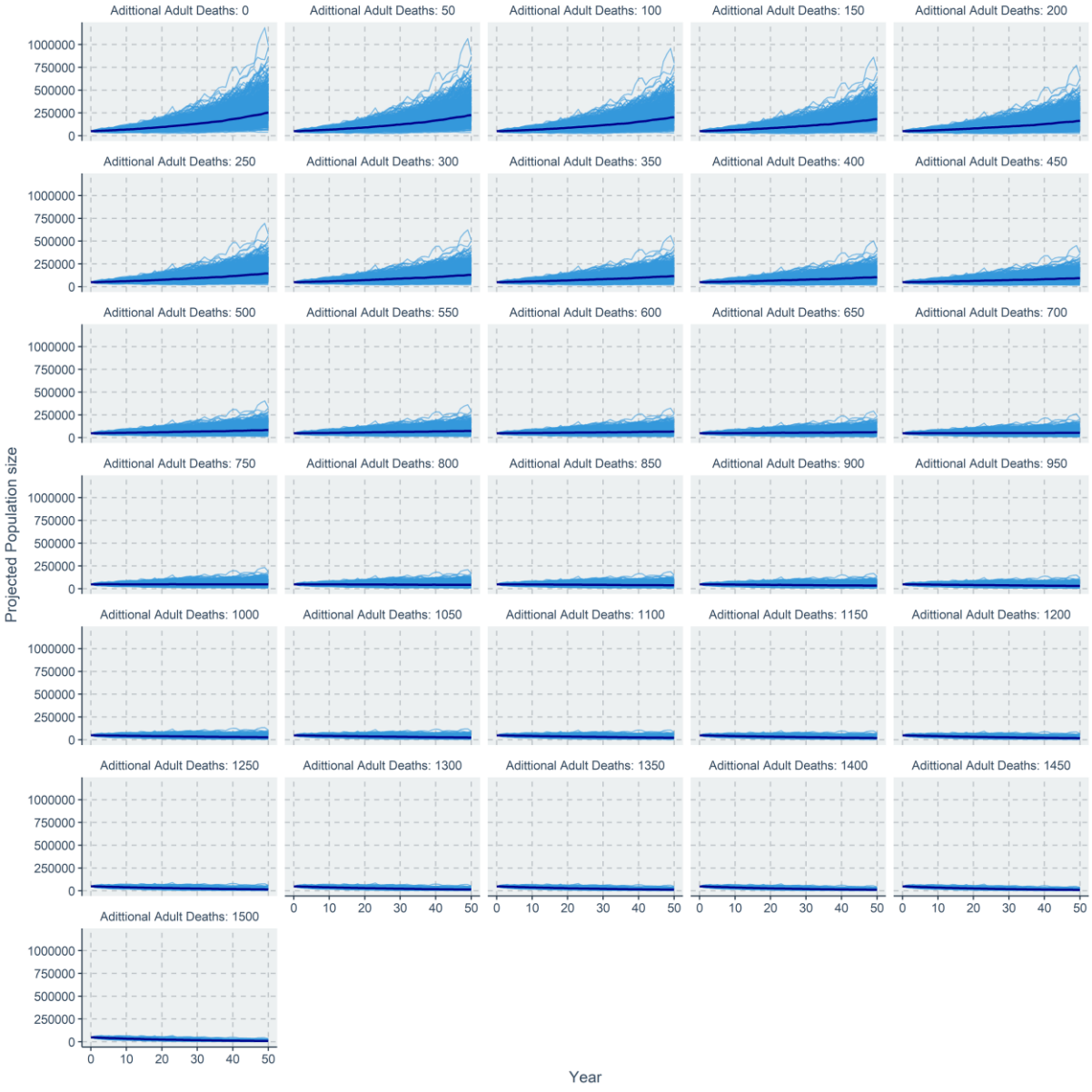

Figure 37: projections of population sizes over a 50-year time-frame. Each plot represents a different impact scenario in terms of additional adult mortalities (starting at 0 i.e. unimpacted). Individual blue lines are different realisations of the population trajectory, when population parameters are sampled from their distributions. The dark blue line is the median at each time point.

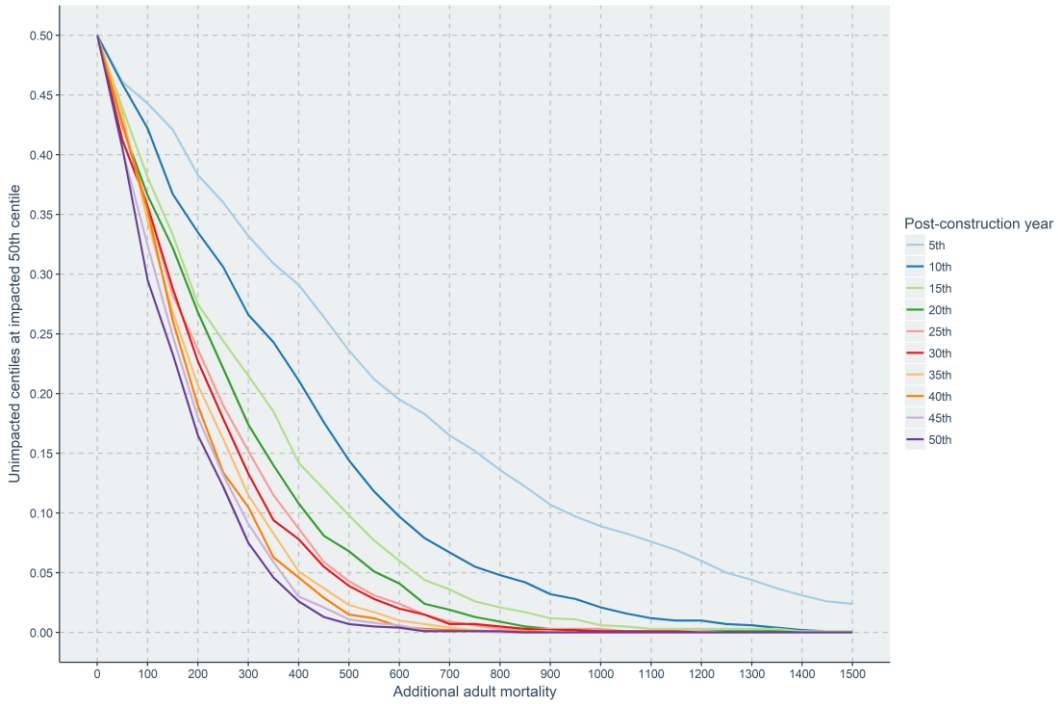

Figure 38: the median of the impacted population as a centile of the unimpacted population, under a range of impact scenarios (additional adult mortalities – x-axis). For example, 0.3 means the median (50th percentile) of the impacted projections sits at the 30th percentile of the unimpacted projections. Individual lines represent years post-construction (0-50 years).

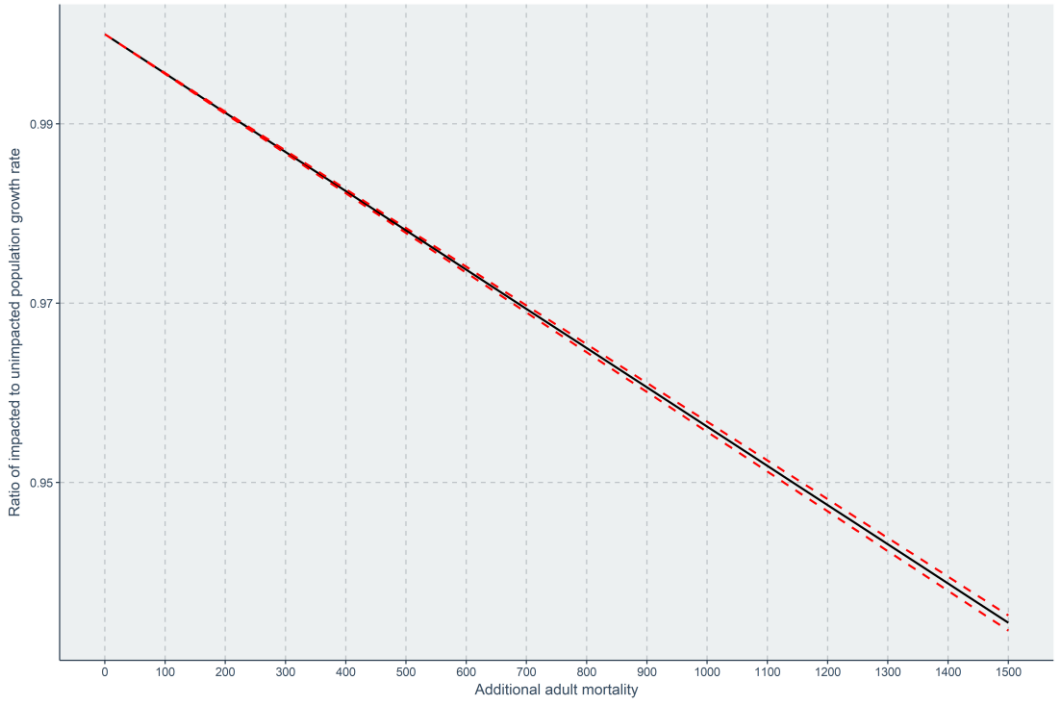

Figure 39: ratio of impacted and unimpacted growth rates under a range of impact scenarios (additional adult mortalities – x-axis) i.e. 0.9 means a 10% decrease in the growth rate under the impact scenario. Figures are based on paired simulations for the impacted and unimpacted populations i.e. based on the same sampled population parameters. The black line represents the 50th percentile (median), red lines give the central 95% of simulated values (2.5% and 97.5% reference points).

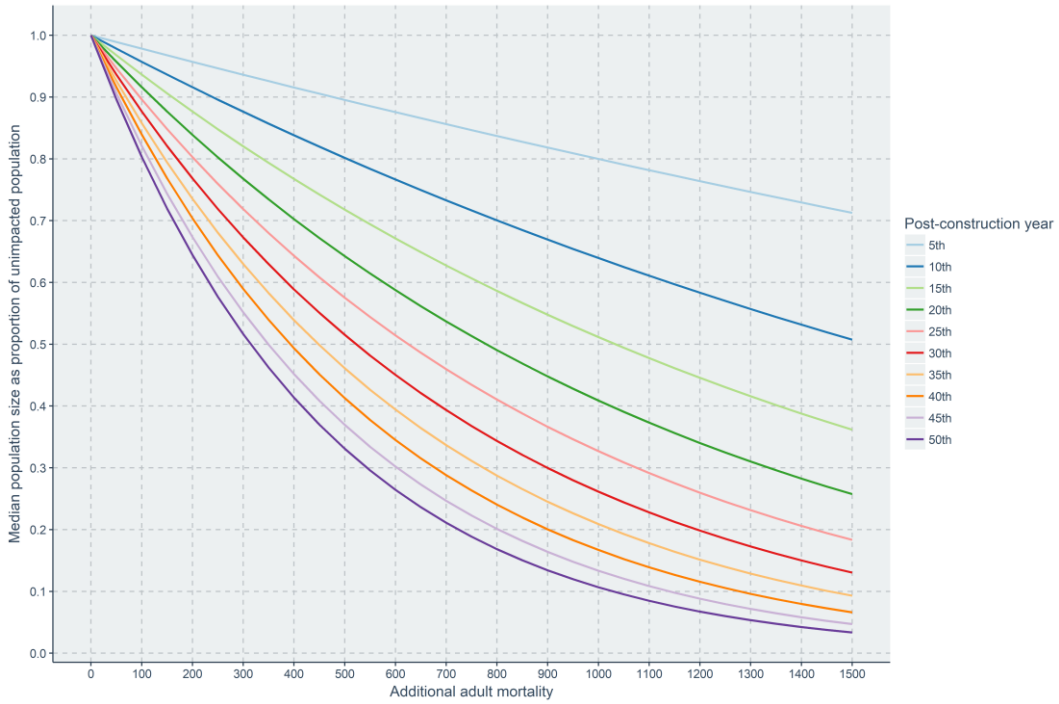

Figure 40: the ratio of the median impacted and median unimpacted population sizes from the simulations i.e. 0.5 means the median impacted population size is one-half the median unimpacted population size. Impact scenarios, in terms of additional adult mortalities, are given on the x-axis. Individual lines represent post-construction time points (projected 0 – 50 years).

Table 12: Growth rates of simulated populations under different impact scenarios. Reference points are 2.5%, 50% (median) and 97.5% of the distribution of simulated growth rates.

Additional adult mortalities	Median growth rates	2.5 percentile of simulated growth rates	97.5 percentile of simulated growth rates
0	1.033	1.014	1.052
50	1.031	1.012	1.050
100	1.029	1.010	1.047
150	1.027	1.008	1.045
200	1.024	1.005	1.043
250	1.022	1.003	1.041
300	1.020	1.001	1.038
350	1.018	0.999	1.036
400	1.015	0.996	1.034
450	1.013	0.994	1.031
500	1.011	0.992	1.029
550	1.009	0.990	1.027
600	1.006	0.987	1.025
650	1.004	0.985	1.022
700	1.002	0.983	1.020
750	1.000	0.981	1.018
800	0.997	0.979	1.015
850	0.995	0.976	1.013
900	0.993	0.974	1.011
950	0.991	0.972	1.009
1000	0.988	0.970	1.006
1050	0.986	0.967	1.004
1100	0.984	0.965	1.002
1150	0.981	0.963	1.000
1200	0.979	0.961	0.997
1250	0.977	0.958	0.995
1300	0.975	0.956	0.993
1350	0.972	0.954	0.990
1400	0.970	0.952	0.988
1450	0.968	0.949	0.986
1500	0.966	0.947	0.984

4.9 Herring Gull – East Caithness Cliffs

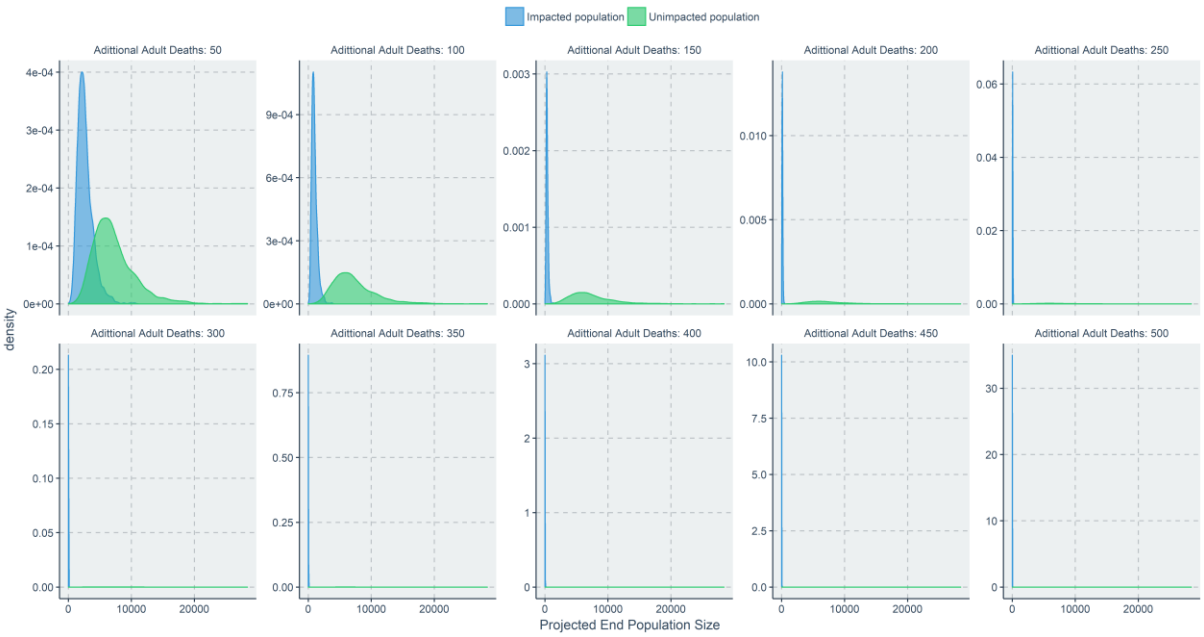

Figure 41: Distributions of end population sizes under simulation. Each plot represents a different impact scenario in terms of additional adult mortalities. The distribution of end population sizes for the unimpacted simulations are given in each.

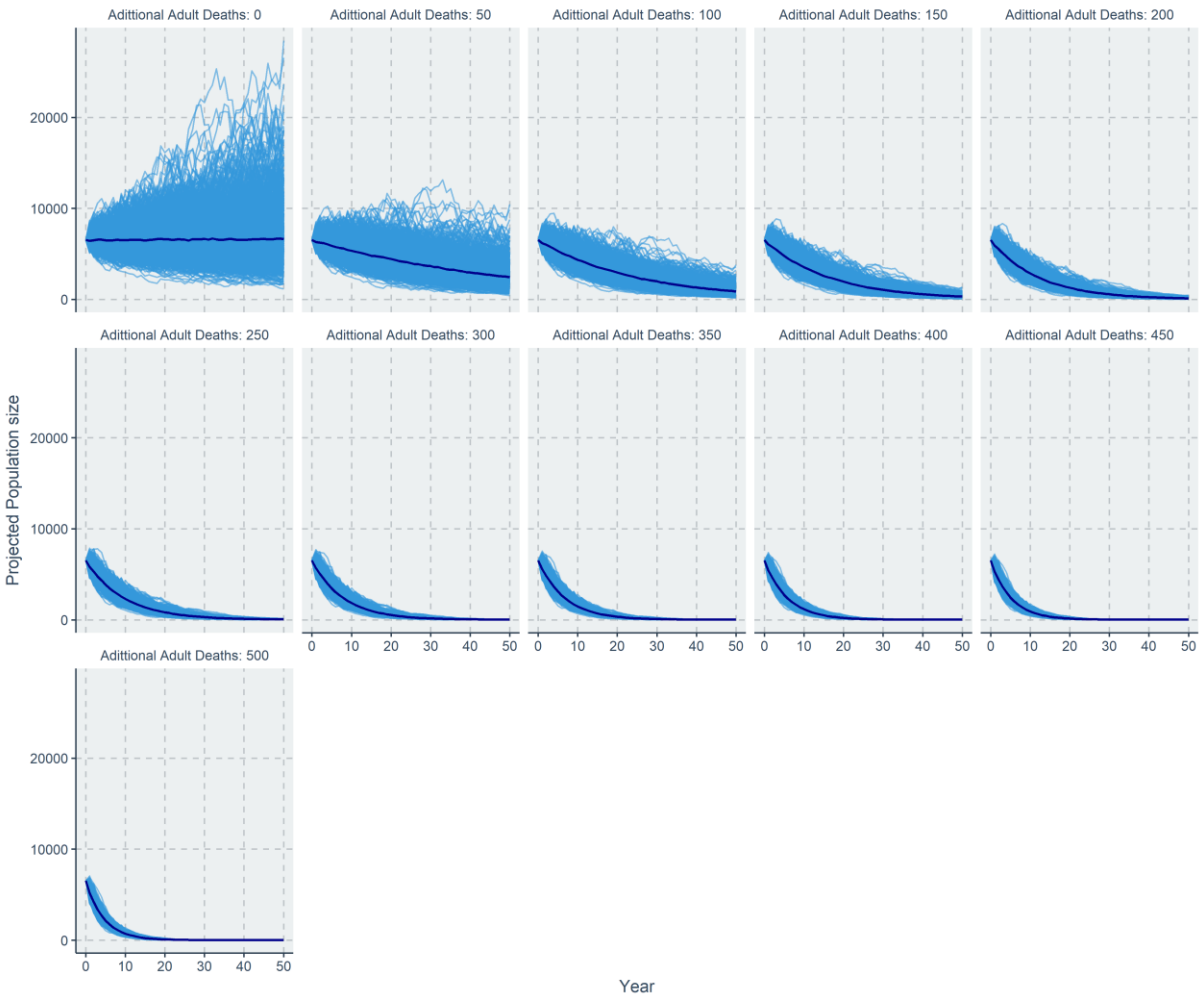

Figure 42: projections of population sizes over a 50-year time-frame. Each plot represents a different impact scenario in terms of additional adult mortalities (starting at 0 i.e. unimpacted). Individual blue lines are different realisations of the population trajectory, when population parameters are sampled from their distributions. The dark blue line is the median at each time point.

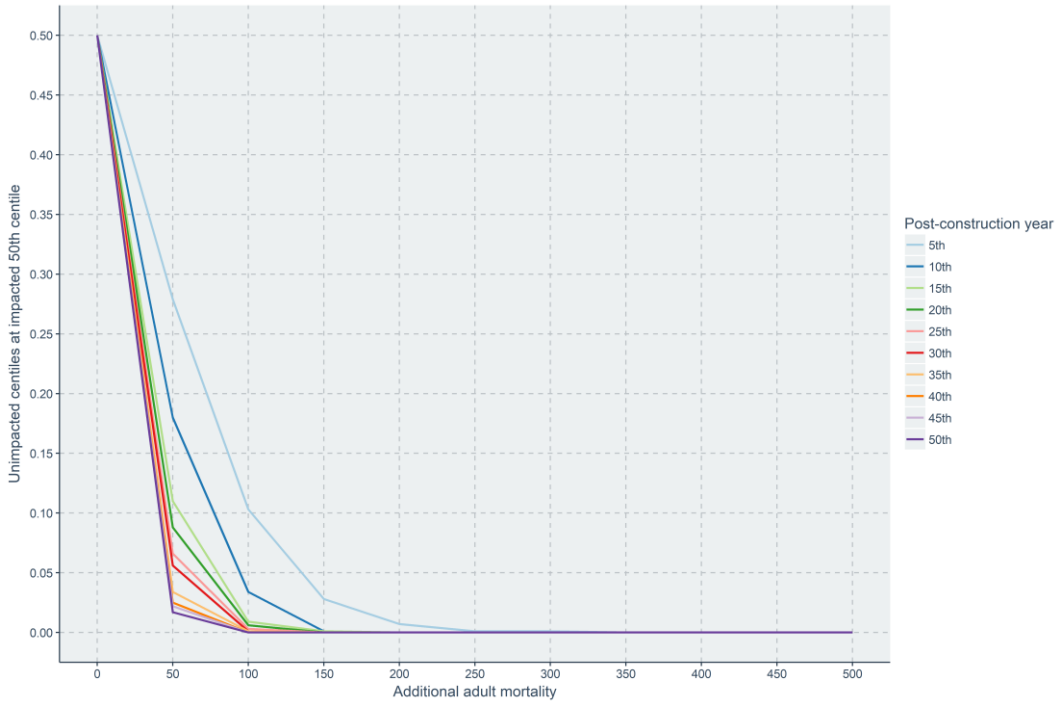

Figure 43: the median of the impacted population as a centile of the unimpacted population, under a range of impact scenarios (additional adult mortalities – x-axis). For example, 0.3 means the median (50th percentile) of the impacted projections sits at the 30th percentile of the unimpacted projections. Individual lines represent years post-construction (0-50 years).

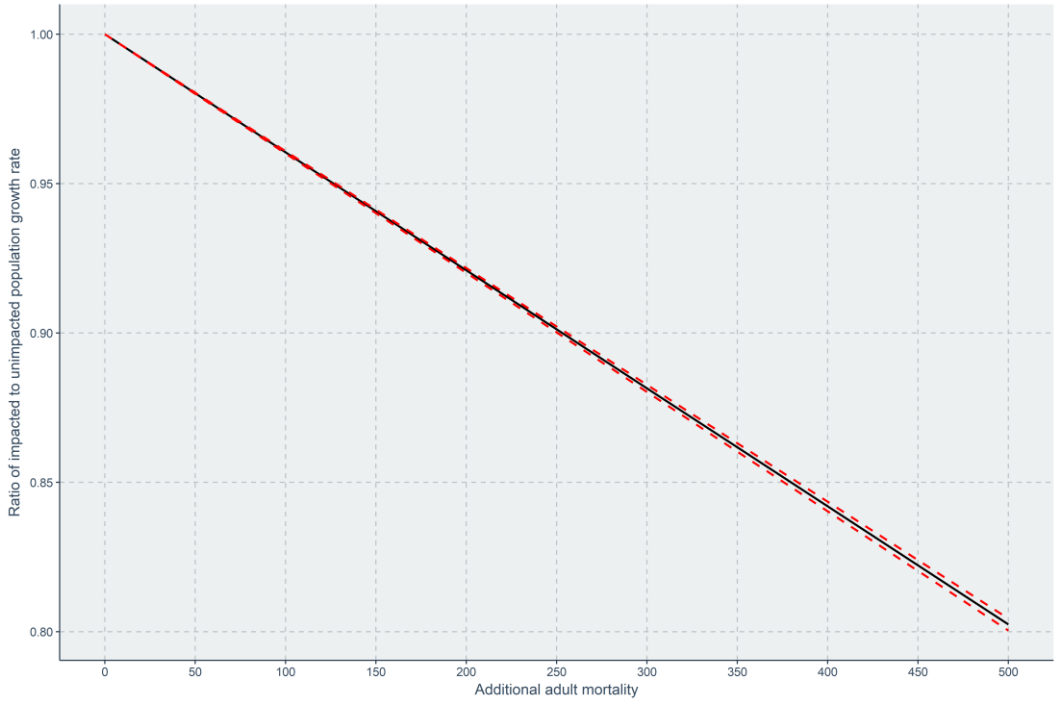

Figure 44: ratio of impacted and unimpacted growth rates under a range of impact scenarios (additional adult mortalities – x-axis) i.e. 0.9 means a 10% decrease in the growth rate under the impact scenario. Figures are based on paired simulations for the impacted and unimpacted populations i.e. based on the same sampled population parameters. The black line represents the 50th percentile (median), red lines give the central 95% of simulated values (2.5% and 97.5% reference points).

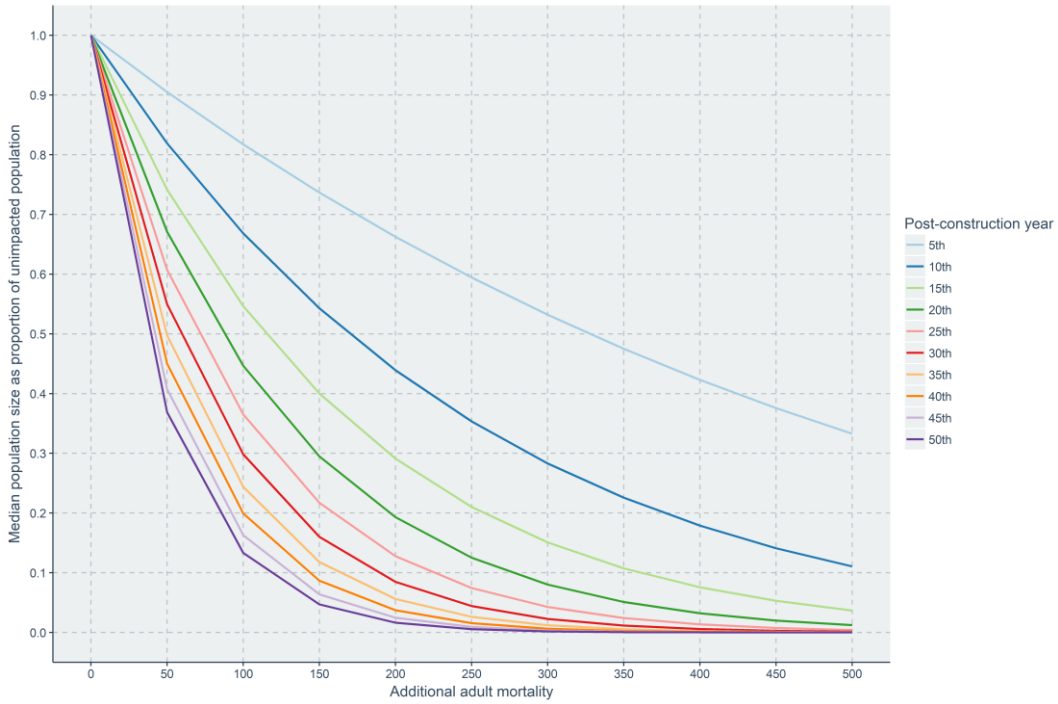

Figure 45: the ratio of the median impacted and median unimpacted population sizes from the simulations i.e. 0.5 means the median impacted population size is one-half the median unimpacted population size. Impact scenarios, in terms of additional adult mortalities, are given on the x-axis. Individual lines represent post-construction time points (projected 0 – 50 years).

Table 13: Growth rates of simulated populations under different impact scenarios. Reference points are 2.5%, 50% (median) and 97.5% of the distribution of simulated growth rates.

Additional adult mortalities	Median growth rates	2.5 percentile of simulated growth rates	97.5 percentile of simulated growth rates
0	1.000	0.981	1.019
50	0.980	0.961	0.999
100	0.961	0.942	0.979
150	0.941	0.923	0.959
200	0.921	0.903	0.939
250	0.901	0.884	0.919
300	0.882	0.864	0.899
350	0.862	0.845	0.879
400	0.842	0.825	0.859
450	0.822	0.806	0.839
500	0.802	0.786	0.819

4.10 Great Black-Backed Gull – East Caithness Cliffs

Due to almost immediate extinction of the population under impact, plots of the comparative distributions impacted/unimpacted are not presented.

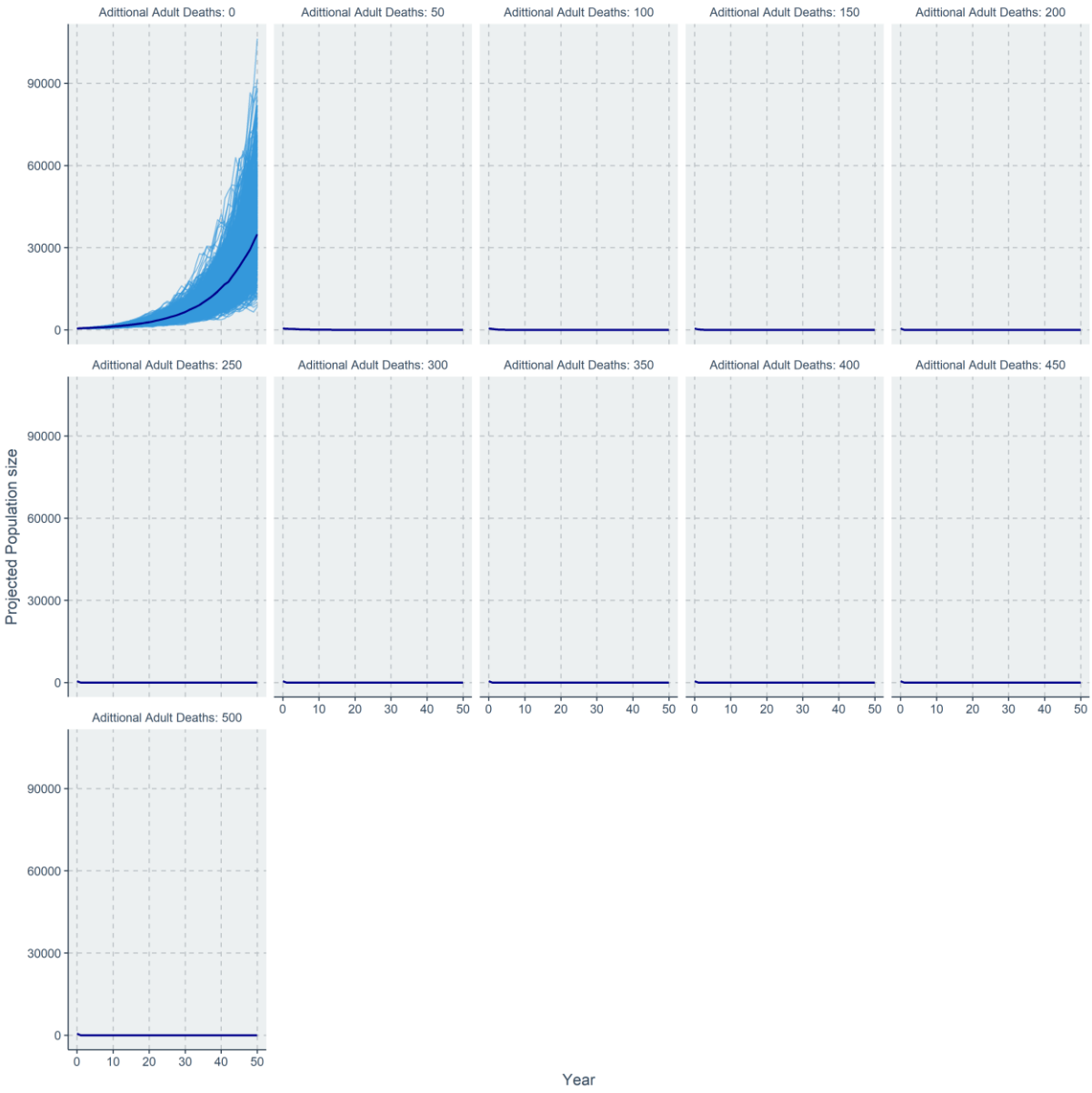

Figure 46: projections of population sizes over a 50-year time-frame. Each plot represents a different impact scenario in terms of additional adult mortalities (starting at 0 i.e. unimpacted). Individual blue lines are different realisations of the population trajectory, when population parameters are sampled from their distributions. The dark blue line is the median at each time point.

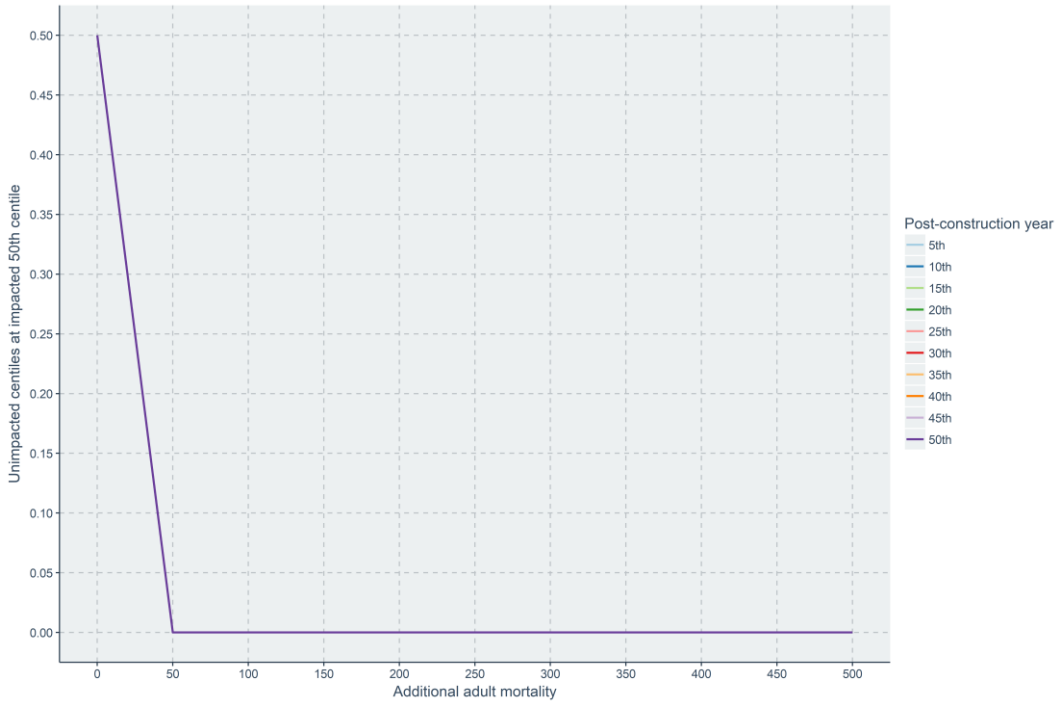

Figure 47: the median of the impacted population as a centile of the unimpacted population, under a range of impact scenarios (additional adult mortalities – x-axis). For example, 0.3 means the median (50th percentile) of the impacted projections sits at the 30th percentile of the unimpacted projections. Individual lines represent years post-construction (0-50 years).

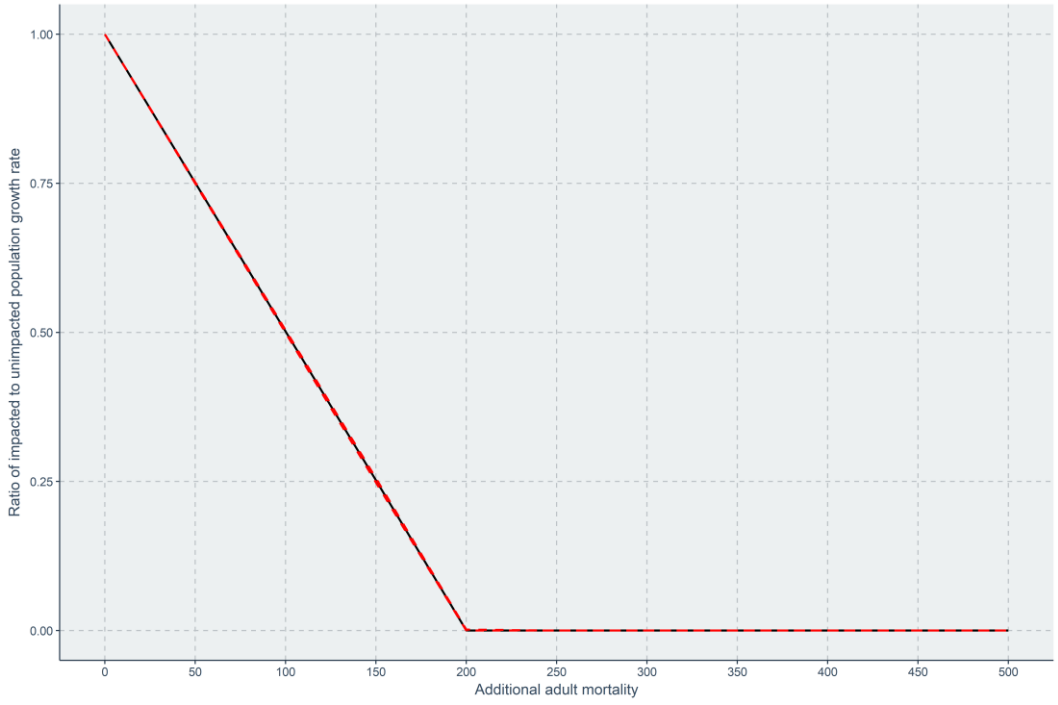

Figure 48: ratio of impacted and unimpacted growth rates under a range of impact scenarios (additional adult mortalities – x-axis) i.e. 0.9 means a 10% decrease in the growth rate under the impact scenario. Figures are based on paired simulations for the impacted and unimpacted populations i.e. based on the same sampled population parameters. The black line represents the 50th percentile (median), red lines give the central 95% of simulated values (2.5% and 97.5% reference points).

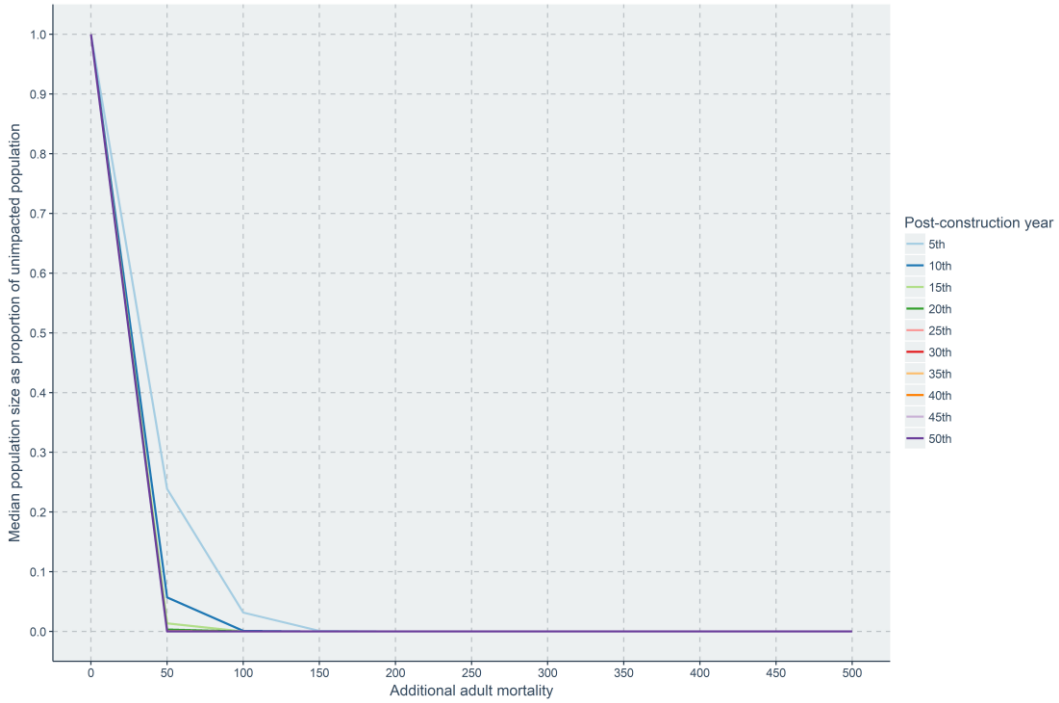

Figure 49: the ratio of the median impacted and median unimpacted population sizes from the simulations i.e. 0.5 means the median impacted population size is one-half the median unimpacted population size. Impact scenarios, in terms of additional adult mortalities, are given on the x-axis. Individual lines represent post-construction time points (projected 0 – 50 years).

Table 14: Growth rates of simulated populations under different impact scenarios. Reference points are 2.5%, 50% (median) and 97.5% of the distribution of simulated growth rates.

Additional adult mortalities	Median growth rates	2.5 percentile of simulated growth rates	97.5 percentile of simulated growth rates
0	1.087	1.068	1.105
50	0.816	0.802	0.830
100	0.545	0.535	0.555
150	0.274	0.267	0.280
200	0.000	0.000	0.002
250	0.000	0.000	0.000
300	0.000	0.000	0.000
350	0.000	0.000	0.000
400	0.000	0.000	0.000
450	0.000	0.000	0.000
500	0.000	0.000	0.000

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RIAA

Displacement Matrices

Moray Offshore Windfarm (West) Limited

Technical Appendix 4.6

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1 HRA Displacement Matrices

1.1 Buchan Ness to Collieston Coast SPA

1.1.1 Fulmar

The unapportioned mean-peak fulmar population estimate within the Moray West Site and 2 km buffer during the breeding season (April-August) is 581 birds. Displacement analysis for fulmar predicts a total unapportioned mortality of 1-2 birds in the breeding season based on a displacement rate range of 10-30% and a mortality rate of 1% (Table 1.1). If it is assumed that all of these birds are attributable to the Buchan Ness and Collieston Coast SPA population, this would represent 0.02-0.05% of the SPA breeding population (3,530 breeding adults) and would result in a 0.26-0.77% increase in background mortality (226 individuals).

Table 1.1: Predicted Fulmar Mortality as a Result of Displacement from Moray West and 2 km Buffer During the Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	1	3	6	12	17	23	29	35	41	46	52	58
20	1	2	6	12	23	35	46	58	70	81	93	105	116
30	2	3	9	17	35	52	70	87	105	122	139	157	174
40	2	5	12	23	46	70	93	116	139	163	186	209	232
50	3	6	15	29	58	87	116	145	174	203	232	261	290
60	3	7	17	35	70	105	139	174	209	244	279	314	348
70	4	8	20	41	81	122	163	203	244	285	325	366	406
80	5	9	23	46	93	139	186	232	279	325	372	418	465
90	5	10	26	52	105	157	209	261	314	366	418	470	523
100	6	12	29	58	116	174	232	290	348	406	465	523	581

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

The unapportioned mean-peak fulmar population estimate within the Moray West Site and 2 km buffer during the post-breeding season (September-October) is 68 birds. Displacement analysis for fulmar predicts a total unapportioned mortality of less than one bird in the post-breeding season based on a displacement rate range of 10-30% and a mortality rate of 1% (Table 1.2). If it is assumed that all of these birds are attributable to the Buchan Ness and Collieston Coast SPA population, this would represent a negligible proportion of the SPA breeding population (3,530 breeding adults) and would result in a negligible increase in background mortality (226 individuals).

Table 1.2: Predicted Fulmar Mortality as a Result of Displacement from Moray West and 2 km Buffer during the Post-Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	1	1	2	3	3	4	5	5	6	7
20	0	0	1	1	3	4	5	7	8	10	11	12	14
30	0	0	1	2	4	6	8	10	12	14	16	18	20
40	0	1	1	3	5	8	11	14	16	19	22	24	27
50	0	1	2	3	7	10	14	17	20	24	27	31	34
60	0	1	2	4	8	12	16	20	24	29	33	37	41
70	0	1	2	5	10	14	19	24	29	33	38	43	48
80	1	1	3	5	11	16	22	27	33	38	43	49	54
90	1	1	3	6	12	18	24	31	37	43	49	55	61
100	1	1	3	7	14	20	27	34	41	48	54	61	68

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

The unapportioned mean-peak fulmar population estimate within the Moray West Site and 2 km buffer during the non-breeding season (November) is 1,223 birds. Displacement analysis for fulmar predicts a total unapportioned mortality of 1-4 birds in the non-breeding season based on a displacement rate range of 10-30% and a mortality rate of 1% (Table 1.3). If it is assumed that all of these birds are attributable to the Buchan Ness and Collieston Coast SPA population, this would represent 0.03-0.10% of the SPA breeding population (3,530 breeding adults) and would result in a 0.54-1.62% increase in background mortality (226 individuals).

However, the displacement mortality attributable to the fulmar population of Buchan Ness to Collieston Coast SPA is likely to be considerably lower than that considered above. The fulmar population at Buchan Ness to Collieston Coast is the smallest of the four SPAs for which an LSE was identified during screening representing less than 5% of the total breeding adult population from these SPAs. In addition, Buchan Ness to Collieston Coast SPA is the furthest of these four SPAs from the Moray West Site. It is therefore considered that fulmars present at the Moray West Site are more likely to originate from the other three SPAs and that the impact on the Buchan Ness to Collieston Coast SPA would be much lower than predicted above.

Table 1.3: Predicted Fulmar Mortality as a Result of Displacement from Moray West and 2 km Buffer During the Non-Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	2	6	12	24	37	49	61	73	86	98	110	122
20	2	5	12	24	49	73	98	122	147	171	196	220	245
30	4	7	18	37	73	110	147	183	220	257	294	330	367
40	5	10	24	49	98	147	196	245	294	342	391	440	489

Table 1.3: Predicted Fulmar Mortality as a Result of Displacement from Moray West and 2 km Buffer During the Non-Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
50	6	12	31	61	122	183	245	306	367	428	489	550	612
60	7	15	37	73	147	220	294	367	440	514	587	660	734
70	9	17	43	86	171	257	342	428	514	599	685	771	856
80	10	20	49	98	196	294	391	489	587	685	783	881	978
90	11	22	55	110	220	330	440	550	660	771	881	991	1101
100	12	24	61	122	245	367	489	612	734	856	978	1101	1223

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

The unapportioned mean-peak fulmar population estimate within Moray West and 2 km buffer during the pre-breeding season (December-March) is 1,630 birds. Displacement analysis for fulmar predicts a total unapportioned mortality of 2-5 birds in the pre-breeding season based on a displacement rate range of 10-30% and a mortality rate of 1% (Table 1.4). If it is assumed that all of these birds are attributable to the Buchan Ness and Collieston Coast SPA population, this would represent 0.05-0.14% of the SPA breeding population (3,530 breeding adults) and would result in a 0.72-2.16% increase in background mortality (226 individuals).

As stated previously, the displacement mortality attributable to the fulmar population at Buchan Ness to Collieston Coast SPA is highly likely to be considerably less than considered above.

Table 1.4: Predicted Fulmar Mortality as a Result of Displacement from Moray West and 2 km Buffer During the Pre-Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	2	3	8	16	33	49	65	82	98	114	130	147	163
20	3	7	16	33	65	98	130	163	196	228	261	293	326
30	5	10	24	49	98	147	196	245	293	342	391	440	489
40	7	13	33	65	130	196	261	326	391	456	522	587	652
50	8	16	41	82	163	245	326	408	489	571	652	734	815
60	10	20	49	98	196	293	391	489	587	685	782	880	978
70	11	23	57	114	228	342	456	571	685	799	913	1027	1141
80	13	26	65	130	261	391	522	652	782	913	1043	1174	1304
90	15	29	73	147	293	440	587	734	880	1027	1174	1320	1467
100	16	33	82	163	326	489	652	815	978	1141	1304	1467	1630

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

1.1.2 Guillemot

It is assumed that displacement resulting from operational activities of Moray West represents the worst case scenario with respect to overall disturbance impacts on guillemot. Therefore, the analysis of disturbance during construction/decommissioning is treated equivalently to the assessment of displacement presented below.

Guillemot was considered to have a high vulnerability to displacement by Wade *et al.* (2016). A review of the appropriate displacement and mortality rates to apply for guillemot is presented in Section 6.3 of the RIAA Report. This review identified a displacement rate range of 50-60% for guillemot with a mortality rate of 1% to be applied based on guidance from SNH/Marine Scotland.

The mean-peak guillemot population estimate within Moray West and 2 km buffer during the breeding season (April-July) that can be apportioned to Buchan Ness to Collieston Coast SPA is 120 birds. Displacement analysis for guillemot predicts mortality of one bird in the breeding season based on a displacement rate range of 50-60% and a mortality rate of 1% (Table 1.5). Therefore birds lost to the population as a result of displacement represent less than 0.01% of the SPA breeding population (17,280 breeding adults) and would result in a 0.06-0.07% increase in background mortality (1,054 individuals).

Table 1.5: Predicted Guillemot Mortality from Buchan Ness to Collieston Coast SPA as a Result of Displacement from Moray West and 2 km Buffer during the Breeding Season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	1	1	2	4	5	6	7	8	10	11	12
20	0	0	1	2	5	7	10	12	14	17	19	22	24
30	0	1	2	4	7	11	14	18	22	25	29	32	36
40	0	1	2	5	10	14	19	24	29	34	38	43	48
50	1	1	3	6	12	18	24	30	36	42	48	54	60
60	1	1	4	7	14	22	29	36	43	50	58	65	72
70	1	2	4	8	17	25	34	42	50	59	67	76	84
80	1	2	5	10	19	29	38	48	58	67	77	86	96
90	1	2	5	11	22	32	43	54	65	76	86	97	108
100	1	2	6	12	24	36	48	60	72	84	96	108	120

	< 1% background mortality		> 1% background mortality/< 1% SPA population		> 1% SPA population

The mean-peak guillemot population estimate within Moray West and 2 km buffer during the post-breeding season (August-September) that can be apportioned to Buchan Ness to Collieston Coast SPA is 1,488 birds. Displacement analysis for guillemot predicts mortality of two to three birds in the breeding season based on a displacement rate range of 50-60% and a mortality rate of 1% (Table 1.6). Therefore birds lost to the population as a result of displacement represent 0.01-0.02% of the SPA breeding population (17,280 breeding adults) and would result in a 0.23-0.28% increase in background mortality (1,054 individuals).

Table 1.6: Predicted Guillemot Mortality from Buchan Ness to Collieston Coast SPA as a Result of Displacement from Moray West and 2 km Buffer During the Post- Breeding Season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	1	2	5	10	15	20	24	29	34	39	44	49
20	1	2	5	10	20	29	39	49	59	68	78	88	98
30	1	3	7	15	29	44	59	73	88	103	117	132	146
40	2	4	10	20	39	59	78	98	117	137	156	176	195
50	2	5	12	24	49	73	98	122	146	171	195	220	244
60	3	6	15	29	59	88	117	146	176	205	234	264	293
70	3	7	17	34	68	103	137	171	205	239	273	308	342
80	4	8	20	39	78	117	156	195	234	273	312	352	391
90	4	9	22	44	88	132	176	220	264	308	352	395	439
100	5	10	24	49	98	146	195	244	293	342	391	439	488

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

The mean-peak guillemot population estimate within the Moray West Site and 2 km buffer during the non-breeding season (October-March) that can be apportioned to Buchan Ness to Collieston Coast SPA is 105 birds. Displacement analysis for guillemot predicts mortality of seven to nine birds in the breeding season based on a displacement rate range of 50-60% and a mortality rate of 1% (Table 1.7). Therefore birds lost to the population as a result of displacement represent less than 0.01% of the SPA breeding population (17,280 breeding adults) and would result in a 0.05-0.06% increase in background mortality (1,054 individuals).

Table 1.7: Predicted Guillemot Mortality from Buchan Ness to Collieston Coast SPA as a Result of Displacement from Moray West and 2 km Buffer During the Non-Breeding Season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	1	1	2	3	4	5	6	7	8	9	11
20	0	0	1	2	4	6	8	11	13	15	17	19	21
30	0	1	2	3	6	9	13	16	19	22	25	28	32
40	0	1	2	4	8	13	17	21	25	29	34	38	42
50	1	1	3	5	11	16	21	26	32	37	42	47	53
60	1	1	3	6	13	19	25	32	38	44	50	57	63
70	1	1	4	7	15	22	29	37	44	51	59	66	74
80	1	2	4	8	17	25	34	42	50	59	67	76	84

Table 1.7: Predicted Guillemot Mortality from Buchan Ness to Collieston Coast SPA as a Result of Displacement from Moray West and 2 km Buffer During the Non-Breeding Season													
Displaced (%)	**Mortality rate (%)**												
	1	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
90	1	2	5	9	19	28	38	47	57	66	76	85	95
100	1	2	5	11	21	32	42	53	63	74	84	95	105
	< 1% background mortality				> 1% background mortality/< 1% SPA population						> 1% SPA population		

1.2 East Caithness Cliffs SPA

1.2.1 Fulmar

The unapportioned mean-peak fulmar population estimate within Moray West and 2 km buffer during the breeding season (April-August) is 581 birds. Displacement analysis for fulmar predicts a total unapportioned mortality of 1-2 birds in the breeding season based on a displacement rate range of 10-30% and a mortality rate of 1% (Table 1.8). If it is assumed that all of these birds are attributable to the East Caithness Cliffs SPA population, this would represent up to 0.01% of the SPA breeding population (30,000 breeding adults) and would result in a 0.03-0.09% increase in background mortality (1,920 individuals).

Table 1.8: Predicted Fulmar Mortality as a Result of Displacement from Moray West and 2 km Buffer During the Breeding Season													
Displaced (%)	**Mortality rate (%)**												
	1	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	1	1	3	6	12	17	23	29	35	41	46	52	58
20	1	2	6	12	23	35	46	58	70	81	93	105	116
30	2	3	9	17	35	52	70	87	105	122	139	157	174
40	2	5	12	23	46	70	93	116	139	163	186	209	232
50	3	6	15	29	58	87	116	145	174	203	232	261	290
60	3	7	17	35	70	105	139	174	209	244	279	314	348
70	4	8	20	41	81	122	163	203	244	285	325	366	406
80	5	9	23	46	93	139	186	232	279	325	372	418	465
90	5	10	26	52	105	157	209	261	314	366	418	470	523
100	6	12	29	58	116	174	232	290	348	406	465	523	581
	< 1% background mortality				> 1% background mortality/< 1% SPA population						> 1% SPA population		

The unapportioned mean-peak fulmar population estimate within the Moray West Site and 2 km buffer during the post-breeding season (September-October) is 68 birds. Displacement analysis for fulmar predicts a total unapportioned mortality of less than one bird in the post-breeding season based on a

displacement rate range of 10-30% and a mortality rate of 1% (Table 1.9). If it is assumed that all of these birds are attributable to the East Caithness Cliffs SPA, this would represent a negligible proportion of the SPA breeding population (30,000 breeding adults) and would result in a negligible increase in background mortality (1,920 individuals).

Table 1.9: Predicted Fulmar Mortality as a Result of Displacement from Moray West and 2 km Buffer During the Post-Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	1	1	2	3	3	4	5	5	6	7
20	0	0	1	1	3	4	5	7	8	10	11	12	14
30	0	0	1	2	4	6	8	10	12	14	16	18	20
40	0	1	1	3	5	8	11	14	16	19	22	24	27
50	0	1	2	3	7	10	14	17	20	24	27	31	34
60	0	1	2	4	8	12	16	20	24	29	33	37	41
70	0	1	2	5	10	14	19	24	29	33	38	43	48
80	1	1	3	5	11	16	22	27	33	38	43	49	54
90	1	1	3	6	12	18	24	31	37	43	49	55	61
100	1	1	3	7	14	20	27	34	41	48	54	61	68

	< 1% background mortality		> 1% background mortality/< 1% SPA population		> 1% SPA population

The unapportioned mean-peak fulmar population estimate within Moray West and 2 km buffer during the non-breeding season (November) is 1,223 birds. Displacement analysis for fulmar predicts a total unapportioned mortality of 1-4 birds in the non-breeding season based on a displacement rate range of 10-30% and a mortality rate of 1% (Table 1.10). If it is assumed that all of these birds are attributable to the East Caithness Cliffs SPA, this would represent up to 0.01% of the SPA breeding population (30,000 breeding adults) and would result in a 0.06-0.19% increase in background mortality (1,920 individuals).

Table 1.10: Predicted Fulmar Mortality as a Result of Displacement from Moray West and 2 km Buffer During the Non-Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	2	6	12	24	37	49	61	73	86	98	110	122
20	2	5	12	24	49	73	98	122	147	171	196	220	245
30	4	7	18	37	73	110	147	183	220	257	294	330	367
40	5	10	24	49	98	147	196	245	294	342	391	440	489
50	6	12	31	61	122	183	245	306	367	428	489	550	612
60	7	15	37	73	147	220	294	367	440	514	587	660	734
70	9	17	43	86	171	257	342	428	514	599	685	771	856

Table 1.10: Predicted Fulmar Mortality as a Result of Displacement from Moray West and 2 km Buffer During the Non-Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
80	10	20	49	98	196	294	391	489	587	685	783	881	978
90	11	22	55	110	220	330	440	550	660	771	881	991	1101
100	12	24	61	122	245	367	489	612	734	856	978	1101	1223

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

The unapportioned mean-peak fulmar population estimate within the Moray West Site and 2 km buffer during the pre-breeding season (December-March) is 1,630 birds. Displacement analysis for fulmar predicts a total unapportioned mortality of 2-5 birds in the pre-breeding season based on a displacement rate range of 10-30% and a mortality rate of 1% (Table 1.11). If it is assumed that all of these birds are attributable to the East Caithness Cliffs SPA, this would represent 0.01-0.02% of the SPA breeding population (30,000 breeding adults) and would result in a 0.08-0.25% increase in background mortality (1,920 individuals).

Table 1.11: Predicted Fulmar Mortality as a Result of Displacement from Moray West and 2 km Buffer During the Pre-Breeding Season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	2	3	8	16	33	49	65	82	98	114	130	147	163
20	3	7	16	33	65	98	130	163	196	228	261	293	326
30	5	10	24	49	98	147	196	245	293	342	391	440	489
40	7	13	33	65	130	196	261	326	391	456	522	587	652
50	8	16	41	82	163	245	326	408	489	571	652	734	815
60	10	20	49	98	196	293	391	489	587	685	782	880	978
70	11	23	57	114	228	342	456	571	685	799	913	1027	1141
80	13	26	65	130	261	391	522	652	782	913	1043	1174	1304
90	15	29	73	147	293	440	587	734	880	1027	1174	1320	1467
100	16	33	82	163	326	489	652	815	978	1141	1304	1467	1630

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

1.2.2 Kittiwake

The mean-peak kittiwake population estimate within the Moray West Site and 2 km buffer during the breeding season (April-August) that can be apportioned to East Caithness Cliffs SPA is 4,888 birds. Displacement analysis for kittiwake predicts mortality of 29 birds in the breeding season based on a displacement rate of 30% and a mortality rate of 2% (Table 1.12). Therefore birds lost to the population

as a result of displacement represent 0.05% of the SPA breeding population (65,000 breeding adults) and would result in a 0.31% increase in background mortality (9,490 individuals).

Table 1.12: Predicted Kittiwake Mortality from East Caithness Cliffs SPA as a Result of Displacement from Moray West and 2 km Buffer During the Breeding Season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	5	10	24	49	98	147	196	244	293	342	391	440	489
20	10	20	49	98	196	293	391	489	587	684	782	880	978
30	15	29	73	147	293	440	587	733	880	1026	1173	1320	1466
40	20	39	98	196	391	587	782	978	1173	1369	1564	1760	1955
50	24	49	122	244	489	733	978	1222	1466	1711	1955	2200	2444
60	29	59	147	293	587	880	1173	1466	1760	2053	2346	2639	2933
70	34	68	171	342	684	1026	1369	1711	2053	2395	2737	3079	3421
80	39	78	196	391	782	1173	1564	1955	2346	2737	3128	3519	3910
90	44	88	220	440	880	1320	1760	2200	2639	3079	3519	3959	4399
100	49	98	244	489	978	1466	1955	2444	2933	3421	3910	4399	4888

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

The mean-peak kittiwake population estimate within Moray West and 2 km buffer during the post-breeding season (September to December) that can be apportioned to East Caithness Cliffs SPA is 86 birds. Displacement analysis for kittiwake predicts mortality of one bird in the post-breeding season based on a displacement rate of 30% and a mortality rate of 2% (Table 1.13). Therefore birds lost to the population as a result of displacement represent less than 0.01% of the SPA breeding population (65,000 breeding adults) and would result in a 0.01% increase in background mortality (9,490 individuals).

Table 1.13: Predicted Kittiwake Mortality from East Caithness Cliffs SPA as a Result of Displacement from Moray West and 2 km Buffer During the Post-Breeding Season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	1	2	3	3	4	5	6	7	8	9
20	0	0	1	2	3	5	7	9	10	12	14	15	17
30	0	1	1	3	5	8	10	13	15	18	21	23	26
40	0	1	2	3	7	10	14	17	21	24	27	31	34
50	0	1	2	4	9	13	17	21	26	30	34	39	43
60	1	1	3	5	10	15	21	26	31	36	41	46	52
70	1	1	3	6	12	18	24	30	36	42	48	54	60
80	1	1	3	7	14	21	27	34	41	48	55	62	69
90	1	2	4	8	15	23	31	39	46	54	62	70	77

Table 1.13: Predicted Kittiwake Mortality from East Caithness Cliffs SPA as a Result of Displacement from Moray West and 2 km Buffer During the Post-Breeding Season													
Displaced (%)	**Mortality rate (%)**												
	1	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
100	1	2	4	9	17	26	34	43	52	60	69	77	86
	< 1% background mortality				> 1% background mortality/< 1% SPA population						> 1% SPA population		

The mean-peak kittiwake population estimate within Moray West and 2 km buffer during the pre-breeding season (September to December) that can be apportioned to East Caithness Cliffs SPA is 83 birds. Displacement analysis for kittiwake predicts mortality of less than one bird in the pre-breeding season based on a displacement rate of 30% and a mortality rate of 2% (Table 1.14**Error! Reference source not found.**). Therefore birds lost to the population as a result of displacement represent a negligible proportion of the SPA population and a negligible increase in background mortality of that population.

Table 1.14: Predicted kittiwake mortality from East Caithness Cliffs SPA as a result of displacement from Moray West and 2 km buffer during the pre-breeding season													
Displaced (%)	**Mortality rate (%)**												
	1	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	0	0	0	1	2	2	3	4	5	6	7	7	8
20	0	0	1	2	3	5	7	8	10	12	13	15	17
30	0	0	1	2	5	7	10	12	15	17	20	22	25
40	0	1	2	3	7	10	13	17	20	23	27	30	33
50	0	1	2	4	8	12	17	21	25	29	33	37	41
60	0	1	2	5	10	15	20	25	30	35	40	45	50
70	1	1	3	6	12	17	23	29	35	41	46	52	58
80	1	1	3	7	13	20	27	33	40	46	53	60	66
90	1	1	4	7	15	22	30	37	45	52	60	67	75
100	1	2	4	8	17	25	33	41	50	58	66	75	83
	< 1% background mortality				> 1% background mortality/< 1% SPA population						> 1% SPA population		

1.2.3 Guillemot

The mean-peak guillemot population estimate within the Moray West Site and 2 km buffer during the breeding season (April-July) that can be apportioned to East Caithness Cliffs SPA is 11,031 birds. Displacement analysis for guillemot predicts mortality of 55-66 birds in the breeding season based on a displacement rate range of 50-60% and a mortality rate of 1% (Table 1.15). Therefore birds lost to the population as a result of displacement represent 0.04-0.05% of the SPA breeding population (142,978 breeding adults) and would result in a 0.63-0.76% increase in background mortality (8,722 individuals).

Table 1.15: Predicted Guillemot Mortality from East Caithness Cliffs SPA as a Result of Displacement from Moray West and 2 km Buffer during the Breeding Season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	11	22	55	110	221	331	441	552	662	772	883	993	1103
20	22	44	110	221	441	662	883	1103	1324	1544	1765	1986	2206
30	33	66	165	331	662	993	1324	1655	1986	2317	2648	2979	3309
40	44	88	221	441	883	1324	1765	2206	2648	3089	3530	3971	4413
50	55	110	276	552	1103	1655	2206	2758	3309	3861	4413	4964	5516
60	66	132	331	662	1324	1986	2648	3309	3971	4633	5295	5957	6619
70	77	154	386	772	1544	2317	3089	3861	4633	5405	6178	6950	7722
80	88	177	441	883	1765	2648	3530	4413	5295	6178	7060	7943	8825
90	99	199	496	993	1986	2979	3971	4964	5957	6950	7943	8936	9928
100	110	221	552	1103	2206	3309	4413	5516	6619	7722	8825	9928	11031

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

If additional mortality of 50 birds per annum is assumed for PVA modelling (the closest modelled output to the predicted in-combination total) then the model predicts a reduction in growth rate of 0.07%. Under this scenario, the predicted median impacted population size after 35-50 years would be approximately 98-97% of that which the model predicts would occur in the in the absence of any additional in-combination impact.

East Caithness Cliffs SPA was designated based on the guillemot population estimated in 1985-88 (106,700 individuals). This population had increased to 158,985 individuals in 1999 but has since declined to 149,228 individuals in 2015. The current population at the SPA is therefore higher than the population at designation. If the predicted in-combination mortality were to occur across the lifetime of the Moray West Offshore Wind Farm the resulting end population is still likely to be higher than the population at designation.

The mean-peak guillemot population estimate within the Moray West Site and 2 km buffer during the post-breeding season (August-September) that can be apportioned to East Caithness Cliffs SPA is 3,519 birds. Displacement analysis for guillemot predicts mortality of 18-21 birds in the post-breeding season based on a displacement rate range of 50-60% and a mortality rate of 1% (Table 1.16). Therefore birds lost to the population as a result of displacement represent 0.01% of the SPA breeding population (142,978 breeding adults) and would result in a 0.20-0.24% increase in background mortality (8,722 individuals).

Table 1.16: Predicted Guillemot Mortality from East Caithness Cliffs SPA as a Result of Displacement from Moray West and 2 km Buffer During the Post- Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	4	7	18	35	70	106	141	176	211	246	282	317	352

Table 1.16: Predicted Guillemot Mortality from East Caithness Cliffs SPA as a Result of Displacement from Moray West and 2 km Buffer During the Post- Breeding Season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
20	7	14	35	70	141	211	282	352	422	493	563	633	704
30	11	21	53	106	211	317	422	528	633	739	845	950	1056
40	14	28	70	141	282	422	563	704	845	985	1126	1267	1408
50	18	35	88	176	352	528	704	880	1056	1232	1408	1584	1760
60	21	42	106	211	422	633	845	1056	1267	1478	1689	1900	2112
70	25	49	123	246	493	739	985	1232	1478	1724	1971	2217	2463
80	28	56	141	282	563	845	1126	1408	1689	1971	2252	2534	2815
90	32	63	158	317	633	950	1267	1584	1900	2217	2534	2851	3167
100	35	70	176	352	704	1056	1408	1760	2112	2463	2815	3167	3519

	< 1% background mortality		> 1% background mortality/< 1% SPA population		> 1% SPA population

The mean-peak guillemot population estimate within the Moray West Site and 2 km buffer during the non-breeding season (October-February) that can be apportioned to East Caithness Cliffs SPA is 758 birds. Displacement analysis for guillemot predicts mortality of 4-5 birds in the non-breeding season based on a displacement rate range of 50-60% and a mortality rate of 1% (Table 1.17). Therefore birds lost to the population as a result of displacement represent less than 0.01% of the SPA breeding population (142,978 breeding adults) and would result in a 0.04-0.05% increase in background mortality (8,722 individuals).

Table 1.17: Predicted guillemot mortality from East Caithness Cliffs SPA as a result of displacement from Moray West and 2 km buffer during the non- breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	2	4	8	15	23	30	38	45	53	61	68	76
20	2	3	8	15	30	45	61	76	91	106	121	136	152
30	2	5	11	23	45	68	91	114	136	159	182	205	227
40	3	6	15	30	61	91	121	152	182	212	242	273	303
50	4	8	19	38	76	114	152	189	227	265	303	341	379
60	5	9	23	45	91	136	182	227	273	318	364	409	455
70	5	11	27	53	106	159	212	265	318	371	424	477	530
80	6	12	30	61	121	182	242	303	364	424	485	545	606
90	7	14	34	68	136	205	273	341	409	477	545	614	682
100	8	15	38	76	152	227	303	379	455	530	606	682	758

	< 1% background mortality		> 1% background mortality/< 1% SPA population		> 1% SPA population

1.2.4 Razorbill

The mean-peak razorbill population estimate within the Moray West Site and 2 km buffer during the breeding season (April-July) that can be apportioned to East Caithness Cliffs SPA is 1,351 birds. Displacement analysis for razorbill predicts mortality of 5-8 birds in the breeding season based on a displacement rate range of 40-60% and a mortality rate of 1% (Table 1.18). Therefore birds lost to the population as a result of displacement represent 0.03-0.04% of the SPA breeding population (21,172 breeding adults) and would result in a 0.24-0.36% increase in background mortality (2,223 individuals).

Table 1.18: Predicted razorbill mortality from East Caithness Cliffs SPA as a result of displacement from Moray West and 2 km buffer during the breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	3	7	14	27	41	54	68	81	95	108	122	135
20	3	5	14	27	54	81	108	135	162	189	216	243	270
30	4	8	20	41	81	122	162	203	243	284	324	365	405
40	5	11	27	54	108	162	216	270	324	378	432	487	541
50	7	14	34	68	135	203	270	338	405	473	541	608	676
60	8	16	41	81	162	243	324	405	487	568	649	730	811
70	9	19	47	95	189	284	378	473	568	662	757	851	946
80	11	22	54	108	216	324	432	541	649	757	865	973	1081
90	12	24	61	122	243	365	487	608	730	851	973	1095	1216
100	14	27	68	135	270	405	541	676	811	946	1081	1216	1351

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

The mean-peak razorbill population estimate within Moray West and 2 km buffer during the post-breeding season (August-September) that can be apportioned to East Caithness Cliffs SPA is 150 birds. Displacement analysis for razorbill predicts mortality of one bird in the post-breeding season based on a displacement rate range of 40-60% and a mortality rate of 1% (Table 1.19). Therefore birds lost to the population as a result of displacement represent less than 0.01% of the SPA breeding population (21,172 breeding adults) and would result in a 0.03-0.04% increase in background mortality (2,223 individuals).

Table 1.19: Predicted razorbill mortality from East Caithness Cliffs SPA as a result of displacement from Moray West and 2 km buffer during the post-breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	1	1	3	4	6	7	9	10	12	13	15
20	0	1	1	3	6	9	12	15	18	21	24	27	30
30	0	1	2	4	9	13	18	22	27	31	36	40	45
40	1	1	3	6	12	18	24	30	36	42	48	54	60

Table 1.19: Predicted razorbill mortality from East Caithness Cliffs SPA as a result of displacement from Moray West and 2 km buffer during the post-breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
50	1	1	4	7	15	22	30	37	45	52	60	67	75
60	1	2	4	9	18	27	36	45	54	63	72	81	90
70	1	2	5	10	21	31	42	52	63	73	84	94	105
80	1	2	6	12	24	36	48	60	72	84	96	108	120
90	1	3	7	13	27	40	54	67	81	94	108	121	135
100	1	3	7	15	30	45	60	75	90	105	120	135	150

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

The mean-peak razorbill population estimate within Moray West and 2 km buffer during the non-breeding season (October-December) that can be apportioned to East Caithness Cliffs SPA is six birds. Displacement analysis for razorbill predicts mortality of less than one bird in the non-breeding season based on a displacement rate range of 40-60% and a mortality rate of 1% (Table 1.20). Therefore birds lost to the population as a result of displacement represent negligible proportion of the SPA breeding population (21,172 breeding adults) and a negligible increase in background mortality (2,223 individuals).

Table 1.20: Predicted razorbill mortality from East Caithness Cliffs SPA as a result of displacement from Moray West and 2 km buffer during the non-breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	0	0	0	0	0	0	1	1	1
20	0	0	0	0	0	0	1	1	1	1	1	1	1
30	0	0	0	0	0	1	1	1	1	1	2	2	2
40	0	0	0	0	1	1	1	1	2	2	2	2	3
50	0	0	0	0	1	1	1	2	2	2	3	3	3
60	0	0	0	0	1	1	2	2	2	3	3	3	4
70	0	0	0	0	1	1	2	2	3	3	4	4	4
80	0	0	0	1	1	2	2	3	3	4	4	5	5
90	0	0	0	1	1	2	2	3	3	4	5	5	6
100	0	0	0	1	1	2	3	3	4	4	5	6	6

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

The mean-peak razorbill population estimate within Moray West and 2 km buffer during the pre-breeding season (January-March) that can be apportioned to East Caithness Cliffs SPA is 151 birds. Displacement

analysis for razorbill predicts mortality of one bird in the pre-breeding season based on a displacement rate range of 40-60% and a mortality rate of 1% (Table 1.21). Therefore birds lost to the population as a result of displacement represent less than 0.01% of the SPA breeding population (21,172 breeding adults) and would result in a 0.02-0.04% increase in background mortality (2,223 individuals).

Table 1.21: Predicted razorbill mortality from East Caithness Cliffs SPA as a result of displacement from Moray West and 2 km buffer during the pre-breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	1	2	3	5	6	8	9	11	12	14	15
20	0	1	2	3	6	9	12	15	18	21	24	27	30
30	0	1	2	5	9	14	18	23	27	32	36	41	45
40	1	1	3	6	12	18	24	30	36	42	48	55	61
50	1	2	4	8	15	23	30	38	45	53	61	68	76
60	1	2	5	9	18	27	36	45	55	64	73	82	91
70	1	2	5	11	21	32	42	53	64	74	85	95	106
80	1	2	6	12	24	36	48	61	73	85	97	109	121
90	1	3	7	14	27	41	55	68	82	95	109	123	136
100	2	3	8	15	30	45	61	76	91	106	121	136	151

	< 1% background mortality		> 1% background mortality/< 1% SPA population		> 1% SPA population

1.3 North Caithness Cliffs SPA

1.3.1 Fulmar

The unapportioned mean-peak fulmar population estimate within the Moray West Site and 2 km buffer during the breeding season (April-August) is 581 birds. Displacement analysis for fulmar predicts a total unapportioned mortality of 1-2 birds in the breeding season based on a displacement rate range of 10-30% and a mortality rate of 1% (Table 1.22). If it is assumed that all of these birds are attributable to the North Caithness Cliffs SPA population, this would represent up to 0.01% of the SPA breeding population (29,400 breeding adults) and would result in a 0.03-0.09% increase in background mortality (1,882 individuals).

Table 1.22: Predicted fulmar mortality as a result of displacement from Moray West and 2 km buffer during the breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	1	3	6	12	17	23	29	35	41	46	52	58
20	1	2	6	12	23	35	46	58	70	81	93	105	116
30	2	3	9	17	35	52	70	87	105	122	139	157	174
40	2	5	12	23	46	70	93	116	139	163	186	209	232
50	3	6	15	29	58	87	116	145	174	203	232	261	290
60	3	7	17	35	70	105	139	174	209	244	279	314	348
70	4	8	20	41	81	122	163	203	244	285	325	366	406
80	5	9	23	46	93	139	186	232	279	325	372	418	465
90	5	10	26	52	105	157	209	261	314	366	418	470	523
100	6	12	29	58	116	174	232	290	348	406	465	523	581

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

The unapportioned mean-peak fulmar population estimate within the Moray West Site and 2 km buffer during the post-breeding season (September-October) is 68 birds. Displacement analysis for fulmar predicts a total unapportioned mortality of less than one bird in the post-breeding season based on a displacement rate range of 10-30% and a mortality rate of 1% (Table 1.23). If it is assumed that all of these birds are attributable to the North Caithness Cliffs SPA, this would represent a negligible proportion of the SPA breeding population (29,400 breeding adults) and would result in a negligible increase in background mortality (1,882 individuals).

Table 1.23: Predicted fulmar mortality as a result of displacement from Moray West and 2 km buffer during the post-breeding season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	1	1	2	3	3	4	5	5	6	7
20	0	0	1	1	3	4	5	7	8	10	11	12	14

Table 1.23: Predicted fulmar mortality as a result of displacement from Moray West and 2 km buffer during the post-breeding season

Displaced (%)	Mortality Rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
30	0	0	1	2	4	6	8	10	12	14	16	18	20
40	0	1	1	3	5	8	11	14	16	19	22	24	27
50	0	1	2	3	7	10	14	17	20	24	27	31	34
60	0	1	2	4	8	12	16	20	24	29	33	37	41
70	0	1	2	5	10	14	19	24	29	33	38	43	48
80	1	1	3	5	11	16	22	27	33	38	43	49	54
90	1	1	3	6	12	18	24	31	37	43	49	55	61
100	1	1	3	7	14	20	27	34	41	48	54	61	68

	< 1% background mortality		> 1% background mortality/< 1% SPA population		> 1% SPA population

The unapportioned mean-peak fulmar population estimate within the Moray West Site and 2 km buffer during the non-breeding season (November) is 1,223 birds. Displacement analysis for fulmar predicts a total unapportioned mortality of 1-4 birds in the non-breeding season based on a displacement rate range of 10-30% and a mortality rate of 1% (Table 1.24). If it is assumed that all of these birds are attributable to the East Caithness Cliffs SPA, this would represent up to 0.01% of the SPA breeding population (29,400 breeding adults) and would result in a 0.07-0.20% increase in background mortality (1,882 individuals).

Table 1.24: Predicted fulmar mortality as a result of displacement from Moray West and 2 km buffer during the non-breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	2	6	12	24	37	49	61	73	86	98	110	122
20	2	5	12	24	49	73	98	122	147	171	196	220	245
30	4	7	18	37	73	110	147	183	220	257	294	330	367
40	5	10	24	49	98	147	196	245	294	342	391	440	489
50	6	12	31	61	122	183	245	306	367	428	489	550	612
60	7	15	37	73	147	220	294	367	440	514	587	660	734
70	9	17	43	86	171	257	342	428	514	599	685	771	856
80	10	20	49	98	196	294	391	489	587	685	783	881	978
90	11	22	55	110	220	330	440	550	660	771	881	991	1101
100	12	24	61	122	245	367	489	612	734	856	978	1101	1223

	< 1% background mortality		> 1% background mortality/< 1% SPA population		> 1% SPA population

The unapportioned mean-peak fulmar population estimate within the Moray West Site and 2 km buffer during the pre-breeding season (December-March) is 1,630 birds. Displacement analysis for fulmar predicts a total unapportioned mortality of 2-5 birds in the pre-breeding season based on a displacement rate range of 10-30% and a mortality rate of 1% (Table 1.25). If it is assumed that all of these birds are attributable to the North Caithness Cliffs SPA, this would represent 0.02-0.06% of the SPA breeding population (29,400 breeding adults) and would result in a 0.09-0.26% increase in background mortality (1,882 individuals).

Table 1.25: Predicted fulmar mortality as a result of displacement from Moray West and 2 km buffer during the pre-breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	2	3	8	16	33	49	65	82	98	114	130	147	163
20	3	7	16	33	65	98	130	163	196	228	261	293	326
30	5	10	24	49	98	147	196	245	293	342	391	440	489
40	7	13	33	65	130	196	261	326	391	456	522	587	652
50	8	16	41	82	163	245	326	408	489	571	652	734	815
60	10	20	49	98	196	293	391	489	587	685	782	880	978
70	11	23	57	114	228	342	456	571	685	799	913	1027	1141
80	13	26	65	130	261	391	522	652	782	913	1043	1174	1304
90	15	29	73	147	293	440	587	734	880	1027	1174	1320	1467
100	16	33	82	163	326	489	652	815	978	1141	1304	1467	1630

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

1.3.2 Kittiwake

The mean-peak kittiwake population estimate within the Moray West Site and 2 km buffer during the breeding season (April-August) that can be apportioned to North Caithness Cliffs SPA is 372 birds. Displacement analysis for kittiwake predicts mortality of one bird in the breeding season based on a displacement rate of 30% and a mortality rate of 2% (Table 1.26). Therefore birds lost to the population as a result of displacement represent less than 0.01% of the SPA breeding population (26,200 breeding adults) and would result in a 0.03% increase in background mortality (3,825 individuals).

Table 1.26: Predicted kittiwake mortality from North Caithness Cliffs SPA as a result of displacement from Moray West and 2 km buffer during the breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	1	2	4	6	8	10	12	14	16	17	19
20	0	1	2	4	8	12	16	19	23	27	31	35	39
30	1	1	3	6	12	17	23	29	35	41	47	52	58
40	1	2	4	8	16	23	31	39	47	54	62	70	78

Table 1.26: Predicted kittiwake mortality from North Caithness Cliffs SPA as a result of displacement from Moray West and 2 km buffer during the breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
50	1	2	5	10	19	29	39	49	58	68	78	87	97
60	1	2	6	12	23	35	47	58	70	82	93	105	117
70	1	3	7	14	27	41	54	68	82	95	109	122	136
80	2	3	8	16	31	47	62	78	93	109	124	140	156
90	2	3	9	17	35	52	70	87	105	122	140	157	175
100	2	4	10	19	39	58	78	97	117	136	156	175	194

	< 1% background mortality		> 1% background mortality/< 1% SPA population		> 1% SPA population

The mean-peak kittiwake population estimate within the Moray West Site and 2 km buffer during the post-breeding season (September-December) that can be apportioned to North Caithness Cliffs SPA is 22 birds. Displacement analysis for kittiwake predicts mortality of less than one bird in the post-breeding season based on a displacement rate of 30% and a mortality rate of 2% (Table 1.27). Therefore birds lost to the population as a result of displacement represent a negligible proportion of the SPA breeding population (26,200 breeding adults) and would result in a negligible increase in background mortality (3,825 individuals).

Table 1.27: Predicted kittiwake mortality from North Caithness Cliffs SPA as a result of displacement from Moray West and 2 km buffer during the post-breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	0	1	1	1	1	2	2	2	2
20	0	0	0	0	1	1	2	2	3	3	3	4	4
30	0	0	0	1	1	2	3	3	4	5	5	6	6
40	0	0	0	1	2	3	3	4	5	6	7	8	9
50	0	0	1	1	2	3	4	5	6	8	9	10	11
60	0	0	1	1	3	4	5	6	8	9	10	12	13
70	0	0	1	2	3	5	6	8	9	11	12	14	15
80	0	0	1	2	3	5	7	9	10	12	14	16	17
90	0	0	1	2	4	6	8	10	12	14	16	17	19
100	0	0	1	2	4	6	9	11	13	15	17	19	22

	< 1% background mortality		> 1% background mortality/< 1% SPA population		> 1% SPA population

The mean-peak kittiwake population estimate within the Moray West Site and 2 km buffer during the pre-breeding season (January to March) that can be apportioned to North Caithness Cliffs SPA is 21 birds. Displacement analysis for kittiwake predicts mortality of less than one bird in the pre-breeding season based on a displacement rate of 30% and a mortality rate of 2% (Table 1.28). Therefore birds lost to the population as a result of displacement represent a negligible proportion of the SPA breeding population (26,200 breeding adults) and would result in a negligible increase in background mortality (3,825 individuals).

Table 1.28: Predicted kittiwake mortality from North Caithness Cliffs SPA as a result of displacement from Moray West and 2 km buffer during the pre-breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	0	1	1	1	1	1	2	2	2
20	0	0	0	0	1	1	2	2	2	3	3	4	4
30	0	0	0	1	1	2	2	3	4	4	5	6	6
40	0	0	0	1	2	2	3	4	5	6	7	7	8
50	0	0	1	1	2	3	4	5	6	7	8	9	10
60	0	0	1	1	2	4	5	6	7	9	10	11	12
70	0	0	1	1	3	4	6	7	9	10	12	13	15
80	0	0	1	2	3	5	7	8	10	12	13	15	17
90	0	0	1	2	4	6	7	9	11	13	15	17	19
100	0	0	1	2	4	6	8	10	12	15	17	19	21

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

1.3.3 Guillemot

The mean-peak guillemot population estimate within the Moray West Site and 2 km buffer during the breeding season (April-July) that can be apportioned to North Caithness Cliffs SPA is 691 birds. Displacement analysis for guillemot predicts mortality of 3-4 birds in the breeding season based on a displacement rate range of 50-60% and a mortality rate of 1% (Table 1.29). Therefore birds lost to the population as a result of displacement represents 0.01% of the SPA breeding population (51,322 breeding adults) and would result in a 0.11-0.13% increase in background mortality (3,131 individuals).

Table 1.29: Predicted guillemot mortality from North Caithness Cliffs SPA as a result of displacement from Moray West and 2 km buffer during the breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	1	3	7	14	21	28	35	41	48	55	62	69
20	1	3	7	14	28	41	55	69	83	97	111	124	138
30	2	4	10	21	41	62	83	104	124	145	166	187	207

Table 1.29: Predicted guillemot mortality from North Caithness Cliffs SPA as a result of displacement from Moray West and 2 km buffer during the breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
40	3	6	14	28	55	83	111	138	166	193	221	249	276
50	3	7	17	35	69	104	138	173	207	242	276	311	345
60	4	8	21	41	83	124	166	207	249	290	332	373	414
70	5	10	24	48	97	145	193	242	290	338	387	435	484
80	6	11	28	55	111	166	221	276	332	387	442	497	553
90	6	12	31	62	124	187	249	311	373	435	497	560	622
100	7	14	35	69	138	207	276	345	414	484	553	622	691

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

The mean-peak guillemot population estimate within the Moray West Site and 2 km buffer during the post-breeding season (August-September) that can be apportioned to North Caithness Cliffs SPA is 1,553 birds. Displacement analysis for guillemot predicts mortality of 8-9 birds in the post-breeding season based on a displacement rate range of 50-60% and a mortality rate of 1% (Table 1.30). Therefore birds lost to the population as a result of displacement represent 0.02% of the SPA breeding population (51,322 breeding adults) and would result in a 0.25-0.30% increase in background mortality (3,131 individuals).

Table 1.30: Predicted guillemot mortality from North Caithness Cliffs SPA as a result of displacement from Moray West and 2 km buffer during the post- breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	2	3	8	16	31	47	62	78	93	109	124	140	155
20	3	6	16	31	62	93	124	155	186	217	248	280	311
30	5	9	23	47	93	140	186	233	280	326	373	419	466
40	6	12	31	62	124	186	248	311	373	435	497	559	621
50	8	16	39	78	155	233	311	388	466	544	621	699	777
60	9	19	47	93	186	280	373	466	559	652	745	839	932
70	11	22	54	109	217	326	435	544	652	761	870	978	1087
80	12	25	62	124	248	373	497	621	745	870	994	1118	1242
90	14	28	70	140	280	419	559	699	839	978	1118	1258	1398
100	16	31	78	155	311	466	621	777	932	1087	1242	1398	1553

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

The mean-peak guillemot population estimate within the Moray West Site and 2 km buffer during the non-breeding season (October-March) that can be apportioned to North Caithness Cliffs SPA is 334 birds. Displacement analysis for guillemot predicts mortality of two birds in the non-breeding season based on a displacement rate range of 50-60% and a mortality rate of 1% (Table 1.31). Therefore birds lost to the population as a result of displacement represent less than 0.01% of the SPA breeding population (51,322 breeding adults) and would result in a 0.05-0.06% increase in background mortality (3,131 individuals).

Table 1.31: Predicted guillemot mortality from North Caithness Cliffs SPA as a result of displacement from Moray West and 2 km buffer during the non- breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	1	2	3	7	10	13	17	20	23	27	30	33
20	1	1	3	7	13	20	27	33	40	47	53	60	67
30	1	2	5	10	20	30	40	50	60	70	80	90	100
40	1	3	7	13	27	40	53	67	80	94	107	120	134
50	2	3	8	17	33	50	67	84	100	117	134	150	167
60	2	4	10	20	40	60	80	100	120	140	160	181	201
70	2	5	12	23	47	70	94	117	140	164	187	211	234
80	3	5	13	27	53	80	107	134	160	187	214	241	267
90	3	6	15	30	60	90	120	150	181	211	241	271	301
100	3	7	17	33	67	100	134	167	201	234	267	301	334

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

1.3.4 Razorbill

The mean-peak razorbill population estimate within the Moray West Site and 2 km buffer during the breeding season (April-July) that can be apportioned to North Caithness Cliffs SPA is 31 birds. Displacement analysis for razorbill predicts mortality of less than one bird in the breeding season based on a displacement rate range of 40-60% and a mortality rate of 1% (Table 1.32). Therefore birds lost to the population as a result of displacement represent a negligible proportion of the SPA breeding population (5,360 breeding adults) and would result in a negligible increase in background mortality (563 individuals).

Table 1.32: Predicted razorbill mortality from North Caithness Cliffs SPA as a result of displacement from Moray West and 2 km buffer during the breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	1	1	1	2	2	2	3	3	3
20	0	0	0	1	1	2	3	3	4	4	5	6	6
30	0	0	0	1	2	3	4	5	6	7	8	8	9

Table 1.32: Predicted razorbill mortality from North Caithness Cliffs SPA as a result of displacement from Moray West and 2 km buffer during the breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
40	0	0	1	1	3	4	5	6	8	9	10	11	13
50	0	0	1	2	3	5	6	8	9	11	13	14	16
60	0	0	1	2	4	6	8	9	11	13	15	17	19
70	0	0	1	2	4	7	9	11	13	15	18	20	22
80	0	1	1	3	5	8	10	13	15	18	20	23	25
90	0	1	1	3	6	8	11	14	17	20	23	25	28
100	0	1	2	3	6	9	13	16	19	22	25	28	31

	< 1% background mortality		> 1% background mortality/< 1% SPA population		> 1% SPA population

The mean-peak razorbill population estimate within the Moray West Site and 2 km buffer during the post-breeding season (August-September) that can be apportioned to North Caithness Cliffs SPA is 19 birds. Displacement analysis for razorbill predicts mortality of less than one bird in the post-breeding season based on a displacement rate range of 40-60% and a mortality rate of 1% (Table 1.33). Therefore birds lost to the population as a result of displacement represent a negligible proportion of the SPA breeding population (5,360 breeding adults) and would result in a negligible increase in background mortality (563 individuals).

Table 1.33: Predicted razorbill mortality from North Caithness Cliffs SPA as a result of displacement from Moray West and 2 km buffer during the post-breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	0	1	1	1	1	1	2	2	2
20	0	0	0	0	1	1	2	2	2	3	3	3	4
30	0	0	0	1	1	2	2	3	3	4	5	5	6
40	0	0	0	1	2	2	3	4	5	5	6	7	8
50	0	0	0	1	2	3	4	5	6	7	8	9	10
60	0	0	1	1	2	3	5	6	7	8	9	10	12
70	0	0	1	1	3	4	5	7	8	9	11	12	14
80	0	0	1	2	3	5	6	8	9	11	12	14	15
90	0	0	1	2	3	5	7	9	10	12	14	16	17
100	0	0	1	2	4	6	8	10	12	14	15	17	19

	< 1% background mortality		> 1% background mortality/< 1% SPA population		> 1% SPA population

The mean-peak razorbill population estimate within the Moray West Site and 2 km buffer during the non-breeding season (October-December) that can be apportioned to North Caithness Cliffs SPA is one bird. Displacement analysis for razorbill predicts mortality of less than one bird in the post-breeding season based on a displacement rate range of 40-60% and a mortality rate of 1% (Table 1.34). Therefore birds lost to the population as a result of displacement represent a negligible proportion of the SPA breeding population (5,360 breeding adults) and would result in a negligible increase in background mortality (563 individuals).

Table 1.34: Predicted razorbill mortality from North Caithness Cliffs SPA as a result of displacement from Moray West and 2 km buffer during the non-breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	0	0	1
70	0	0	0	0	0	0	0	0	0	0	0	1	1
80	0	0	0	0	0	0	0	0	0	0	1	1	1
90	0	0	0	0	0	0	0	0	0	1	1	1	1
100	0	0	0	0	0	0	0	0	1	1	1	1	1

	< 1% background mortality		> 1% background mortality/< 1% SPA population		> 1% SPA population

The mean-peak razorbill population estimate within the Moray West Site and 2 km buffer during the pre-breeding season (January-March) that can be apportioned to North Caithness Cliffs SPA is 20 birds. Displacement analysis for razorbill predicts mortality of less than one bird in the pre-breeding season based on a displacement rate range of 40-60% and a mortality rate of 1% (Table 1.35). Therefore birds lost to the population as a result of displacement represent a negligible proportion of the SPA breeding population (5,360 breeding adults) and would result in a negligible increase in background mortality (563 individuals).

Table 1.35: Predicted razorbill mortality from North Caithness Cliffs SPA as a result of displacement from Moray West and 2 km buffer during the pre-breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	0	1	1	1	1	1	2	2	2
20	0	0	0	0	1	1	2	2	2	3	3	4	4
30	0	0	0	1	1	2	2	3	4	4	5	5	6
40	0	0	0	1	2	2	3	4	5	5	6	7	8
50	0	0	0	1	2	3	4	5	6	7	8	9	10

Table 1.35: Predicted razorbill mortality from North Caithness Cliffs SPA as a result of displacement from Moray West and 2 km buffer during the pre-breeding season													
Displaced (%)	**Mortality rate (%)**												
	1	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
60	0	0	1	1	2	4	5	6	7	8	9	11	12
70	0	0	1	1	3	4	5	7	8	10	11	12	14
80	0	0	1	2	3	5	6	8	9	11	13	14	16
90	0	0	1	2	4	5	7	9	11	12	14	16	18
100	0	0	1	2	4	6	8	10	12	14	16	18	20
	< 1% background mortality				> 1% background mortality/< 1% SPA population						> 1% SPA population		

1.3.5 Puffin

The mean-peak puffin population estimate within the Moray West Site and 2 km buffer during the breeding season (April-July) that can be apportioned to North Caithness Cliffs SPA is 165 birds. Displacement analysis for puffin predicts mortality of two birds in the breeding season based on a displacement rate range of 50-60% and a mortality rate of 2% (Table 1.36**Error! Reference source not found.**). Therefore birds lost to the population as a result of displacement represents 0.05-0.06% of the SPA breeding population (3,500 breeding adults) and would result in a 0.5-0.6% increase in background mortality (329 individuals).

Table 1.36: Predicted puffin mortality from North Caithness Cliffs SPA as a result of displacement from Moray West and 2 km buffer during the breeding season													
Displaced (%)	**Mortality rate (%)**												
	1	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	0	0	1	2	3	5	7	8	10	12	13	15	16
20	0	1	2	3	7	10	13	16	20	23	26	30	33
30	0	1	2	5	10	15	20	25	30	35	40	44	49
40	1	1	3	7	13	20	26	33	40	46	53	59	66
50	1	2	4	8	16	25	33	41	49	58	66	74	82
60	1	2	5	10	20	30	40	49	59	69	79	89	99
70	1	2	6	12	23	35	46	58	69	81	92	104	115
80	1	3	7	13	26	40	53	66	79	92	105	119	132
90	1	3	7	15	30	44	59	74	89	104	119	133	148
100	2	3	8	16	33	49	66	82	99	115	132	148	165
	< 1% background mortality				> 1% background mortality/< 1% SPA population						> 1% SPA population		

The mean-peak puffin population estimate within Moray West and 2 km buffer during the post-breeding season (August-September) that can be apportioned to North Caithness Cliffs SPA is five birds. Displacement analysis for puffin predicts mortality of less than one bird in the post-breeding season based on a displacement rate range of 50-60% and a mortality rate of 2% (Table 1.37). Therefore birds lost to the population as a result of displacement a negligible proportion of the SPA breeding population (3,500 breeding adults) and would result in a negligible increase in background mortality (329 individuals).

Table 1.37: Predicted puffin mortality from North Caithness Cliffs SPA as a result of displacement from Moray West and 2 km buffer during the post- breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	0	0	0	0	0	0	0	0	1
20	0	0	0	0	0	0	0	1	1	1	1	1	1
30	0	0	0	0	0	0	1	1	1	1	1	1	2
40	0	0	0	0	0	1	1	1	1	1	2	2	2
50	0	0	0	0	1	1	1	1	2	2	2	2	3
60	0	0	0	0	1	1	1	2	2	2	2	3	3
70	0	0	0	0	1	1	1	2	2	2	3	3	4
80	0	0	0	0	1	1	2	2	2	3	3	4	4
90	0	0	0	0	1	1	2	2	3	3	4	4	5
100	0	0	0	1	1	2	2	3	3	4	4	5	5

	< 1% background mortality		> 1% background mortality/< 1% SPA population		> 1% SPA population

The mean-peak puffin population estimate within the Moray West Site and 2 km buffer during the non-breeding season (October-March) that can be apportioned to North Caithness Cliffs SPA is less than one bird. Displacement analysis for puffin predicts mortality of less than one bird in the non-breeding season based on a displacement rate range of 50-60% and a mortality rate of 2% (Table 1.38). Therefore birds lost to the population as a result of displacement a negligible proportion of the SPA breeding population (3,500 breeding adults) and would result in a negligible increase in background mortality (329 individuals).

Table 1.38: Predicted puffin mortality from North Caithness Cliffs SPA as a result of displacement from Moray West and 2 km buffer during the non- breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 1.38: Predicted puffin mortality from North Caithness Cliffs SPA as a result of displacement from Moray West and 2 km buffer during the non- breeding season													
Displaced (%)	**Mortality rate (%)**												
	1	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
70	0	0	0	0	0	0	0	0	0	0	0	0	0
80	0	0	0	0	0	0	0	0	0	0	0	0	0
90	0	0	0	0	0	0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0	0	0	0	0	0	0
	< 1% background mortality				> 1% background mortality/< 1% SPA population						> 1% SPA population		

1.4 Troup, Pennan and Lion's Head SPA

1.4.1 Fulmar

The unapportioned mean-peak fulmar population estimate within the Moray West Site and 2 km buffer during the breeding season (April-August) is 581 birds. Displacement analysis for fulmar predicts a total unapportioned mortality of 1-2 birds in the breeding season based on a displacement rate range of 10-30% and a mortality rate of 1% (Table 1.39). If it is assumed that all of these birds are attributable to Troup, Pennan and Lion's Heads SPA population, this would represent 0.01-0.02% of the SPA breeding population (8,800 breeding adults) and would result in a 0.10-0.31% increase in background mortality (563 individuals).

Table 1.39: Predicted fulmar mortality as a result of displacement from Moray West and 2 km buffer during the breeding season													
Displaced (%)	**Mortality rate (%)**												
	1	**2**	**5**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
10	1	1	3	6	12	17	23	29	35	41	46	52	58
20	1	2	6	12	23	35	46	58	70	81	93	105	116
30	2	3	9	17	35	52	70	87	105	122	139	157	174
40	2	5	12	23	46	70	93	116	139	163	186	209	232
50	3	6	15	29	58	87	116	145	174	203	232	261	290
60	3	7	17	35	70	105	139	174	209	244	279	314	348
70	4	8	20	41	81	122	163	203	244	285	325	366	406
80	5	9	23	46	93	139	186	232	279	325	372	418	465
90	5	10	26	52	105	157	209	261	314	366	418	470	523
100	6	12	29	58	116	174	232	290	348	406	465	523	581
	< 1% background mortality				> 1% background mortality/< 1% SPA population						> 1% SPA population		

The unapportioned mean-peak fulmar population estimate within Moray West and 2 km buffer during the post-breeding season (September-October) is 68 birds. Displacement analysis for fulmar predicts a total unapportioned mortality of less than one bird in the post-breeding season based on a displacement rate range of 10-30% and a mortality rate of 1% (Table 1.40). If it is assumed that all of these birds are attributable to Troup, Pennan and Lion's Heads SPA, this would represent a negligible proportion of the SPA breeding population (8,800 breeding adults) and would result in a negligible increase in background mortality (563 individuals).

Table 1.40: Predicted fulmar mortality as a result of displacement from Moray West and 2 km buffer during the post-breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	1	1	2	3	3	4	5	5	6	7
20	0	0	1	1	3	4	5	7	8	10	11	12	14
30	0	0	1	2	4	6	8	10	12	14	16	18	20
40	0	1	1	3	5	8	11	14	16	19	22	24	27
50	0	1	2	3	7	10	14	17	20	24	27	31	34
60	0	1	2	4	8	12	16	20	24	29	33	37	41
70	0	1	2	5	10	14	19	24	29	33	38	43	48
80	1	1	3	5	11	16	22	27	33	38	43	49	54
90	1	1	3	6	12	18	24	31	37	43	49	55	61
100	1	1	3	7	14	20	27	34	41	48	54	61	68

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

The unapportioned mean-peak fulmar population estimate within the Moray West Site and 2 km buffer during the non-breeding season (November) is 1,223 birds. Displacement analysis for fulmar predicts a total unapportioned mortality of 1-4 birds in the non-breeding season based on a displacement rate range of 10-30% and a mortality rate of 1% (Table 1.41). If it is assumed that all of these birds are attributable to the East Caithness Cliffs SPA, this would represent up to 0.01-0.04% of the SPA breeding population (8,800 breeding adults) and would result in a 0.22-0.65% increase in background mortality (563 individuals).

Table 1.41: Predicted fulmar mortality as a result of displacement from Moray West and 2 km buffer during the non-breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	2	6	12	24	37	49	61	73	86	98	110	122
20	2	5	12	24	49	73	98	122	147	171	196	220	245
30	4	7	18	37	73	110	147	183	220	257	294	330	367
40	5	10	24	49	98	147	196	245	294	342	391	440	489
50	6	12	31	61	122	183	245	306	367	428	489	550	612

Table 1.41: Predicted fulmar mortality as a result of displacement from Moray West and 2 km buffer during the non-breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
60	7	15	37	73	147	220	294	367	440	514	587	660	734
70	9	17	43	86	171	257	342	428	514	599	685	771	856
80	10	20	49	98	196	294	391	489	587	685	783	881	978
90	11	22	55	110	220	330	440	550	660	771	881	991	1101
100	12	24	61	122	245	367	489	612	734	856	978	1101	1223

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

The unapportioned mean-peak fulmar population estimate within the Moray West Site and 2 km buffer during the pre-breeding season (December-March) is 1,630 birds. Displacement analysis for fulmar predicts a total unapportioned mortality of 2-5 birds in the pre-breeding season based on a displacement rate range of 10-30% and a mortality rate of 1% (Table 1.42). If it is assumed that all of these birds are attributable to the North Caithness Cliffs SPA, this would represent 0.02-0.06% of the SPA breeding population (8,800 breeding adults) and would result in a 0.29-0.87% increase in background mortality (563 individuals).

Table 1.42: Predicted fulmar mortality as a result of displacement from Moray West and 2 km buffer during the pre-breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	2	3	8	16	33	49	65	82	98	114	130	147	163
20	3	7	16	33	65	98	130	163	196	228	261	293	326
30	5	10	24	49	98	147	196	245	293	342	391	440	489
40	7	13	33	65	130	196	261	326	391	456	522	587	652
50	8	16	41	82	163	245	326	408	489	571	652	734	815
60	10	20	49	98	196	293	391	489	587	685	782	880	978
70	11	23	57	114	228	342	456	571	685	799	913	1027	1141
80	13	26	65	130	261	391	522	652	782	913	1043	1174	1304
90	15	29	73	147	293	440	587	734	880	1027	1174	1320	1467
100	16	33	82	163	326	489	652	815	978	1141	1304	1467	1630

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

1.4.2 Kittiwake

The mean-peak kittiwake population estimate within the Moray West Site and 2 km buffer during the breeding season (April-August) that can be apportioned to Troup, Pennan and Lion's Heads SPA is 894 birds. Displacement analysis for kittiwake predicts mortality of three birds in the breeding season based on a displacement rate of 30% and a mortality rate of 2% (Table 1.43). Therefore birds lost to the population as a result of displacement represent less than 0.01% of the SPA breeding population (63,200 breeding adults) and would result in a 0.03% increase in background mortality (9,272 individuals).

Table 1.43: Predicted kittiwake mortality from Troup, Pennan and Lion's Heads SPA as a result of displacement from Moray West and 2 km buffer during the breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	1	2	5	9	14	19	23	28	33	37	42	47
20	1	2	5	9	19	28	37	47	56	65	75	84	93
30	1	3	7	14	28	42	56	70	84	98	112	126	140
40	2	4	9	19	37	56	75	93	112	131	149	168	187
50	2	5	12	23	47	70	93	117	140	163	187	210	233
60	3	6	14	28	56	84	112	140	168	196	224	252	280
70	3	7	16	33	65	98	131	163	196	229	261	294	327
80	4	7	19	37	75	112	149	187	224	261	299	336	373
90	4	8	21	42	84	126	168	210	252	294	336	378	420
100	5	9	23	47	93	140	187	233	280	327	373	420	467

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

The mean-peak kittiwake population estimate within Moray West and 2 km buffer during the post-breeding season (September-December) that can be apportioned to Troup, Pennan and Lion's Heads SPA is 32 birds. Displacement analysis for kittiwake predicts mortality of less than one bird in the breeding season based on a displacement rate of 30% and a mortality rate of 2% (Table 1.44). Therefore birds lost to the population as a result of displacement represent a negligible proportion of the SPA breeding population (63,200 breeding adults) and would result in a negligible increase in background mortality (9,272 individuals).

Table 1.44: Predicted kittiwake mortality from Troup, Pennan and Lion's Heads SPA as a result of displacement from Moray West and 2 km buffer during the post-breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	1	1	1	2	2	2	3	3	3
20	0	0	0	1	1	2	3	3	4	4	5	6	6
30	0	0	0	1	2	3	4	5	6	7	8	9	9
40	0	0	1	1	3	4	5	6	8	9	10	11	13

Table 1.44: Predicted kittiwake mortality from Troup, Pennan and Lion's Heads SPA as a result of displacement from Moray West and 2 km buffer during the post-breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
50	0	0	1	2	3	5	6	8	9	11	13	14	16
60	0	0	1	2	4	6	8	9	11	13	15	17	19
70	0	0	1	2	4	7	9	11	13	16	18	20	22
80	0	1	1	3	5	8	10	13	15	18	20	23	25
90	0	1	1	3	6	9	11	14	17	20	23	26	28
100	0	1	2	3	6	9	13	16	19	22	25	28	32

	< 1% background mortality		> 1% background mortality/< 1% SPA population		> 1% SPA population

The mean-peak kittiwake population estimate within the Moray West Site and 2 km buffer during the pre-breeding season (January-March) that can be apportioned to Troup, Pennan and Lion's Heads SPA is 31 birds. Displacement analysis for kittiwake predicts mortality of less than one bird in the breeding season based on a displacement rate of 30% and a mortality rate of 2% (Table 1.45). Therefore birds lost to the population as a result of displacement represent a negligible proportion of the SPA breeding population (63,200 breeding adults) and would result in a negligible increase in background mortality (9,272 individuals).

Table 1.45: Predicted kittiwake mortality from Troup, Pennan and Lion's Heads SPA as a result of displacement from Moray West and 2 km buffer during the pre-breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	1	1	1	2	2	2	2	3	3
20	0	0	0	1	1	2	2	3	4	4	5	6	6
30	0	0	0	1	2	3	4	5	6	6	7	8	9
40	0	0	1	1	2	4	5	6	7	9	10	11	12
50	0	0	1	2	3	5	6	8	9	11	12	14	15
60	0	0	1	2	4	6	7	9	11	13	15	17	18
70	0	0	1	2	4	6	9	11	13	15	17	19	21
80	0	0	1	2	5	7	10	12	15	17	20	22	24
90	0	1	1	3	6	8	11	14	17	19	22	25	28
100	0	1	2	3	6	9	12	15	18	21	24	28	31

	< 1% background mortality		> 1% background mortality/< 1% SPA population		> 1% SPA population

1.4.3 Guillemot

The mean-peak guillemot population estimate within the Moray West Site and 2 km buffer during the breeding season (April-July) that can be apportioned to Troup, Pennan and Lion's Heads SPA is 743 birds. Displacement analysis for guillemot predicts mortality of four birds in the breeding season based on a displacement rate range of 50-60% and a mortality rate of 1% (Table 1.46). Therefore birds lost to the population as a result of displacement represents 0.01% of the SPA breeding population (59,764 breeding adults) and would result in a 0.10-0.12% increase in background mortality (3,646 individuals).

Table 1.46: Predicted guillemot mortality from Troup, Pennan and Lion's Heads SPA as a result of displacement from Moray West and 2 km buffer during the breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	1	1	4	7	15	22	30	37	45	52	59	67	74
20	1	3	7	15	30	45	59	74	89	104	119	134	149
30	2	4	11	22	45	67	89	111	134	156	178	201	223
40	3	6	15	30	59	89	119	149	178	208	238	268	297
50	4	7	19	37	74	111	149	186	223	260	297	334	372
60	4	9	22	45	89	134	178	223	268	312	357	401	446
70	5	10	26	52	104	156	208	260	312	364	416	468	520
80	6	12	30	59	119	178	238	297	357	416	476	535	595
90	7	13	33	67	134	201	268	334	401	468	535	602	669
100	7	15	37	74	149	223	297	372	446	520	595	669	743

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

The mean-peak guillemot population estimate within the Moray West Site and 2 km buffer during the post-breeding season (August-September) that can be apportioned to Troup, Pennan and Lion's Heads SPA is 361 birds. Displacement analysis for guillemot predicts mortality of two birds in the post-breeding season based on a displacement rate range of 50-60% and a mortality rate of 1% (Table 1.47). Therefore birds lost to the population as a result of displacement represents less than 0.01% of the SPA breeding population (59,764 breeding adults) and would result in a 0.05-0.06% increase in background mortality (3,646 individuals).

Table 1.47: Predicted guillemot mortality from Troup, Pennan and Lion's Heads SPA as a result of displacement from Moray West and 2 km buffer during the post- breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	1	2	4	7	11	14	18	22	25	29	33	36
20	1	1	4	7	14	22	29	36	43	51	58	65	72
30	1	2	5	11	22	33	43	54	65	76	87	98	108
40	1	3	7	14	29	43	58	72	87	101	116	130	145

Table 1.47: Predicted guillemot mortality from Troup, Pennan and Lion's Heads SPA as a result of displacement from Moray West and 2 km buffer during the post- breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
50	2	4	9	18	36	54	72	90	108	127	145	163	181
60	2	4	11	22	43	65	87	108	130	152	173	195	217
70	3	5	13	25	51	76	101	127	152	177	202	228	253
80	3	6	14	29	58	87	116	145	173	202	231	260	289
90	3	7	16	33	65	98	130	163	195	228	260	293	325
100	4	7	18	36	72	108	145	181	217	253	289	325	361

	< 1% background mortality		> 1% background mortality/< 1% SPA population		> 1% SPA population

The mean-peak guillemot population estimate within the Moray West Site and 2 km buffer during the non-breeding season (October-March) that can be apportioned to Troup, Pennan and Lion's Heads SPA is 78 birds. Displacement analysis for guillemot predicts mortality of less than one bird in the breeding season based on a displacement rate range of 50-60% and a mortality rate of 1% (Table 1.48). Therefore birds lost to the population as a result of displacement represents a negligible proportion of the SPA breeding population (59,764 breeding adults) and would result in a negligible increase in background mortality (3,646 individuals).

Table 1.48: Predicted guillemot mortality from Troup, Pennan and Lion's Heads SPA as a result of displacement from Moray West and 2 km buffer during the non- breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	1	2	2	3	4	5	5	6	7	8
20	0	0	1	2	3	5	6	8	9	11	12	14	16
30	0	0	1	2	5	7	9	12	14	16	19	21	23
40	0	1	2	3	6	9	12	16	19	22	25	28	31
50	0	1	2	4	8	12	16	19	23	27	31	35	39
60	0	1	2	5	9	14	19	23	28	33	37	42	47
70	1	1	3	5	11	16	22	27	33	38	44	49	54
80	1	1	3	6	12	19	25	31	37	44	50	56	62
90	1	1	4	7	14	21	28	35	42	49	56	63	70
100	1	2	4	8	16	23	31	39	47	54	62	70	78

	< 1% background mortality		> 1% background mortality/< 1% SPA population		> 1% SPA population

1.4.4 Razorbill

The mean-peak razorbill population estimate within the Moray West Site and 2 km buffer during the breeding season (April-July) that can be apportioned to Troup, Pennan and Lion's Heads SPA is 86 birds. Displacement analysis for razorbill predicts mortality of up to one bird in the breeding season based on a displacement rate range of 40-60% and a mortality rate of 1% (Table 1.49). Therefore birds lost to the population as a result of displacement represent 0.01% of the SPA breeding population (6,432 breeding adults) and would result in a 0.05-0.08% increase in background mortality (675 individuals).

Table 1.49: Predicted razorbill mortality from Troup, Pennan and Lion's Heads SPA as a result of displacement from Moray West and 2 km buffer during the breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	1	2	3	3	4	5	6	7	8	9
20	0	0	1	2	3	5	7	9	10	12	14	15	17
30	0	1	1	3	5	8	10	13	15	18	21	23	26
40	0	1	2	3	7	10	14	17	21	24	28	31	34
50	0	1	2	4	9	13	17	22	26	30	34	39	43
60	1	1	3	5	10	15	21	26	31	36	41	46	52
70	1	1	3	6	12	18	24	30	36	42	48	54	60
80	1	1	3	7	14	21	28	34	41	48	55	62	69
90	1	2	4	8	15	23	31	39	46	54	62	70	77
100	1	2	4	9	17	26	34	43	52	60	69	77	86

	< 1% background mortality		> 1% background mortality/< 1% SPA population		> 1% SPA population

The mean-peak razorbill population estimate within the Moray West Site and 2 km buffer during the post-breeding season (August-September) that can be apportioned to Troup, Pennan and Lion's Heads SPA is 21 birds. Displacement analysis for razorbill predicts mortality of less than one bird in the post-breeding season based on a displacement rate range of 40-60% and a mortality rate of 1% (Table 1.50). Therefore birds lost to the population as a result of displacement represent less than 0.01% of the SPA breeding population (6,432 breeding adults) and would result in a 0.01-0.02% increase in background mortality (675 individuals).

Table 1.50: Predicted razorbill mortality from Troup, Pennan and Lion's Heads SPA as a result of displacement from Moray West and 2 km buffer during the post-breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	0	1	1	1	1	1	2	2	2
20	0	0	0	0	1	1	2	2	3	3	3	4	4
30	0	0	0	1	1	2	3	3	4	4	5	6	6
40	0	0	0	1	2	3	3	4	5	6	7	8	8

Table 1.50: Predicted razorbill mortality from Troup, Pennan and Lion's Heads SPA as a result of displacement from Moray West and 2 km buffer during the post-breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
50	0	0	1	1	2	3	4	5	6	7	8	9	10
60	0	0	1	1	3	4	5	6	8	9	10	11	13
70	0	0	1	1	3	4	6	7	9	10	12	13	15
80	0	0	1	2	3	5	7	8	10	12	13	15	17
90	0	0	1	2	4	6	8	9	11	13	15	17	19
100	0	0	1	2	4	6	8	10	13	15	17	19	21

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

The mean-peak razorbill population estimate within the Moray West Site and 2 km buffer during the non-breeding season (October-December) that can be apportioned to Troup, Pennan and Lion's Heads SPA is one bird. Displacement analysis for razorbill predicts mortality of less than one bird in the non-breeding season based on a displacement rate range of 40-60% and a mortality rate of 1% (1.51). Therefore birds lost to the population as a result of displacement represent a negligible proportion of the SPA breeding population (6,432 breeding adults) and would result in a negligible increase in background mortality (675 individuals).

Table 1.51: Predicted razorbill mortality from Troup, Pennan and Lion's Heads SPA as a result of displacement from Moray West and 2 km buffer during the non-breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	0	0	1
70	0	0	0	0	0	0	0	0	0	0	0	1	1
80	0	0	0	0	0	0	0	0	0	0	1	1	1
90	0	0	0	0	0	0	0	0	0	1	1	1	1
100	0	0	0	0	0	0	0	0	1	1	1	1	1

< 1% background mortality | > 1% background mortality/< 1% SPA population | > 1% SPA population

The mean-peak razorbill population estimate within the Moray West Site and 2 km buffer during the rebreeding season (January-March) that can be apportioned to Troup, Pennan and Lion's Heads SPA is 21 birds. Displacement analysis for razorbill predicts mortality of less than one bird in the non-breeding season based on a displacement rate range of 40-60% and a mortality rate of 1% (1.52). Therefore birds lost to the population as a result of displacement represent a negligible proportion of the SPA breeding population (6,432 breeding adults) and would result in a negligible increase in background mortality (675 individuals).

Table 1.52: Predicted razorbill mortality from Troup, Pennan and Lion's Heads SPA as a result of displacement from Moray West and 2 km buffer during the pre-breeding season

Displaced (%)	Mortality rate (%)												
	1	2	5	10	20	30	40	50	60	70	80	90	100
10	0	0	0	0	0	1	1	1	1	1	2	2	2
20	0	0	0	0	1	1	2	2	3	3	3	4	4
30	0	0	0	1	1	2	3	3	4	4	5	6	6
40	0	0	0	1	2	3	3	4	5	6	7	8	8
50	0	0	1	1	2	3	4	5	6	7	8	10	11
60	0	0	1	1	3	4	5	6	8	9	10	11	13
70	0	0	1	1	3	4	6	7	9	10	12	13	15
80	0	0	1	2	3	5	7	8	10	12	14	15	17
90	0	0	1	2	4	6	8	10	11	13	15	17	19
100	0	0	1	2	4	6	8	11	13	15	17	19	21

	< 1% background mortality		> 1% background mortality/< 1% SPA population		> 1% SPA population

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Influence of Flight Speed Parameters in Collision Risk Modelling (CRM)

Moray Offshore Windfarm (West) Limited

Appendix 4.7

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1 Introduction

1.1.1.1 This Technical Appendix presents a summary of collision risk modelling results carried out with flight speed data chosen as best available evidence for both the RIAA and EIA report compared against alternative data that has historically been applied to modelling.

1.1.1.2 The Appendix provides an overview of the apportioned collision impacts to each SPA for all species assessed as being at risk of collision effects.

1.2 Background

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

1.2.1.2 At present, flight speed data for use in CRM relies on published data (Pennycuick 1997; Alerstam *et al.,* 2007) based on very small sample sizes ranging from 32 (northern gannet) down to 2 (black-legged kittiwake). On the other hand, the laser rangefinder track data recorded by Skov *et al.* (2018) at Thanet Offshore Wind Farm, off the Kent coast, offer species-specific empirical data on flight speeds from large numbers of individuals (Table 1.1), albeit in non-adverse weather conditions (although tthis potential limitation is considered likely also to apply to Penncuick 1997 and Alerstam *et al.,* 2007).

1.2.1.1 As such, those data are a valuable source of information on more realistic mean flight speeds and associated variability in offshore wind farms necessary for improving estimates of the flux of birds for the species in question. While it may be suggested that a flight speed calculated from records of non-breeding kittiwake recorded in the North Sea off the Kent coast has the potential to not be representative of breeding birds in the Moray Firth, it is clear that the alternative data from Alerstam *et al*., (2007) is highly likely to be even less representative. The flight speed calculated in Alerstam *et al*. (2007) was calculated from a small sample size of birds observed in either southern Sweden or within the Arctic circle and no determination is given between migratory or foraging birds from colonies. Indeed, the large range of species included in Alerstam *et al*. (2007) suggests that significant non-breeding and/or migratory flights comprised a significant component of the data set.

1.2.1.2 Table 1.1 provides a comparison between the species-specific mean flight speeds often used in CRM and those recorded by Skov *et al.,* (2018). For the former, the total track time for the two radar recordings of kittiwake was 660 seconds. Furthermore, the flight speed data for all four gull species (kittiwake, lesser black-backed gull, great black-backed gull and herring gull) was restricted to radar recordings from migration flight which are expected to be birds flying at an airspeed close to that associated with maximum lift-drag ratio (Alerstam *et al.* 2007). This would imply that the very small sample sizes of flight speed data used at present in CRM are not necessarily behaviourally representative of bird flight at sea. Indeed the flight speeds recorded by Skov *et al. (*2018) were markedly lower than the generic speeds typically recommended in guidance (Alerstam *et al.,* 2007).

Table 1.1: Species-Specific Mean Flight Speeds (m/s) Often Used in CRM, and those Measured from Single Rangefinder Segments Recorded at Thanet (SD is shown in brackets)		
Species	**Flight Speed Commonly Used (no. of tracks)**	**Flight Speed Estimated by the Skov *et al.* (2018) Study**
Gannet	14.9* (n=32)	13.33 (4.24) [n=683]
Kittiwake	13.1** (n=2)	8.71 (3.16) [n= 287]
Lesser black-backed gull	13.1** (n=11)	9.80 (3.63)*** [n=790]
Great black-backed gull	13.7** (n=4)	
Herring gull	12.8** (n=18)	

* Pennycuick (1997)
**Alerstam *et al.* (2007)
***Estimated with data for all large gulls combined

1.2.1.3 Against this background, the flight speeds from Skov *et al.* (2018) are therefore the best available evidence to inform the collision risk assessment of Moray West as presented in EIA Report Volume 4 – Technical Appendix 10.2: Collision Risk Modelling and carried forward into the RIAA.

1.2.1.4 Nevertheless, collision risk estimates calculated using flight speeds from Alerstam *et al.* (2007) or Pennycuick (1987) are also presented in Volume 4 – Technical Appendix B of Appendix 10.2: Collision Risk Modelling. This additional Appendix to the RIAA brings this information together and summarises apportioned estimates to each SPA.

2 Collision Risk Results

2.1.1.1 The tables below provide collision risk modelling results at a variety of Band (2012) model options and avoidance rates. Results are provided for both Skov *et al.,* (2018) flight speeds as applied in the EIA Report and RIAA and those from Pennycuick (1987) or Alerstam *et al.* (2007).

2.2 Gannet

2.2.1.1 The annual collision risk estimates (Options 1, 2 and 3) calculated for gannet using Band (2012) are shown in Table 2.1.

Table 2.1: Annual collision risk estimates for gannet calculated using Options 1, 2 and 3 of the Band (2012) collision risk model.

Avoidance rate (%)	Collision risk estimates (no. of collisions/annum)	
	Best estimate: Skov *et al*. (2018	Best estimate: Pennycuick (1987)
Option 1		
98.7	85	91
98.9	72	77
99.1	59	63
Option 2		
98.7	15	16
98.9	12	13
99.1	10	11
Option 3		
98	6	7

2.3 Kittiwake

2.3.1.1 The annual collision risk estimates (Options 1, 2 and 3) calculated for kittiwake using Band (2012) are shown in Table 2.2.

Table 2.2: Annual collision risk estimates for kittiwake calculated using Options 1, 2 and 3 of the Band (2012) collision risk model.

Avoidance rate (%)	Collision risk estimates (no. of collisions/annum)	
	Best estimate: Skov *et al*. (2018	Best estimate: Alerstam *et al*., 2007)
Option 1		
98.7	211	279
98.9	179	236
99.1	146	193
99.2	130	172
99.5	81	107
Option 2		

Table 2.2: Annual collision risk estimates for kittiwake calculated using Options 1, 2 and 3 of the Band (2012) collision risk model.		
Avoidance rate (%)	**Collision risk estimates (no. of collisions/annum)**	
	Best estimate: Skov *et al*. (2018	**Best estimate: Alerstam *et al*., 2007)**
98.7	129	170
98.9	109	144
99.1	89	118
99.2	79	105
99.5	50	65
Option 3		
98	56	60

2.4 Herring Gull

2.4.1.1 The annual collision risk estimates (Options 1, 2 and 3) calculated for herring gull using Band (2012) are shown in Table 2.3.

Table 2.3: Annual collision risk estimates for herring gull calculated using Options 1, 2 and 3 of the Band (2012) collision risk model.		
Avoidance rate (%)	**Collision risk estimates (no. of collisions/annum)**	
	Best estimate: Skov *et al*. (2018	**Best estimate: Alerstam *et al*., 2007)**
Option 1		
99.4	44	52
99.5	36	43
99.6	29	34
Option 2		
99.4	15	18
99.5	13	15
99.6	10	12
Option 3		
98.8	13	14
99.0	11	12
99.2	9	9

2.5 Great Black-Backed Gull

2.5.1.1 The annual collision risk estimates (Options 1, 2 and 3) calculated for great black-backed gull using Band (2012) are shown in Table 2.4.

Table 2.4: Annual collision risk estimates for great black-backed gull calculated using Options 1, 2 and 3 of the Band (2012) collision risk model.

Avoidance rate (%)	Collision risk estimates (no. of collisions/annum)	
	Best estimate: Skov *et al*. (2018	**Best estimate: Alerstam *et al*., 2007)**
Option 1		
99.4	27	34
99.5	23	28
99.6	18	22
Option 2		
99.4	11	14
99.5	9	11
99.6	7	9
Option 3		
98.8	11	13
99.0	10	11
99.2	8	9

3 Apportioned Impacts to SPAs

3.1 Kittiwake

3.1.1.1 The seasonal collision risk estimates calculated for kittiwake using Band (2012) are shown in **Error! Reference source not found.** for each relevant SPA. The tables presents the annual unapportioned mortality and then resultant apportioned values (including sabbatical and age structure considerations) following the methodology outlined in Appendix 4.2. Values in parentheses refer to those calculated using flight speed data from Alerstam *et al*., (2007).

Table 3.1: Seasonal collision risk estimates for kittiwake apportioned to SPAs using best estimate and Skov *et al.,* (2018) flight speeds. Results using Alerstam et al., (2007) flight speeds in parentheses.

Project	Band Model	Annual Unapportioned Collision Mortality	Seasonal Collision Mortality Apportioned to SPA		
			Breeding	Post-Breeding	Pre-breeding
East Caithness Cliffs	Band (2012): Option 2 , 98.9% avoidance	109 (144)	56 (74)	1 (1)	1 (1)
North Caithness Cliffs	Band (2012): Option 2 , 98.9% avoidance	109 (144)	2 (3)	0 (0)	0 (0)
Troup, Pennan and Lion's Heads	Band (2012): Option 2 , 98.9% avoidance	109 (144)	5 (7)	1 (1)	0 (0)

3.2 Herring Gull

3.2.1.1 The seasonal collision risk estimates calculated for herring gull using Band (2012) are shown in Table 3.2 for each relevant SPA. The tables presents the annual unapportioned mortality and then resultant apportioned values (including sabbatical and age structure considerations) following the methodology outlined in Appendix 4.2.. Values in parentheses refer to those calculated using flight speed data from Alerstam *et al.,* (2007).

Table 3.2: Seasonal collision risk estimates for herring gull apportioned to SPAs using best estimate and Skov *et al.*, (2018) flight speeds. Results using Alerstam *et al.,* (2007) flight speeds in parentheses.

Project	Band Model	Annual Unapportioned Collision Mortality	Seasonal Collision Mortality Apportioned to SPA	
			Breeding	Non-Breeding
Buchan Ness to Collieston Coast	Band (2012): Option 2 , 99.5% avoidance	13 (15)	0 (0)	0 (0)
East Caithness Cliffs	Band (2012): Option 2 , 99.5% avoidance	13 (15)	4 (5)	0 (0)

Table 3.2: Seasonal collision risk estimates for herring gull apportioned to SPAs using best estimate and Skov *et al*., (2018) flight speeds. Results using Alerstam *et al.,* (2007) flight speeds in parentheses.

Project	Band Model	Annual Unapportioned Collision Mortality	Seasonal Collision Mortality Apportioned to SPA	
			Breeding	Non-Breeding
Troup, Pennan and Lion's Heads	Band (2012): Option 2 , 99.5% avoidance	13 (15)	0 (0)	0 (0)

4 Population Viability Analysis

4.1.1.1 Outputs of Population Viability Analysis (PVA) for the kittiwake qualifying feature of East Caithness Cliffs SPA are provided in Table 4.1. Predicted apportioned mortality from collision risk from Moray West Offshore Wind Farm is at 58 birds annually when applying Skov *et al.,* (2018) flight speed data. When applying Alerstam et al. (2007) flight speed data this increases to 76 birds.

4.1.1.2 The PVA undertaken for Moray West (as fully detailed in Appendix 4.5 of the RIAA) is presented at intervals of 50 bird mortalities. Therefore, Table 4.1 below presents outputs at 50 and 100 birds respectively, with the knowledge that the mortality predicted with Alerstam *et al.,* (2007) flight speed data would be approximately equidistant between the two values.

Table 4.1: PVA Outputs for Kittiwake at East Caithness Cliffs SPA Assuming a Mortality of 50 and 100 Birds (100 birds values given in prarentheses).

Impact Scenario	Years	% Change in Growth Rate	Ratio of Unimpacted to Impacted Growth Rate	Ratio of Unimpacted to Impacted Population Size	Centile for Impacted Population
Unimpacted	-	-	-	1	0.50
Impacted	35	-0.23 (-0.45)	0.998 (0.996)	0.93 (0.86)	0.43 (0.34)
	50			0.90 (0.80)	0.41 (0.30)

5 References

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